IMF Country Reports 22/272

Germany: Financial Sector Assessment Program-Technical Note-Stress Testing, Interconnectedness, and Risk Analysis

INTERNATIONAL MONETARY FUND

INTERNATIONAL MONETARY FUND

IMF Country Report No. 22/272

GERMANY

FINANCIAL SECTOR ASSESSMENT PROGRAM

August 2022

TECHNICAL NOTE—STRESS TESTING, INTERCONNECTEDNESS, AND RISK ANALYSIS

This Technical Note on Stress Testing, Interconnectedness, and Risk Analysis for the Germany FSAP was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed in April 2022.

Copies of this report are available to the public from

International Monetary Fund • Publication Services
PO Box 92780 • Washington, D.C. 20090
Telephone: (202) 623-7430 • Fax: (202) 623-7201
E-mail: publications@imf.org Web: http://www.imf.org
Price: $18.00 per printed copy

International Monetary Fund
Washington, D.C.

INTERNATIONAL MONETARY FUND

GERMANY

FINANCIAL SECTOR ASSESSMENT PROGRAM

August 4, 2022

TECHNICAL NOTE

STRESS TESTING, INTERCONNECTEDNESS AND 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 Germany. 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

CONTENTS

BOXES

FIGURES

TABLES

APPENDIX

Glossary

AC	Amortized Cost
AE	Advanced Economy
AFS	Available for Sale
APP	Asset Purchase Programme
BIS	Bank for International Settlements
CAPEX	Capital Expenditure
CBC	Counter Balancing Capacity
CET1	Common Equity Tier 1 Capital Ratio
COREP	Common Reporting Framework
CRE	Commercial Real Estate
CCyB	Countercyclical Capital Buffer
CVA	Credit Valuation Adjustments
DSTI	Debt Service to Total Income
EA	Euro Area
EAD	Exposure At Default
EBA	European Banking Authority
EBIT	Earnings Before Interest and Taxes
ECB	European Central Bank
ECL	Expected Credit Loss
EMDE	Emerging Markets and Developing Economies
EONIA	Euro Overnight Index Average
EU	European Union
FCI	Financial Condition Index
FINREP	Financial Reporting
FSAP	Financial System Assessment Program
FVOCI	Fair Value through Other Comprehensive Income
FVPL	Fair Value through Profit or Loss
FX	Foreign Currency
GAAP	Generally Accepted Accounting Standards
GAS	Global Assumptions
GDP	Gross Domestic Product
G-RAM	Global Risk Assessment Matrix
GFC	Global Financial Crisis
HFCS	Household Finance and Consumption Survey
HFT	Held for Trading
ICR	Interest Coverage Ratio
IFRS	International Financial Reporting Standards
IMF	International Monetary Fund
IRB	Internal Ratings-Based
IRRBB	Interest Rate Risk in the Banking Book
KfW	Kreditanstalt für Wiederaufbau

LATA	Liquid Assets to Total Assets
LCR	Liquidity Coverage Ratio
LGD	Loss Given Default
LSI	Less Significant Institutions
LTV	Loan-to-Value Ratio
MFI	Monetary Financial institutions
MLV	Mortgage Lending Value
NACE	Nomenclature of Economic Activities
NBFI	Non-Bank Financial Institution
NFC	Non-Financial Corporates
NII	Net Interest Income to interest bearing total assets
NPL	Nonperforming Loan
NSFR	Net Stable Funding Ratio
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
PD	Probability of Default
PEPP	Pandemic Emergency Purchase Program
PELTRO	Pandemic Emergency Long-Term Refinancing Operation
PiT	Point in Time
PSID	Panel Survey of Income Dynamics
P&L	Profit and Loss
RAM	Risk Assessment Matrix
RoA	Return on Assets
RoE	Return on Equity
RRE	Residential Real Estate
RWA	Risk-Weighted Assets
STD	Short-Term Debt
SME	Small and Medium-sized Enterprise
SI	Significant Institutions
SSM	Single Supervisory Mechanism
STA	Standardized Approach
STD	Short-Term Debt
STE	Short-Term Exercise
STeM	Stress Testing Matrix
SSyRB	Sectoral Systemic Risk Buffer
TD	Total Debt
TLTRO	Targeted Long-Term Refinancing Operation
TTC	Through The Cycle
TLTRO	Targeted Longer-Term Refinancing Operations
TR	Transition Rate
UB	Unemployment Benefits
WEO	World Economic Outlook

EXECUTIVE SUMMARY[1]

The financial sector weathered COVID relatively well on the back of high pre-crisis capital and liquidity buffers, strong public and private sector balance sheets, and unprecedented public and ECB support. Immediate risks to Germany's financial stability of Russia's invasion of Ukraine appear to be manageable due to the banks' limited direct exposures to Russia. However, risks associated with the economic fallout could impact some individual financial institutions, non-performing loans, and house prices. Real GDP growth was projected to regain momentum from mid-2022 onwards, but the war could hinder the recovery through supply constraints, higher-than-expected above-target inflation (with higher energy prices and supply constraints), a tightening of financial conditions, and shifts in investors' confidence.

The two structural vulnerabilities identified in the 2016 FSAP, namely low bank profitability and misalignments in the real estate sector prices, have become more prominent and represent potential risk amplifying channels. The FSAP's residential and commercial property analyses shows higher tail risks since the onset of the pandemic and pockets of vulnerabilities, particularly in larger cities. The FSAP welcomes progress toward closing residential real estate data gaps to support risk monitoring and calibration of macroprudential tools. Also, the FSAP states that limited non-interest revenues, cost factors, and competition will continue to hinder German banks' performance. Interest rate increases will raise profits, albeit with some delay. At the same time, during the pandemic nonperforming loans remained low, and the significant drop in enterprises' sales was cushioned by timely official support measures and corporates' operational adjustments that limited the rise in debt at risk.

The FSAP solvency and liquidity stress tests show that the German significant institutions (SIs) and less significant institutions (LSIs) are resilient under the baseline and adverse scenarios. The main risks to financial stability relate to a global resurgence of COVID-19 cases with extended supply chain disruptions and de-anchoring of inflation expectations in the U.S. and advanced Europe with a scarcity of gas and oil. For SIs, under the V-shaped adverse scenario with conservative assumptions regarding interest rate pass-through, the aggregate capital shortfall remains small (0.3 percent of GDP), with three SIs out of fifteen in the sample falling below the hurdle rate assuming a binding CCyB in 2023-24 but with capitalization of all banks above the minimum CET1 ratio.[2] With very high overall capitalization, under the V-shaped adverse stress test scenario, LSIs' aggregate capital remains very high; only 21 very small banks (with up to 3 percent of total LSIs assets) fall below the hurdle rate. Also, the banking system appears generally resilient to liquidity stress. Under the liquidity severe adverse scenario, selected banks' U.S. dollar exposures could pose a risk and

[1] This technical note was prepared by Gerard Almekinders, Dan Cheng, Alla Myrvoda, Marco Pani, Thierry Tressel, and Sebastian Weber.

[2] The analysis is performed under the conservative assumption that shocks to policy rates are fully passed through to funding costs of banks, and the speed of pass-through is consistent with the supervisory data reporting in the "Interest Rate in the Banking Book" template of the ECB. The FSAP net interest income satellite model implies that pass-through from deposit rates to lending rates is smaller than one. These assumptions result in conservative estimates of the IRRBB.

require access to the central bank swap line. The FSAP recommends the need to: (i) continue closely monitor banks' prudential ratios, in particular large SI commercial banks, and establish microprudential buffers (Pillar 2 guidance) for less capitalized banks as needed; (ii) strengthen LSIs interest rate risk monitoring, including by gathering data on the remaining maturity of retail deposits, wholesale funding, and interest-bearing assets to perform top-down stress tests of interest rate risks. The FSAP also recommends that data sharing between the Bundesbank and the ECB is strengthened.

The interconnectedness and contagion analysis shows that the interbank contagion risks flow from SIs to LSIs and from LSIs as a group to SIs. Germany's interbank system is strongly interconnected, and a relatively small number of banks account for a large share of interconnections. Germany's financial system is highly interconnected across borders through financial claims and liabilities. The interbank market appears segmented among SIs, and among LSIs. Risks of domestic interbank contagion flow mostly from SIs to LSIs and from LSIs as a group to SIs, and a few large banks account for most of the contagion risks. The FSAP recommends that risk monitoring and the analysis of domestic and cross-border interconnectedness continue to be strengthened, with a focus on key domestic interbank market institutions and other markets where exposures are located, as needed.

The non-financial corporate sector (NFC) appears broadly resilient to shocks. The pandemic caused a large shock to enterprises' sales. A sensitivity analysis illustrates the critical importance of the authorities' and firms' responses to cushion the impact of the pandemic on NFCs' balance sheets. In the baseline scenario, enterprises' capacity to service their debts, measured by the interest coverage ratio (ICR), improves over time and both the share of debt in firms with an ICR<1 and the share of debt in firms with cash<0 falls over time. In the adverse scenario, the significant contraction of economic activity in 2023 causes the share of debt in firms with an ICR<1 to rise again. The share of debt in firms with cash<0 remains more elevated than in the baseline and the probability of default rises in 2023, albeit from a low base and remains relatively low in absolute terms.

Tail risks in real estate have increased since the onset of the pandemic, particularly in the CRE market. High RRE valuations suggest price misalignments in the residential sector, with pockets of vulnerabilities in larger cities. Standard indicators of overvaluation suggest a 21-37 percent deviation from long-run averages as of end-2021, and an econometric model at the country-level that takes account or real interest rates suggests RRE overvaluation of about 10-15 percent as of 2021Q3. The analysis suggests potential pockets of vulnerabilities in bank exposures to real estate.

BACKGROUND: VULNERABILITY AND RISKS

A. Introduction

1. Growth in Germany has been resilient amidst comfortable buffers. GDP contracted by 4.6 percent in 2020, less than in most other European peers, thanks to substantial fiscal support and accommodative financing conditions. Public and private sector balance sheets were strong entering into the crisis – with public debt below 60 percent of GDP, non-financial corporate (NFC) debt lower than in European peers, household debt gradually declining, and banking sector capital and liquidity buffers comfortable—providing buffers to absorb shocks

2. The banking system withstood the COVID-shock. Since the start of the pandemic the German banking sector expanded further its assets, financed mainly by wholesale funding, amid substantial fiscal and monetary support for the economy. Between December 2019 and December 2021, total assets of German banks increased by 10.5 percent (€0.9 trillion, equivalent to 24 percent of annual GDP); about two-thirds of this increase (€560 billion) was funded by interbank liabilities, including toward the ECB; customer deposits also increased, by a lesser extent (€365 billion). Bank lending rose 5.4 percent in real terms. Over half of the increase in loans was driven by savings and cooperative banks, and a significant share of the credit went to housing mortgages (7.1 percent y-o-y to September 2021). In 2022, financial conditions started tightening, with 10-year Bund yields rising 100 basis points.

3. However, the sizable costs associated with Russia's invasion of Ukraine are expected to delay the recovery further. Supply bottlenecks and renewed COVID outbreaks hampered the recovery from the pandemic, with GDP growing by 2.8 percent in 2021 (Figure 1, Table 4). Before Russia's large-scale invasion of Ukraine on February 24 growth was projected to pick up in 2022 as supply disruptions were gradually dissipating, private consumption rebounding, and production caught up with historically high unfilled orders. At the time the analysis was concluded, the gross impact of the Russia-Ukraine war is estimated in the WEO baseline at 2.5 percent of GDP in 2022 (about 0.5 percent to be offset by fiscal relief measures). The invasion is expected to sizably impact the German economy via inflation, potential energy shortages and confidence effects holding back consumption, investment and exports. The surge in energy and food prices is likely to translate into inflation of around [5.5] percent on average for 2022. Germany's industrial base is highly dependent on fossil fuel imports, and Russia is Germany's larger trading partner in natural gas.[3] Rationing of energy imports and high economic uncertainty from the ongoing war and sanctions could further hit Germany's real growth prospects for 2022 and the medium-term through real sector channels. To support the recovery, the authorities further extended some key COVID-related fiscal to June

[3] According to Eurostat, 50-75 percent of Germany's gas natural imports came from Russia in 2021 Q1.

2022 (Figure 2),[4] introduced measures to help households and firms cope with higher energy costs, and stepped-up efforts to secure energy supplies.

B. Financial System Landscape

4. The banking sector's structure is large and complex. The banking sector is comprised of more than 1400 entities, including local subsidiaries and branches of foreign banks. As of end-2021, its total assets amounted to euro 9.2 trillion, equivalent to about 2 ½ times annual GDP; total equity invested in the sector amounted to euro 565 billion (about 15 percent of GDP), for an average capital/assets ratio of 6.1 percent. The LSI sector is large, with total assets amounting to about 60 percent of total banking system assets.

Table 1. Germany: Banking System Structure, December 2021

	Private pillars		Public pillar		Cooperative pillar	Others[1]	Total
	Commercial	Real estate	Regional (*Landesbanken*)	Savings (*Sparkassen)*	*(Volks*-and *Raiffeisenbanken*)		
SIs[2]	6	2	5	0	2	2	17
LSIs	136	25	1	371	771	17	1,321
Total	142	27	6	371	773	19	1,338

Source: Bundesbank; ECB; and Fund staff elaboration.

Note: Five SIs with national GAAP accounts are not included in the solvency stress test.

[1] Excluding 109 branches of foreign banks and four SIs which are holdings.

[2] Excluding 4 systemically important entities classified as "financial holdings" by the ECB.

5. The banking system is broadly composed of three "pillars" based on legal form and traditional business focus (Table 2):

- **The private "pillar"** includes about 170 banks, of which about 140 are commercial banks and the others are real estate and specialized banks, accounting for 44 percent of the assets of the banking sector (about 100 percent of GDP). This group includes several systemically important institutions, including Germany's largest bank, Deutsche Bank, with 1.3 trillion EUR in assets ([37] percent of GDP, 14.3 percent of the banking sector).

- **The "public pillar" includes savings banks (*Sparkassen*) and regional banks (*Landesbanken*).** Originally established to extend financial inclusion to the poorer members of society, savings banks are owned by local governments (municipalities and counties), have strong links to local communities, pursue social instead of profit objectives, and do not

[4] Germany deployed two fiscal packages in 2020, and fiscal policy remained expansionary in 2021. Key COVID-related measures were extended first to May and then to June 2022. These measures comprised ramped-up public health spending, grants to firms, subsidies for the extended short-time work benefits ("Kurzarbeit") scheme (extended up to June 2022), transfers to subnational governments, and additional public investment.

distribute dividends but capitalize their net earnings as net equity. Regional banks are publicly-owned banks that provide wholesale banking services to savings banks in their own local state (*Land*); they hold a large share of savings banks' liquidity in the form of deposits, and support local businesses and development projects.

- **The "cooperative pillar" includes** about 800 "primary" banks and their umbrella organizations. Cooperative banks (mostly known under the names of *Volksbanken* or *Raiffeisenbanken*) are owned by their members, to whom they provide banking services. They are organized in financial networks, like *Sparda* banks and *PSD* banks, and are supported by various institutional network organizations which provide them with a variety of banking services and are owned by the banks themselves; most notable among them is the national umbrella organization DZ, that also acts as their liquidity manager.

Commercial banks account for almost one-half of assets and one-third of equity, but the group with the largest number of entities are cooperative banks, followed by savings banks (Table 3).

Table 2. Germany: Banks by Category, December 2021

Pillar	Category of banks	Number of banks		Total assets		Average assets per bank
			percent	billions	*percent*	billions
Private	Commercial	142	10.6	3,351.1	38.2	23.6
	Real estate	27	2.0	482.1	5.5	17.9
Public	Regional banks (*Landesbanken)*	6	0.4	804.8	9.2	134.1
	Savings banks	371	27.7	1550.5	17.7	4.2
Cooperative	Cooperative banks (excl. DZ)	772	57.7	830.4	9.5	1.1
Other banks[1]	(Includes DZ)	20	1.4	1,758.4	20.0	92.5
	Total	**1,337**	**100.0**	**8,777.3**	**100.0**	**6.6**

Source: Supervisory data provided by the authorities, and Fund staff elaboration.

[1]Exlcuidng 109 branches of foreign banks and 4 Sis which are holdings. The data for DZ Bank included in the total are indicative Fund staff estimates.

Box 1. Germany: Cooperative Banks

Cooperative banks in Germany are incorporated under the legal format of a "registered cooperative" (*eingetragene Genossenschaft*, e.G.), which requires them to serve the interests of their members and involve the members in the governance of the bank.

While formally and legally mutually independent, they are organized under a common umbrella organization, the National Association of German Cooperative Banks *(BVR e.V.*), and in five regional associations, two special associations, a financial network – the *Genossenschaftliche Finanzgruppe Volksbanken Raiffeisenbanken* (*GFVR)*) – and a central banking group (*Deutsche Zentral-Genossenschaft Bank,* aka *DZ Bank*). As of December 31, 2021, this network includes 772 "primary" cooperative banks. Besides local cooperative banks (*Volksbanken* and *Raiffeisenbanken*) this network includes the banks of the Sparda Group and PSD Banks, other cooperative banks such as banks associated with churches, and specialized banks such as the *Deutsche Apotheker- und Aerztebank* and the *BBB Bank*.

Box Table 1.1. Composition of the German Cooperative Banking Sector, by Asset Level.[1]

	Number of banks	% of total	Total Assets	% of total
DZ Bank	1	0.1	284[2]	21.9
Coops in top quintile	52	7.1	436	33.7
Coop in 4th quintile	113	15.4	263	20.3
Coop in 3rd quintile	171	23.3	192	14.8
Coop in 2nd quintile	226	30.7	95	7.3
Coop in 1st quintile	171	23.3	24	1.8
Total	734	100.0	1,294	100.0

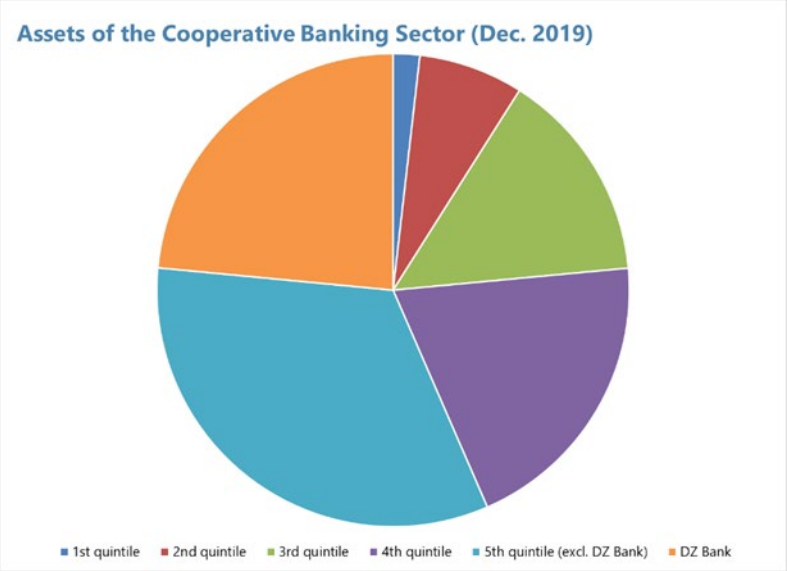
Source: Fitch; other public sources; and Fund staff elaboration.

[1] As of December 2019. Quintiles refer to the distribution of the asset distribution of all German banks (cooperative and not).

[2] Sources: 2019 Annual Financial Statements and Management Report of DZ Bank.

German cooperative banks include about 18.4 million members, serve about 30 million customers, employ 170,000 people in about 8,000 branches, and hold assets for about €1,140 million (12 percent of the German banking sector). Cooperative banks hold about one-fifth of customer deposits (but more than 30 percent of savings deposits) and have an equivalent market share of customer loans. Cooperative banks are particularly focused on local small and medium enterprises and local customers in rural areas and small towns; they hold a large market share of mortgage loans and credit to SMEs.

Box 1. German Cooperative Banks (Continued)



Source: Fitch Dec 2019; other public sources; and Fund staff elaboration.

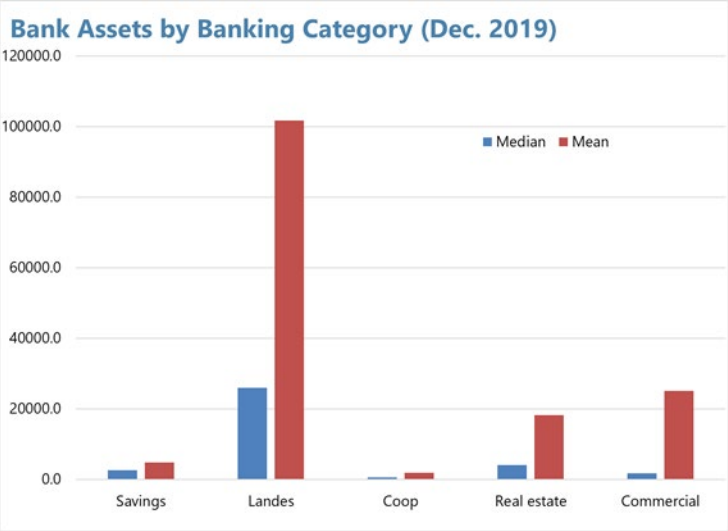
Typically, cooperative banks are smaller than banks of other categories, although 52 cooperative banks (not counting DZ) fall in the top quintile of the asset distribution of all German banks, and DZ is the second largest German bank by assets. More than one-half of cooperative banks however fall in the bottom two quintiles of the asset distribution, and about one-fourth in the bottom quintile, but they account for about 7 and 2 percent, respectively, of the total assets of the cooperative banking sector.

Cooperative banks participate in the BVR Protection Scheme, supervised by BaFin, established in 1934. To date, no cooperative bank has ever filed for bankruptcy. As in all German banks, customer deposits are also covered up to €100,000 by the deposit guarantee scheme.

The DZ Banking Group, whose holding is the DZ Bank, is the central institution of the Volksbanken Raiffeisenbanken Cooperative Financial Network. The holding of the group, DZ Bank, is owned by the cooperative banks and provides them with a variety of banking services (enabling them to exploit otherwise inaccessible economies of scale) and also acts as a commercial bank for companies and other legal entities. With €310 billion of assets and about 13,000 employees, DZ Bank is among the largest banks in Germany and accounts for about one-fourth of the total assets of the German cooperative banking sector.

Box 1. German Cooperative Banks (Concluded)

This organization has important implications for the liquidity buffers of individual cooperative banks and of the cooperative banking sector as a whole. Two features are particularly important in this regard: on one side, most cooperative banks hold a large share of their liquidity in the form of claims on DZ Bank (interbank claims and securities) and other central institutions of the cooperative banking network (indeed, the BVR recommends cooperative banks to place at least 7.5% of the liquidity collected from customers' deposits in the form of claims on DZ Bank); on the other, such central organizations stand ready to step in to provide liquidity support to any member of the network under liquidity strain, including by lending them securities that can be used as collateral to borrow from the central bank. As a result, the liquidity buffers of individual cooperative banks – even if properly defined to include interbank deposits held at DZ Bank – tend to underestimate the liquidity that would be available to withstand idiosyncratic liquidity strains; on the other hand, if the entire cooperative *sector* experienced common liquidity strains, such interbank deposits should be netted out as they are a liability for DZ Bank that would be rapidly utilized under strain conditions.



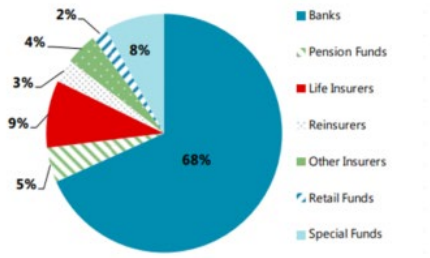
Source: Fitch, Dec 2019.

Figure 1. Financial Sector Overall Structure, 2016 to 2021

(as share of the total financial sector assets)

The overall banking sector's share in the financial sector has been declining over the years, while special funds have been expanding.

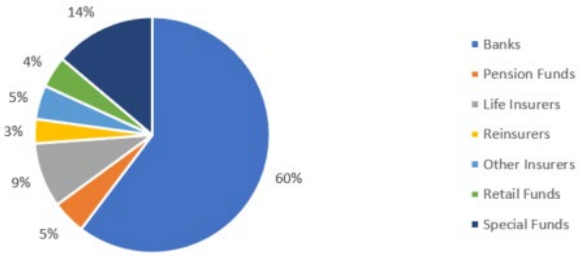
End 2016



Source: Bundesbank

*Measured by Total Assets. Does not sum to 100% due to rounding.

End 2021



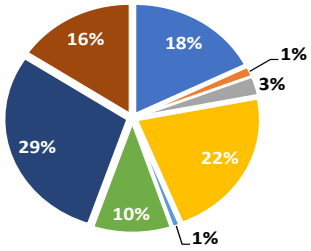
2021 Q3 percentages.

Note: ESA 2010 sectors S121, S125, S126 and S127 are not included.

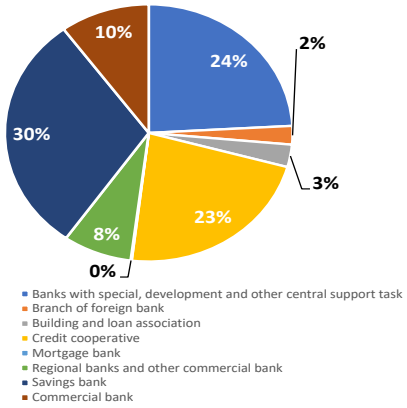
Less Significant Institutions (LSIs) Structure, 2016 and 2020

Less significant banking institutions' assets have been steadily growing, 17 percent since 2016.

End 2016



End 2020



Source: Bundesbank and IMF staff calculation.

C. Banking Sector Development Since the COVID-19 Pandemic

6. Banking sector indicators remain overall sound, reflecting in part supporting measures (Tables 9, 10).

- *Bank's capital buffers strengthened since the last FSAP.* Regulatory capital and the regulatory Tier 1 capital to risk-weighted assets increased, to 18.8 percent and 16.8 percent, respectively, end-2021. All types of banks have buffers well above the regulatory minimum. Earnings retention partly explains this positive trend.

- *Bank NPLs are low and have declined since the last FSAP.* NPLs to total gross loans was at 1.5 percent in 2021. The unwinding of support may uncover pockets of vulnerabilities.

- *The net foreign position in foreign exchange (FX) to capital slightly declined* to 3.4 percent in 2020 from 4 percent in 2016 and reversed to 4.4 percent by end-2021.

D. Scope and Scenario of the Risk Analysis

7. The risk analysis of the FSAP covers the main risk segments of the financial sector as well as risks in the real estate markets and among non-financial firms. Relying on the most recent toolkits, the analysis comprises solvency and liquidity stress tests of the banking sector, interconnectedness and contagion analysis, and as special topics, a non-financial corporate risk analysis and real estate market risk analysis. The work of the risk analysis took place in the unusual circumstances of the pandemic and the development of the war in Ukraine. The banking risk analysis was undertaken with end 2021 data for Significant Institutions and 2021:Q3 data for Less Significant Institutions. While the outlook globally and domestically remains uncertain and constantly evolving, due to the continuing pandemic and the recently started war in Ukraine, the results of the analysis based on a severe adverse scenario does provide useful quantifications of the conditional impact of downward shocks and of channels of contagion. This note also contributes to the assessment of the robustness of Germany's banking system to events that could strain its liquidity buffers. The robustness of banks' liquidity buffers is assessed in a forward-looking manner through a set of cash-flow-based stress tests run on a sample of banks[5] up to a one-year time horizon from the reference date (September 2021 for LSIs and Decemeber-2021 for SIs). The tests are based on a "going concern" (business continuity) hypothesis and contemplates four different scenarios. The non-financial corporation risk analysis provides both sensitivity analysis and scenario-based stress tests to assess the impact of the pandemic and policy response on balance sheets and in a forward-looking manner, prospects and risks for the NFC sector in Germany. The real estate analysis analyzes risks in the residential real estate and commercial real estate market in Germany, including by applying new techniques to assess the likelihood of a housing bust.

[5] The liquidity stress test focuses on banking institutions headquartered in Germany. German subsidiaries of foreign banking groups are included if their legal headquarters are in Germany; local branches of foreign banks are not included. Tests are performed on a random sample of LSI banks and 17 SI banks. Not included in the sample are 4 SI banking institutions classified as "financial holdings."

E. Risk and Vulnerabilities

NFC Balance Sheets

8. Amid strong overall pre-pandemic performance of Germany's NFC sector, the results of small and medium-sized enterprises (SMEs) stand out (Table 1).[6] In the 10 years between the GFC and the start of the pandemic in 2020, Germany's NFC sector on average achieved slightly better results than during the 11 years before the GFC, which included the Asian financial crisis and the recession in advanced economies related to the bursting of the dot.com stock market bubble in the early 2000s. However, whereas large companies' financial results were on average somewhat weaker during 2010-2019, the SME sector achieved considerably stronger results in percent of sales and return on assets. Germany's national development bank Kreditanstalt für Wiederaufbau (KfW) assesses the period 2010-2019 to be "largely a brilliant decade for German SMEs" (KfW 2020).

Profitability of Nonfinancial Corporations, 1997-2019

	1997-2007	2010-2019
Annual resut before taxes on income (percent of sales)	4.0	4.2
Large companies	3.8	3.4
Small and mid-sized companies (SMEs)1/	4.1	5.7
Return on assets (in percent, after tax)	4.2	4.5
Large companies	3.7	3.4
Small and mid-sized companies (SMEs)1/	5.0	6.9

Source: Deutsche Bundesbank; and IMF staff calculations.

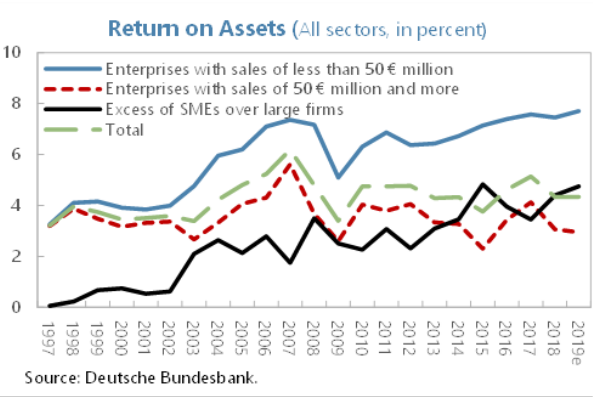
1/ SMEs are defined as firms with annual turnover of less than €50 million.

9. SMEs' sustained improvement in profitability in the years preceding the pandemic mainly reflected strong performance outside the manufacturing sector (Figure 2). SMEs' return on assets (RoA) trended upward since the GFC whereas large firms' RoA continued to fluctuate around the longer-term average of 3.5 percent. The widening difference in performance was most pronounced outside of the manufacturing sector. SMEs in manufacturing also achieved a higher RoA but the gap with large firms was more steady, hovering around 1.5 percentage points during the 10-year pre-pandemic period. Notwithstanding its somewhat easing shares of sales and profits, the manufacturing sector remains an important sector which continues to represent a large share of the NFC sector's total assets and an important share of the sector's liabilities to banks.

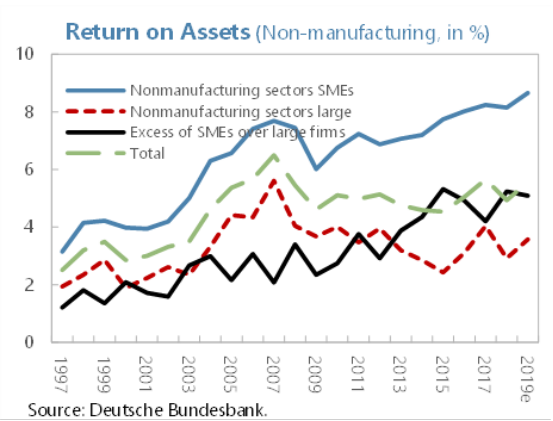
[6] The statistics of the Deutsche Bundesbank define SMEs as enterprises with sales of less than €50 million. KfW's statistics define SMEs as enterprises with turnover of up to €500 million.

Figure 2. Profitability of the SME Sector

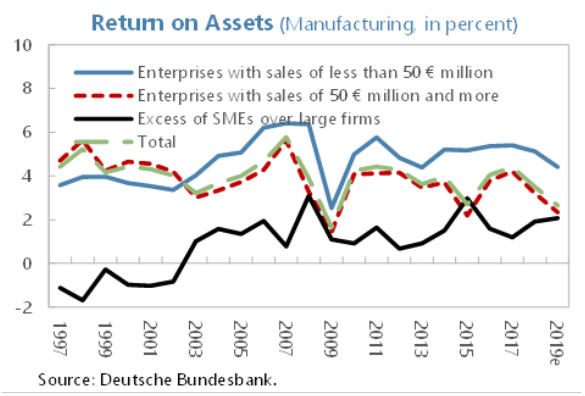
Smaller enterprises outperformed larger ones....



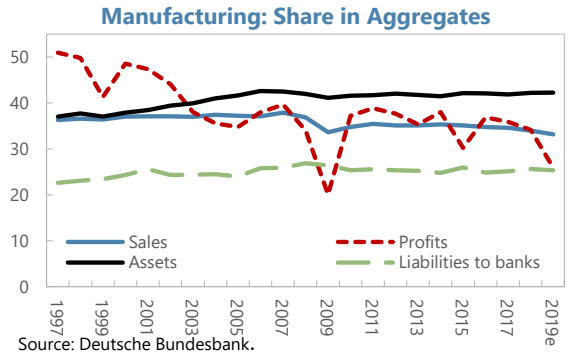
...especially outside the manufacturing sector.



In manufacturing, return on assets fluctuated around the long-term average, with a steady premium for small firms.

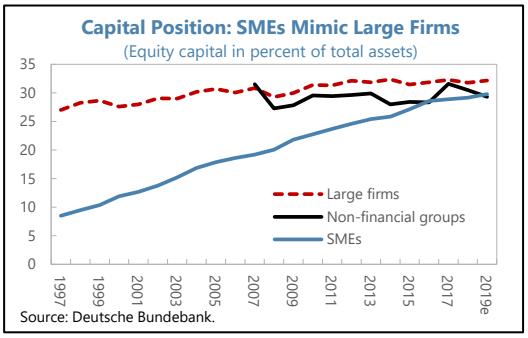


Manufacturing remains an important sector in terms of assets, sales, and profits.

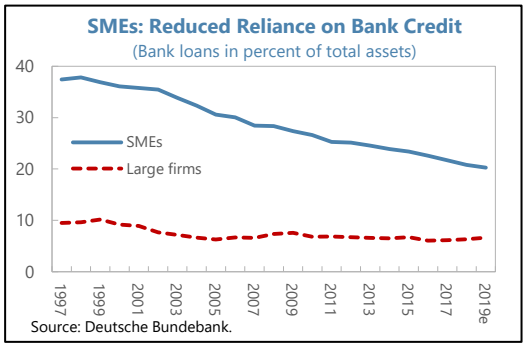


10. Sustained strong profitability allowed the NFC sector, especially SMEs, to expand capital buffers and reduce reliance on bank financing:

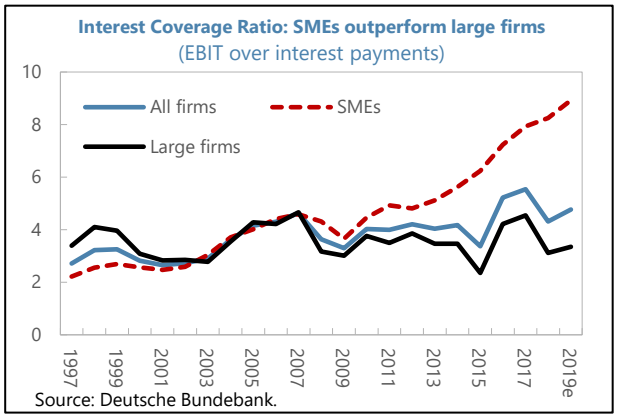
- The capital ratio of large enterprises rose from 28 percent in 2000 to an average of 32 percent during the ten years preceding the pandemic. This exceeds the average capital ratio of 29.5 percent maintained by the sample of about 230 non-financial enterprise groups listed in Germany in the Prime Standard segment of the Frankfurt stock exchange which is separately monitored by the Deutsche Bundesbank.

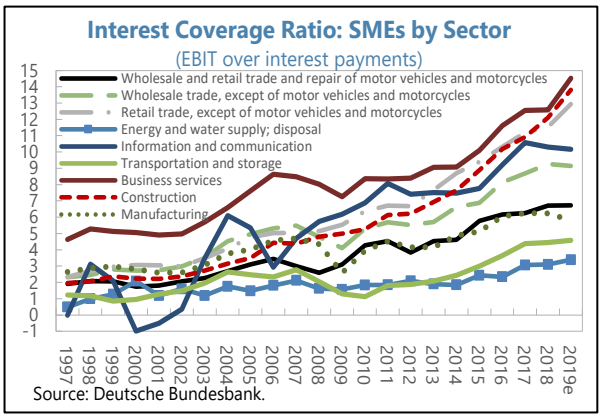


- The SME sector's equity capital ratio saw a particularly noteworthy rise, to the point that, at 29 percent in 2019, it came close to that of large firms and listed groups. This allowed SMEs to deleverage and materially reduce the share of bank loans in their total liabilities.
- Thanks to the rising capitalization of firms large and small, the capital ratio of Germany's NFC sector as a whole was able to catch up with that in leading European peers (Deutsche Bundesbank (2019)).



11. Sustained profitability alongside gradually declining reliance on bank credit allowed NFCs to contain indebtedness (see next section) and handle the outstanding debt well, with SMEs again looking strong in many sectors. Steadily improving earnings before interest and taxes (EBIT) alongside a falling interest payment burden as a result of lower indebtedness caused SMEs' interest coverage ratio (ICR, calculated as EBIT over interest payments) to rise in the years following the GFC. The sectoral breakdown suggests that the improvement in this key indicator of viability was broad-based among SMEs.[7] Given the Bundesbank's narrow definition of SMEs, the favorable developments in these sectoral averages are not driven by a few outliers. By contrast, during this period large firms' aggregate ICR hovered around the long-term average of 3.5.

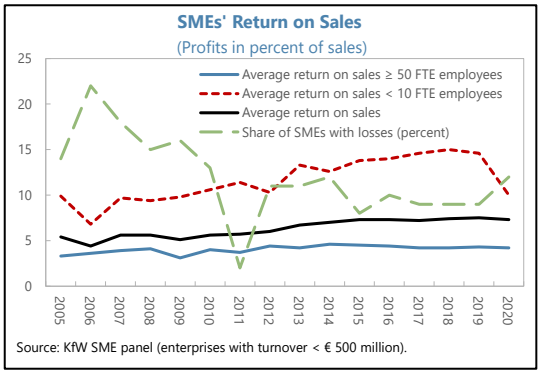


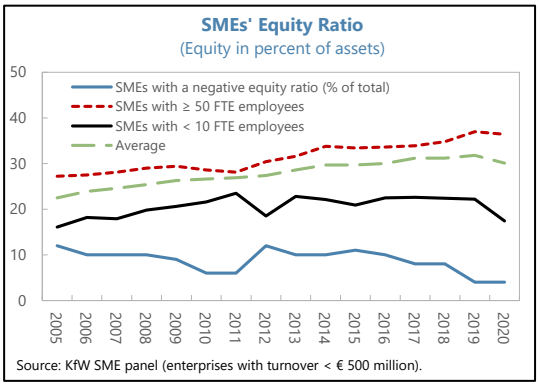


[7] Firms that lack the capacity to generate positive profits net of debt service for several years (i.e., firm with ICR<1) are considered unviable. If such "zombie firms" remain in operation, they hold back the reallocation of resources to profitable firms and thereby constrain productivity growth. Expansionary monetary policy in the aftermath of the GFC is often thought to have given rise to further zombification of firms, whereby cheap financing helps keep otherwise unviable firms in business. Indeed, Bittner et al (2021) found that unconventional monetary policy has been associated with increased zombie lending by relatively weak banks which in turn allowed the zombie firms to increase their trade credit from suppliers, thus increasing credit risk in the financial system. Nevertheless, granular analysis in Deutsche Bundesbank (2020) suggests that the prevalence of zombification has remained broadly stable at about 6 percent of all NFC firms over the past decade. Banerjee and Hofmann (2021), looking only at listed firms, also finds that the share of zombie firms in Germany has been broadly stable, in this case at about 10 percent of firms.

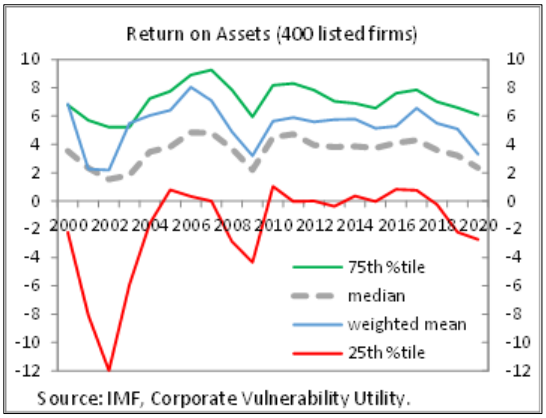
12. The various support measures implemented by the authorities alongside the resilience of the NFC sector helped the sector weather the pandemic relatively well.

- Preliminary data for 2020 discussed in Deutsche Bundesbank (2021) indicates that NFCs' total income declined by €220 billion, or 3.1 percent.[8] However, enterprises' total expenses before taxes on income were lower by a similar amount. Corporate profits before taxes declined by 3.8 percent, but measured relative to the reduced revenue figures, the annual result before taxes on income remained virtually unchanged at 4.1 percent of sales. In line with this, KfW's SME panel of 9,889 enterprises with annual turnover of less than €500 million data suggests that, in the aggregate, SMEs have managed a broadly unchanged return on sales. However, the smallest SMEs appear to have had a particularly difficult time. They have had to draw on their buffers. To the extent that they are operating in sectors for which 2021 was also a difficult year, buffers may have become thin.





- The distribution of listed NFCs' RoA fell to levels last observed during the GFC. But the downturn in RoA in 2020 is milder than the one during the recessions related to the popping of the dot.com bubble in 2000/01 and the GFC in 2008/09. The downward trend exacerbated a slide which had started in 2018 when many export-oriented firms were affected by weakening demand from China.[9] Listed nonfinancial groups monitored by the Bundesbank saw a slump in profits for groups

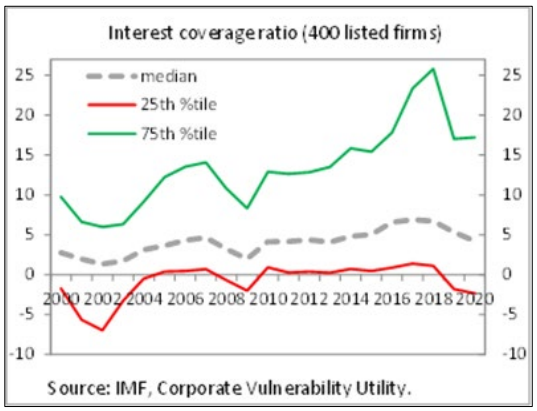


[8] In the Bundesbank's experience, weaker-performing enterprises have tended to report their financial statements later. This can bias the preliminary data based on partial reporting especially during a downturn.

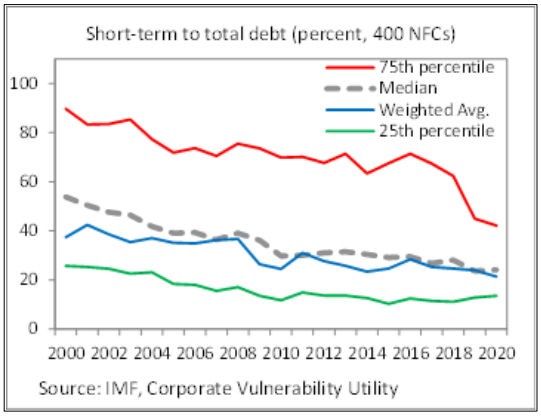
[9] The RoA for the 25th percentile of firms was already substantially negative in this chart in 2019 because the sample of firms in the IMF Corporate Vulnerability Utility includes firms in the sample whose fiscal year ends before the end of the calendar year. For example, these firms' financial results and financial statements for the broken fiscal year 2019/2020 are captured in calendar year 2019 in the Utility. The RoA for the 25th percentile of firms in the sample of 294 listed firms analyzed in the sensitivity analysis was 1.0 in 2019.

with a focus on the production sector during the first half of 2020 but a strong recovery in the two subsequent semesters (Figure 2).[10]

- On the eve of the pandemic, the whole distribution of the ICR of listed firms was higher than during the previous two decades. Although the 25th percentile of firms already turned negative in 2019 reflecting the fact that a number of firms' fiscal years start in the previous calendar year. It should also be noted that not all the news on NFC operations in 2020 was downbeat. Of the 57 listed firms with an ICR below 1 in 2019 which were also in our 2020 sample, 17 firms with a total debt of €17.5bn achieved improved earnings in 2020, pushing their ICR above 1. These firms operate in new or more recession-proof sectors such as (solar) energy, telecom, food, pharmaceuticals, e-commerce, construction, and salt and sugar production.



- Firms have taken advantage of the generally loose domestic and international financing conditions to improve the maturity profile of their debt. With the falling share of short-term debt, rollover risks have become more contained at the aggregate level.

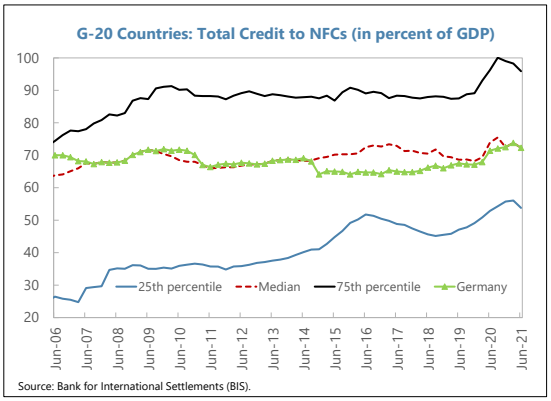


13. Thanks to the official support measures and corporates' resilience, their increased indebtedness amid the pandemic was matched by higher cash holdings, insolvencies continued their decade-long downward trend, and the NFC sector's NPLs reverted to pre-pandemic lows:

- As also reported in the FSC's Annual Report to the Bundestag, gross consolidated NFC debt rose by 5 percentage points of GDP in 2020, to 62.5 percent of GDP, equal to the 2009 GFC high (Figure 1). About two thirds of the increase in the debt ratio was due to increased borrowing and the remaining one third was due to the 3 percent decline in nominal GDP in 2020. The 5 percentage points rise in the ratio of consolidated NFC debt to GDP partly reflected the drawdown of credit lines to preserve liquidity during the pandemic and was broadly matched by rising NFC cash holdings. Net consolidated NFC debt, which nets out cash holdings, barely

[10] The Bundesbank compiles and disseminates data on the performance and balance sheets of non-financial groups admitted to the Prime Standard segment of the Frankfurt Stock Exchange which regularly publish IFRS consolidated financial statements and make a noteworthy contribution to value added in Germany. The nonfinancial groups achieved total revenues of 51 percent of GDP per annum on the eve of the pandemic. Their debt had risen to 28 percent of GDP by end-2019.

increased in Germany in 2020. As a result, Germany's net NFC debt to GDP ratio and NFC debt to income ratio remain below peers.



- German NFCs' unconsolidated gross debt is at the median for G20 countries (72 percent of GDP in mid-2021 but vulnerability to possible swings in the market price of risk and/or the level of risk aversion is limited by the relatively small outstanding amounts of high-yield corporate bonds (1.7 percent of GDP, less than half euro area peers and about a fifth of the United States) and investment-grade corporate bonds (16.4 percent of GDP, compared to 21.5 percent of GDP in the euro area and about 29 percent of GDP in the US).

- While bankruptcies of consumers and self-employed jumped in 2021, corporate insolvencies fell for the 12th year in a row in 2021 to the lowest level since the adoption of the 1999 Insolvency Act. The May 2021 full reinstatement of the obligation to file insolvencies after a 14-month full or partial suspension has not yet led to corporate insolvencies picking up.

- By end-2020, debt at risk—defined as total debt of listed firms with an interest coverage ratio (ICR) below 1 as a percentage of total debt of all listed firms—remained contained at 16 percent of total corporate debt (up from 4 percent at end-2019). Moreover, preliminary data for the first nine months of 2021 suggests a recovery of listed NFCs' earnings in both the manufacturing and services sector which should stem the rise in debt at risk. Indeed, by September 2021, non-performing bank loans to the NFC sector were back at pre-pandemic lows in absolute value (€39 billion) and in percent of gross loans (2.3 percent).

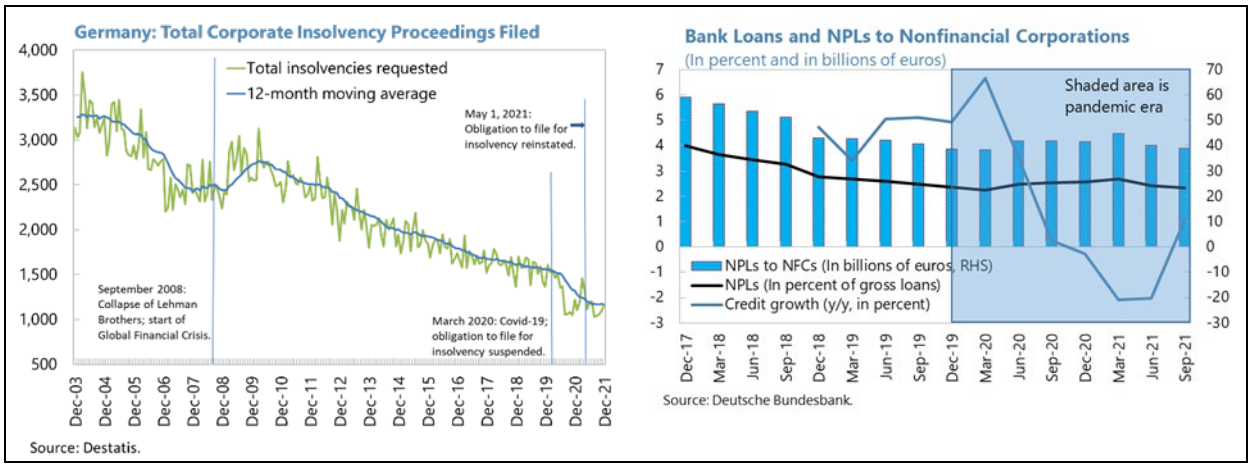
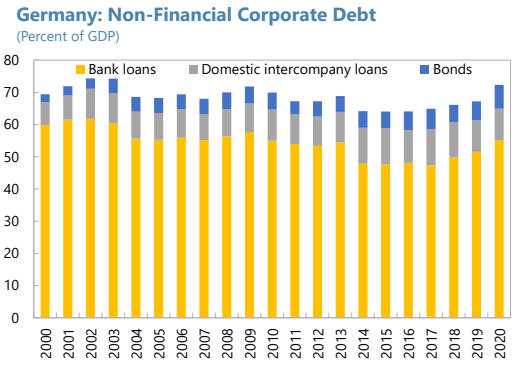


Figure 3. Nonfinancial Corporate (NFC) Debt Over Time and Compared to Peers

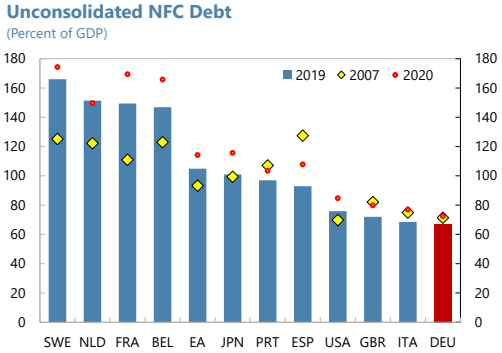
As also reported in the Financial Stability Council's Annual Report to the Bundestag, consolidated NFC debt rose by 5 percent of GDP in 2020, to 62.5 percent of GDP, equaling the 2009 GFC high. The increase in NFCs' cash holdings during 2020 suggests that, at the aggregate level, the additional borrowing was mainly for precautionary purposes.

While rangebound for two decades, unconsolidated debt rose by 5½ percent of GDP in 2020, to a 17-year high



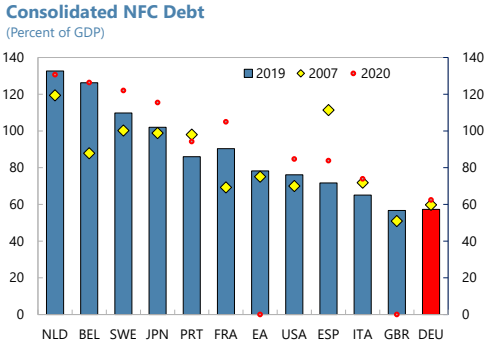
Source: Eurostat via Haver Analytics and IMF staff calculations.

The 2020 increase in Germany was smaller than in peers (median rise: 9 percent of GDP) and from a lower level.



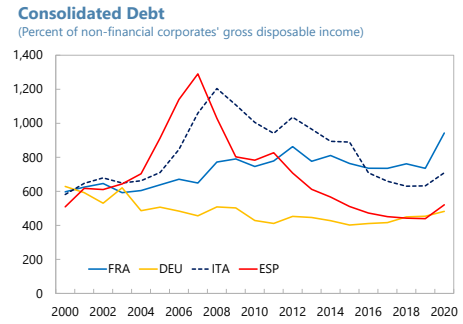
Sources: Haver Analytics, and IMF staff estimates.

Consolidated NFC debt, which nets out intercompany loans, rose by 5 percent of GDP in 2020, to 62.5 percent of GDP, equaling the 2009 GFC high



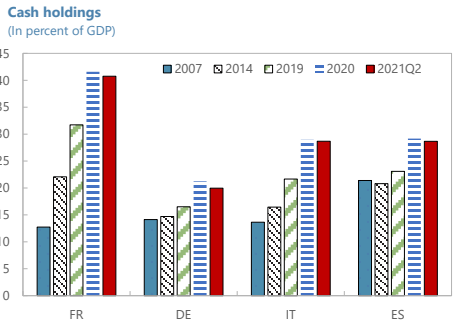
Sources: Haver Analytics, and IMF staff calculations

At about 5 times NFCs' disposable income, consolidated debt is also at a post-GFC high in multiples of income, but still lower than in peers



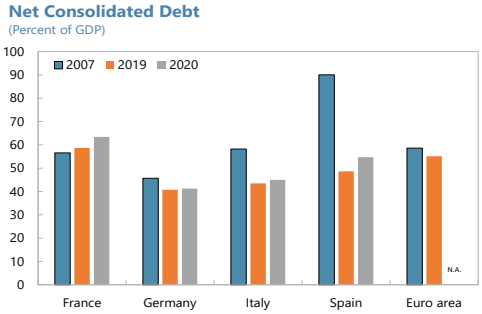
Sources: Haver Analytics and IMF staff estimations.

NFCs' cash holdings rose considerably in 2020, suggesting that additional borrowing was largely precautionary…



Sources: Haver Analytics.

…and net consolidated NFC debt, which also nets out cash holdings, barely increased in Germany in 2020.

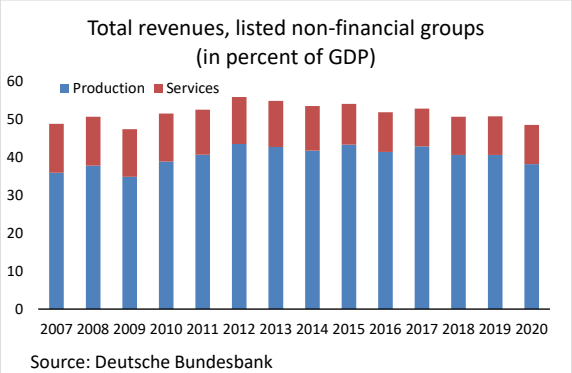


Sources: Haver Analytics and IMF staff calculations.

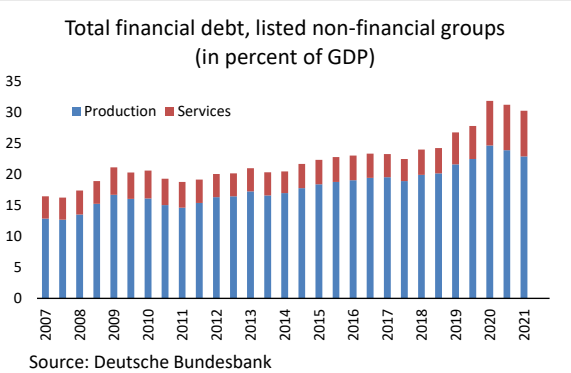
Figure 4. Germany: Key Indicators for Listed Non-Financial Groups

The Bundesbank compiles and disseminates semi-annual data on the performance and balance sheets of non-financial groups admitted to the Prime Standard segment of the Frankfurt Stock Exchange which regularly publish IFRS consolidated financial statements and make a noteworthy contribution to value added in Germany.

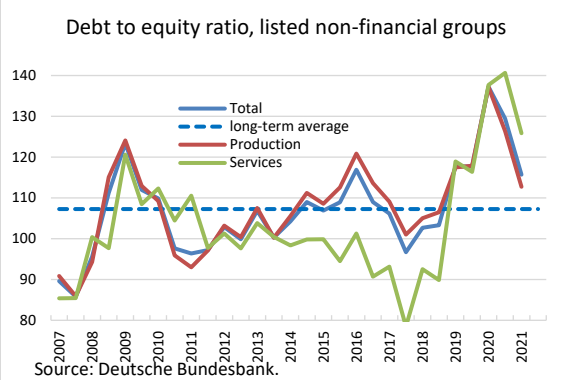
On the eve of the pandemic, total revenues of listed non-financial groups was about 51 percent of GDP per annum.



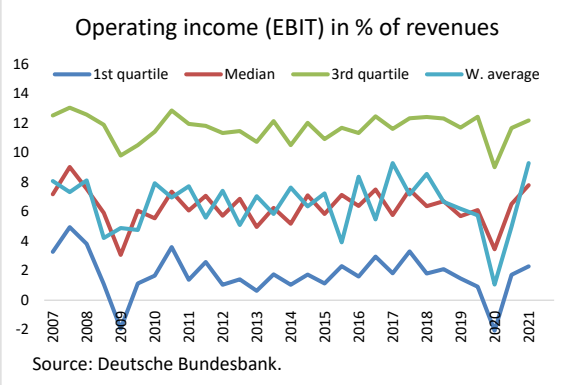
Unlike revenues, debt was trending up pre-pandemic, to 28 percent of GDP by end-2019.



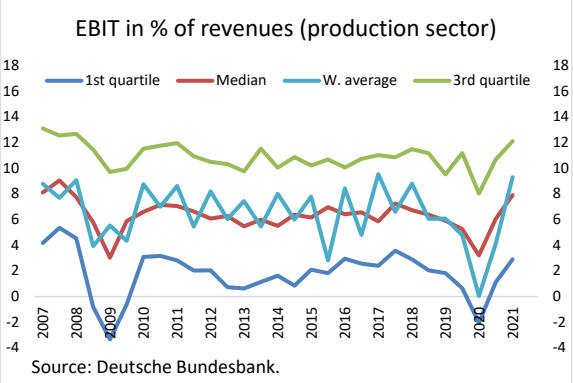
The debt-to-equity ratio reverted to the long-term average in H1 2021 thanks to groups' surging equity.



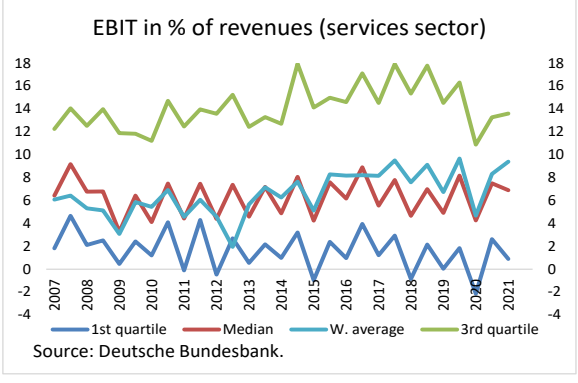
The pandemic extended the 2018/19 slide in profits. The dip and subsequent recovery look similar to the GFC.



The weighted average profitability of groups with a focus on the production sector fell to 0 in the first half of 2020.



Groups with a focus on the services sector did not experience as deep a decline in profitability.



Banks

14. The profitability of the German banking system is relatively low by international comparison. German banks reported lower return on total assets, on risk-weighted assets, and on equity (ROE) than the EU averages in 2020. At 2.7 percent in 2020, the aggregate ROE of German banks also fell short of cost of capital, estimated in the range of 8-12 percent by European banks.[11] This reflects a combination of cyclical and structural factors. Low interest rates have squeezed net interest incomes of German retail banks, while efforts to increase fee and commission income have been constrained amid customer risk aversion, preference for savings rather than asset management products, limited customer experience with fee-based products, and strong bank competition and dense branch networks.

15. The aggregate profitability figures, however, mask significant heterogeneity among different bank types. Savings banks and cooperatives have performed better than private, although profitability has been declining for all bank groups over time due to pressures stemming from low interest rates. In part, this reflects private banks' struggle with and prolonged implementation periods of restructuring plans to resolve legacies of the global financial crisis (GFC). Savings and cooperative banks' higher profitability is largely explained by increased lending volumes (including to real estate) and a regional focus sheltering them from the heated competition, leading to a substantial increase in their market share in lending to households and enterprises (particularly SMEs).

16. Rising risks and vulnerabilities challenge the sustainability of saving and cooperative banks' business models, and call for ongoing risk monitoring. Until now, increased lending, particularly for residential and commercial real estate, has helped saving and cooperative banks boost revenues and partially offset declining interest rates. Going forward, however, rising risks and vulnerabilities in the German banking sector, particularly in real estate, challenge the sustainability of such business models and banks' ability to continue generating profits. Against this backdrop, however, BaFin has introduced a macroprudential policy package, including a sectoral systemic risk buffer on RRE exposures. Other risks, including those stemming from interest rate changes, slow digitalization, cyber risks, and geopolitical developments, are also on the rise. Thus, efforts to collect data on bank exposures to various risks should be accelerated.

Real Estate

17. Since the start of the current upswing in the German RRE market in 2010, RRE prices increased by about 91 percent by end-2021 increasing faster than in many other OECD countries (Figure 5). Until 2009, Germany experienced relatively weak RRE price growth, where nominal prices increased only by about 25 percent during 1990-2009.[12] The current upswing in the

[11] As reported by the EBA Risk Assessment Questionnaire (Autumn 2021), more than 70 percent of banks estimate their cost of equity in the range of 8 to 12 percent. The figure for German banks is based on profit before tax for all categories of banks (1.12 percent for after-tax ROE) reported by the Bundesbank.

[12] Source: Bulwien AG. House price growth during 1990-2009 was 25.4 percent.

RRE market began in 2010, and continued throughout the COVID-19 pandemic, with house prices increasing by some 91 (63) percent in nominal (real) terms during 2010-21.[13]

18. RRE prices increased the most in the largest 7 cities, growing by some 144 percent during 2010-21, and outpacing many cities around the world. The fastest price growth in German RRE markets was observed in more populated larger cities. Specifically, during 2010-21, residential property prices in the largest 7 cities increased by 144 (109) percent in nominal (real).[14]

19. The COVID-19 pandemic resulted in divergent dynamics in RRE and CRE markets, with some CRE sub-sectors experiencing price declines (Figure 5). While Germany's RRE prices continued to increase by end-2021, CRE prices declined since the onset of the COVID-19 pandemic, but with significant heterogeneity among different property types. CRE prices declined by 0.8 percent in 2021 (increased by 6.4 percent in 2019). After declining in 2021H1, average office prices grew by 0.2 percent in 2021 (9.6 percent in 2019), and retail property prices (largely nonfood) have continued to fall (-3.1 percent in 2021) since late 2018 due to competition with e-commerce that further exacerbated during the COVID-19 pandemic.[15]

20. Performance of CRE sub-sectors also varies by location, where prices in prime locations in larger cities increased the most. Within the CRE sector, there is significant heterogeneity not only among different sub-sectors, but also by location. For instance, office properties in prime locations in larger cities performed better – including following the COVID-19 outbreak – than properties in less populated areas, which experienced stagnation or outright price decline. Within the retail sector, there is a distinction between the food- and non-food-related properties, as food-related properties, particularly in prime locations have been in greater demand than non-food-related properties, such as shopping malls, which have been struggling for a few years due to the shift in consumer preferences to online shopping. This trend was further exacerbated by the COVID-19 pandemic.

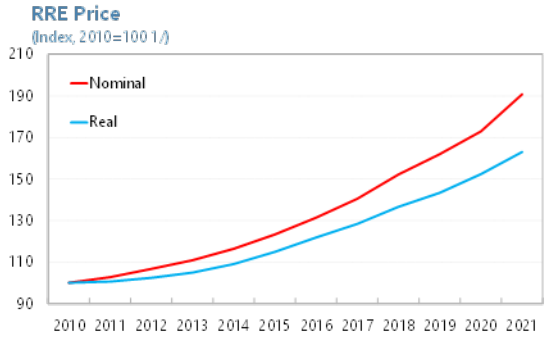
[13] Estimates based on vdpResearch using annual average residential prices. Real residential prices calculated by deflating nominal estimates by the CPI. Estimates based on other sources (BIS, Hypoport AG, Bulwiengesa AG, Destatis, vdpResearch, etc.) produce somewhat different estimates due to different methodology and coverage.

[14] Source: vdpResearch.

[15] The estimates cited refer to vdpResearch residential and commercial real estate price statistics.

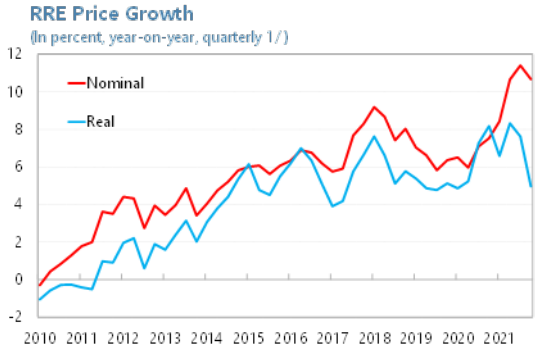
Figure 5. Residential Real Estate Price Dynamics

House prices increased by 91 percent in nominal and 63 percent in real terms between 2010-21, according to vdpResearch data.



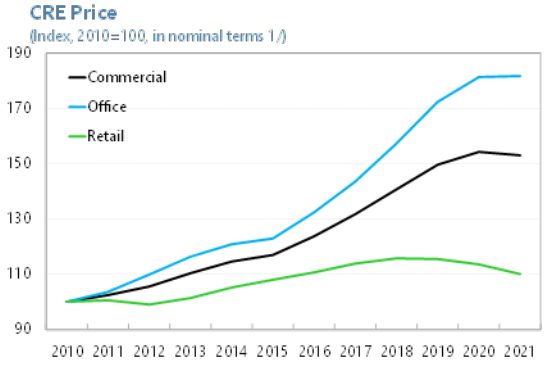
Source: vdpResearch; CEIC; and IMF staff estimates and calculations.
1/ vdpResearch annual estimates of nominal residential prices. Real prices obtained by deflating nominal prices by the CPI.

RRE price growth reached 10.7 percent (5 percent) growth year-on-year in 2021Q4 in nominal (real) terms.



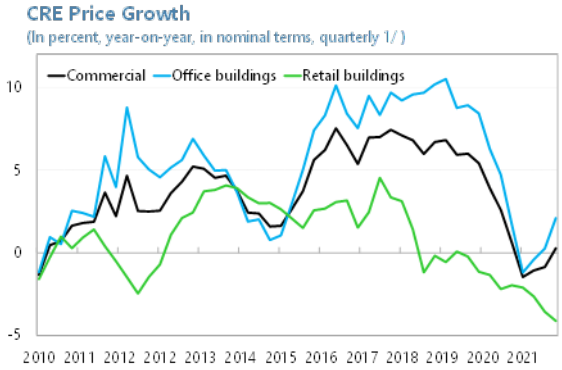
Source: vdpResearch; CEIC; and IMF staff estimates and calculations.
1/ vdpResearch quarterly estimates of nominal residential prices. Real prices obtained by deflating nominal prices by the CPI.

While overall CRE prices increased by 53 percent (31 percent) in nominal (real) terms between 2010-21, there is significant heterogeneity withing the sector: office prices grew by 82 percent (55 percent), retail prices by 10 percent (-6 percent).



Source: vdpResearch; and IMF staff estimates and calculations.
1/ vdpResearch annual estimates of nominal commercial, office, and retail property prices.

After some decline in the first half of 2021, office property prices registered 0.2 percent y/y growth in 2021, while retail property prices declined further by 3.1 percent largely on account of competition from online retailers, further exacerbated by the COVID-19 pandemic.



Source: vdpResearch; and IMF staff estimates and calculations.
1/ vdpResearch quarterly estimates of nominal commercial, office, and retail properties.

F. Macro-Financial Scenarios

Solvency Stress Tests

21. The FSAP assessed the following key macro-financial risks (RAM: Table 6): an escalation of the conflict that could be associated with a Russian gas shut off, higher commodity prices; a global resurgence of COVID-19 with extended supply chain disruptions; and de-anchoring of inflation expectations in the U.S. and advanced Europe, leading to rising core yields and risk premia.

- *Global resurgence of COVID-19 with extended supply chain disruptions* could require costly containment efforts if protracted in time, causing greater scarring to the economic fabric and financial sector's balance sheets, adding pressure on capital buffers and margins, and triggering credit tightening, an increase of zombie corporates, a wave of bankruptcies and higher NPLs.

- *De-anchoring of inflation expectations in the U.S. and/or advanced European economies with scarcity of gas and oil.* The baseline scenarios already include above-target inflation from rising oil and gas prices due to the Russian invasion of Ukraine. In the adverse scenario, Covid-19- and Russian war related constraints on the supply of manufactured parts and raw materials, including gas and oil, lead to a commodity price hike, higher-than-expected above-target inflation and a real GDP decline including significant damages to the large manufacturing sector in Germany. Unexpected monetary tightening in the U.S. and in the euro area and repositioning by market participants lead to tightening of financial conditions, rise in risk premia and funding costs, and a global housing bust. Higher rates together with supply constraints cause losses of confidence, a drop in demand and recessionary pressure in Germany and lead to an increase in corporate and household NPLs. Moreover, the shift in market sentiment and lower investor confidence against some high-debt EA countries could raise sovereign yields, have knock-on effects on the broader financial sector and affect German banks' and other financial institutions' holdings in these countries.

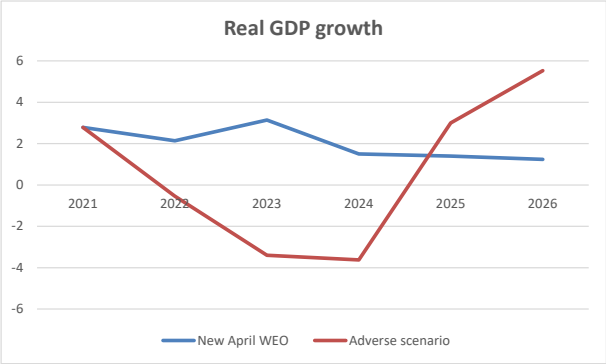
- The FSAP assessed the German banking system's resilience to shocks against the March 15 WEO baseline scenario and a RAM-based adverse scenario (Appendix IA, STeM). The assessment included three global shocks (global resurgence of the pandemic, de-anchoring of inflation expectations in the U.S., and geopolitical risks related to the Ukraine-Russia war), a high-debt countries euro area shock (Figure 6), and a structural shock related to digitalization. The adverse scenario includes the shocks above with severity based upon the statistical approach (3 standard deviations from the baseline over two years)[16]. The adverse scenario has a V-shape with a deeper through and involves a 13.4 percent decline in real GDP by 2024 (Figure 6). The adverse scenario assumes that the output gap closes in 2025 and involves stagflation and monetary tightening followed by monetary policy loosening associated with a drop in demand (Figure 7). House prices decline by 23.35 percent, and stock prices by 28.6 percent by 2024. Unemployment increases by 6.6 percentage points above the baseline and remains 0.8 percentage points above the baseline at the end of the projection horizon.

[16] The analysis includes an adverse scenario that combines three G-RAM risks (Covid pandemic, inflation expectations de-anchoring, and Ukraine-Russia war). The severity, measured as real GDP deviation from the baseline, generated in the exercise is more severe and quantitatively, including the monetary policy reaction, and qualitatively different than the latest 2021 EU stress test. The global layers explain about two-thirds of the severity and domestic layers the remaining third.

Figure 6. Macroeconomic Scenarios

The realization of global and local adverse shocks entails a sharp decline in real GDP growth in 2022 and recovery by 2025

	WEO	Adverse scenario
2021	2.8	2.8
2022	2.1	-0.5
2023	3.1	-3.4
2024	1.5	-3.6
2025	1.4	3.0
2026	1.2	5.5



Source: IMF staff GFM simulations.

Liquidity Stress Tests

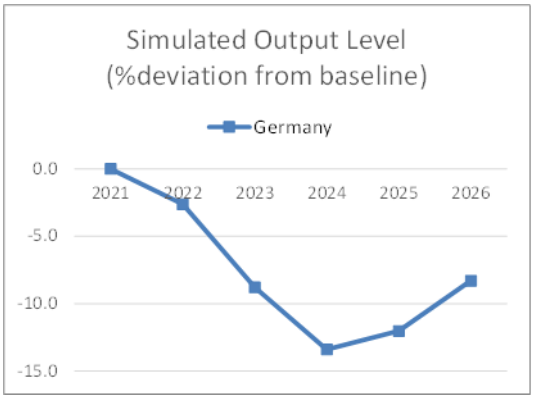
22. The liquidity stress test focuses on banking institutions headquartered in Germany. German subsidiaries of foreign banking groups are included if their legal headquarters are in Germany; local branches of foreign banks are not included. The liquidity stress tests aimed at assessing the resilience of German banks to extreme but plausible liquidity strains and are based on a randomly collected sample of LSI banks that include banks of various categories and of all 17 SI banks.[17]

23. To assess the liquidity of the German banking sector three different stress scenarios were considered, representing different unlikely but plausible stress events that could pose exceptional demands on banks' liquidity. A benchmark ("baseline") scenario, which is also most likely to occur, captures strain on bank liquidity under otherwise "normal" conditions as a result of cyclical fluctuations and other occasional but not altogether exceptional events. A less likely and short-lived first stress scenario outlines what could happen if a new wave of the pandemic triggered renewed precautionary measures and restrictions that induced a new decline in economic activity. Two most severe stress scenarios – more persistent, and whose likelihood has increased in the wake of recent developments in the inflation and geopolitical front – describe the possible impact on bank liquidity of a new surge in risk aversion toward highly leveraged euro area countries and of persistent high inflation rates that trigger a monetary policy response. These last two scenarios, which could stem from the same factors, entail very similar effects and yield also similar results.

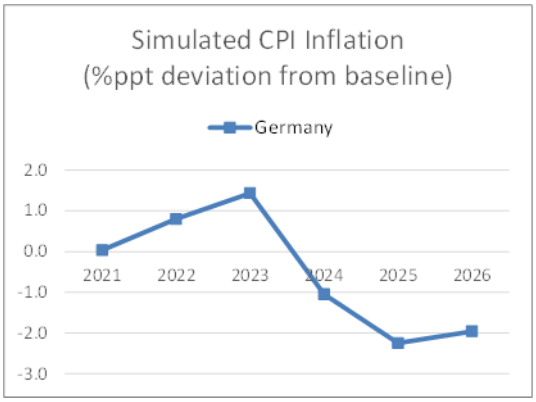
[17] Not included in the sample are 4 SI banking institutions classified as "financial holdings."

Figure 7. Adverse Scenario Simulations[1]

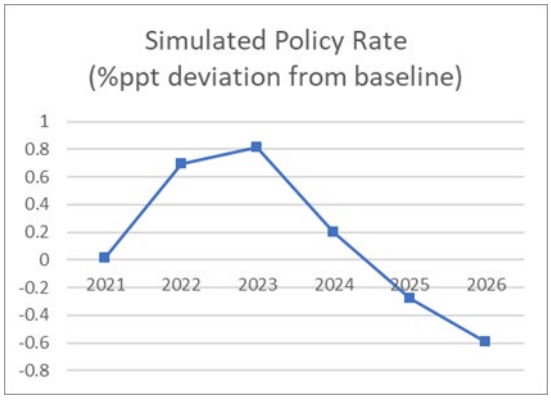
Real GDP falls to 13.4 percent below baseline by 2024…



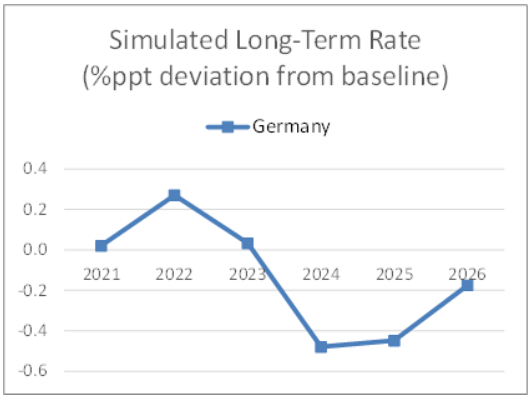
…inflation shoots up 1.4 percentage points above baseline in 2023 and then falls in negative territory …



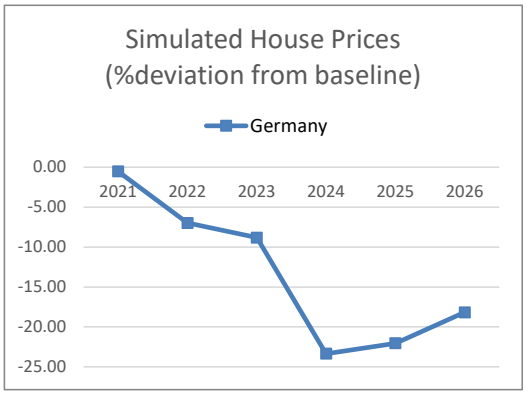
… as a result the ECB tigthens monetary policy in the near term, and loosens in outer years …



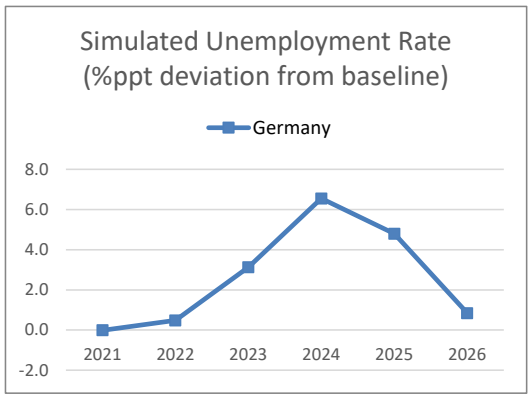
… long-term rates rise in Germany, but by less than short-term rates, resulting initially in a flattening of the yield curve.



A global housing bust results in a decline in residential real estate prices of about 23 percent by 2024…



… unemployment rises 6 percentage points above baseline by 2024



Source: IMF staff GFM simulations.

[1] Simulations were performed with the Global Macrofinancial Model (GFM). Reference: Vitek, F., 2018, "The Global Macrofinancial Model", IMF Working Paper 2018/081

SOLVENCY STRESS TEST OF BANKS

A. Overview

24. The objective of the risk analysis component of the FSAP is to identify macro-financial vulnerabilities and is different from supervisory (EBA) approaches. The EBA-SSM-ECB exercise is a bottom-up stress test where banks are required to project the impact of the scenarios on their projected capital position and P&L subject to strict constraints defined in the common methodology. By contrast, the FSAP stress test is a top-down exercise with projections generated by in-house models developed by the FSAP team. While the FSAP and EBA scenarios could share a consistent narrative of risks, they differ in terms of the granularity of data used, and calibration of the various shocks. Hence, EBA and IMF results are not directly comparable.

25. The solvency stress tests cover the largest 16 SIs with accounts under IFRS9 accounting and 1293 LSIs with accounts under national GAAP.[18] The 16 SIs and the 1293 LSIs account for about 87 percent of bank assets. The stress tests were conducted on the balance sheets and profit and loss (P&L) of the 16 SIs at the end of 2021 (cut-off date of the stress tests for SIs) and on the balance sheet and P&L of the LSIs at the end of 2021:Q3 (cut-off date of the stress tests for LSIs). The data on SIs were obtained from the ECB-SSM (FinRep and CoRep templates, and STE files on Interest Rate Risk in the Banking Book (IRRBB)) and the data on LSIs were obtained from the Bundesbank (FinRep and CoRep templates). We also obtained data on default rates and loss rates for loans to NFC from the Bundesbank credit registry, aggregated at the economic sector level. For SIs, the stress test considered foreign exposures to France, Italy, Spain, the UK and the US, in addition to domestic exposures. As for domestic exposures, stressed foreign exposures of SIs include private sector exposures (non-financial corporates, households, financial institutions) and sovereign exposures. For LSIs, only domestic exposures are considered in the analysis.

26. For the SIs, the stress tests follow a balance sheet approach at a consolidated level, and were based on accounting (IFRS9), and regulatory capital ratios. IFRS9 accounting and the ECL (Expected Credit Loss) aim at moving from a lagged incurred loss to the ECL approach. The risk-based classification (staging) corresponds to different levels of risks. Exposures generally enter Stage 1 upon origination. Depending on change in risk, they may migrate to Stage 2 or Stage 3 (corresponding to a non-performing exposures). Stage 1 exposures are provisioned on a 12-month horizon, while Stage 2 and Stage 3 exposures are provisioned with a life-time horizon. Modeling of transition matrices which depend on the macro-financial cycle requires estimations of transition rates described in the transition table of Figure 2, where TR_{-xy} is the transition rate between Stage x and Stage y. In absence of historical data with long enough time series to permit modeling of transition rates, transition flows are estimated based on the beta-linking approach. [19] Starting point

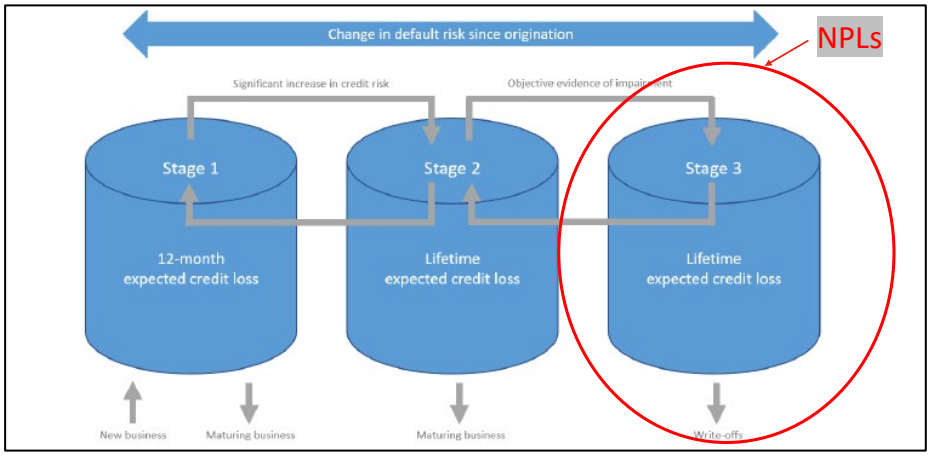
[18] The five SIs under national GAAP accounting were not included in the solvency stress tests due to constraints in adapting stress test templates. As a result, 89.5 percent of SIs' assets are included in the stress test.

[19] This approach assumes constant elasticities between other transition rates and PDs (to which TR1-3 and TR2-3 are equal). These constant elasticities are consistent with those relied upon in recent European FSAPs, in particular the

(continued)

PiT PDs and TTC PDs are those reported by each SI in the supervisory templates. Stress tests are realized under a static balance sheet assumption meaning that there are no write-offs and new originations equal maturing loans. In line with the regulatory framework, the performance of banks is assessed based on the Common Tier one (CET1) capital ratio and a common hurdle rate of 8.25 percent, including the minimum CET1 of 4.5 percent, the capital conservation buffer of 2.5 percent, the countercyclical capital buffer of 0.75 percent starting 2023, and a systemic risk buffer of 0.5 percent.[20]

Table 3. IFSR9 Transition Matrix: Concept and Parameters



		year t+1					
		Stage 1	Stage 2	Stage 3	Mature	Write-offs	Σ
year t	Stage 1	TR1-1	TR1-2	TR1-3	M1	x	1
	Stage 2	TR2-1	TR2-2	TR2-3	M2	x	1
	Stage 3	TR3-1	TR3-2	TR3-3	x	**Write-off rate**	1

Notes:
TR-13 and TR2-3: PDs
TR-3-1 and TR-3-2: cures

Source: IMF staff.

27. For the LSIs, the stress test considered a balance sheet approach at a domestic consolidated approach, and the stress test modeling followed national GAAP accounting.

28. The solvency stress tests rely upon several auxiliary models in addition to the balance sheet model. The solvency balance sheet model ensures consistency in the projections of the balance sheet, P&L, and capital ratios of the banks under a given macro-financial scenario, relying on several satellite models for the projections of credit risk, interest rates and income components.

France FSAP of 2019. See Gross, M., Laliotis, D., Leika, M., and P. Lukyantsau, 2020, "Expected Credit Loss Modeling from a Top-Down Stress Testing Perspective", IMF Working Paper No. 2020/111.

[20] The choice of a hurdle rate common to all banks was made for confidentiality issues. Hence, the G-SII buffer, the O-SII buffer and any Pillar 2R and Pillar 2G buffers are not included as part of the hurdle rate.

An accounting model generates the dynamics of IFRS9 transition matrices (based on an underlying model developed for South Africa) and the calculation of provisions under the expected credit loss approach. Specifically, paths for probabilities of default (PDs), lending rates, deposit rates, pre-provisioning income, and sovereign spreads relative to the repo rate were generated for the baseline scenario and for the adverse scenario. Risk Weighted Assets (RWAs) resulted from the shocked risk parameters (PDs, LGDs) and the simulated provisions.[21] Satellite models for credit risk are developed at the bank level and are broken down into four sectors: non-financial corporates, households, financial institutions and the sovereign. Net interest income is computed from the paths of simulated lending rates and deposit rates (which are split into two sectors: households/retail, and financial and non-financial corporates), the path of sovereign yields (specific to each bank, taking into accounting different maturities for sovereign debt portfolios), and the projected evolution of the stock of loans, deposits and sovereign debt holdings.[22] Net fees and commissions, non-interest rate expenses and other income are assumed to grow in line with total assets.[23] However, in the adverse scenario, net fees and commission are assumed to drop by 10 percent in 2022, stay constant in 2023, and grow again during 2024-2026. The simulations are performed under a static balance sheet (assuming that bank assets and liabilities stay broadly constant), with the share of write-offs and maturing loans at the asset class level consistent with recent historical data from supervisory files. There is no managerial action and no portfolio rebalancing.

B. Modeling of Credit Risk and RWAs

Non-Financial Corporates' Default Probabilities and LGDs

29. Satellite models for non-financial private sector exposures are based on bank level panel regressions of default rates and loss rates (see Box 2). Time series and pooled panel regressions of default rates and loss rates are run for loans to NFCs and are used to generate simulations of annualized PDs at a quarterly frequency, which are then averaged into annual PDs, and scenario-dependent estimates of LGDs.[24] The period of estimation 2008:Q1 – 2019:Q4 has two desirable properties: first, it includes at least one financial cycle (the Global Financial Crisis); second, it does not include the pandemic period. The pandemic is characterized by unprecedented policy support which may have attenuated the relationship between credit risk and the macroeconomic cycle. Thus, our model is likely to result in a more conservative estimate of credit risk in the banking system as it does not incorporate the direct impact of specific policies that may have helped support

[21] Risk densities for other RWAs are assumed to remain constant. Other RWAs categories include securitization in the banking book, equity risk in the banking book, counterparty credit risks, and CVA and CPP risks.

[22] Regarding lending rates and deposit rates, the levels of interest rates are bank-specific and depend on the initial starting value at the end of 2020 provided by each bank, but changes in these interest rates are common to all banks, and determined by the changes in the predicted values based on the regression models.

[23] Satellite models were developed for net fees and commission income, non-interest expenses and other income, but they turned out to be only very weakly correlated with the macro-financial cycle and had weak in-sample properties. The preferred option was to assume that net fees and commissions, non-interest rate expenses, and other income each remain a constant share of total assets throughout the projection horizon.

[24] LGDs are estimated based on the formula: LGD = Loss rate / default frequency.

borrowers. The specification search revealed that a model with real GDP growth as macroeconomic control variable performed the best both for sectoral regressions and for pooled regressions. However, for completeness we also report coefficients for unemployment and FCI for sectoral regressions; and the coefficient for FCI for pooled regressions.[25]

30. The preferred estimates show a strong correlation between real GDP growth and credit risk. Pooled panel regressions are reported in Table 13 and the sectoral regression coefficients of macroeconomic variables (each entered one at a time) are reported in Table 13. The estimated coefficients of the pooled panel regressions (column 1 of Table 13.A) imply that a 3 standard deviation shock to real GDP growth results in a 0.25 percentage points average increase in non-financial corporations' annualized default rates, starting from a 0.53 percent annualized average default rate for the banking system (based on the EBA risk dashboard for 2021:Q3). This implies a 47 percent increase in the NFC default rate and a 12 percent increase in loss rate by 2024. Sectoral regressions reported in Table 13 show that there is however substantial difference across sectors regarding the impact of macroeconomic variables on credit risk, with sectors such as manufacturing and retail and wholesale trade being more sensitive to the macroeconomic cycle than other sectors. Aggregate data on sectoral exposures by type of banks published by Haver Analytics were relied upon to construct aggregated regression coefficients from sectoral regressions by type of banks. These aggregated coefficients are reported in Table 13. For the purpose of the stress tests, for LSIs we use the average coefficient on the real GDP variable for Savings banks and for credit cooperatives (the coefficients are very close at the 3rd decimal); for SIs, we use the average coefficient on the real GDP variable for big banks and for Landesbanken (coefficients are, again, very similar).

[25] In the pooled regressions, the coefficient on the unemployment rate does not appear to display desirable properties from a statistical or economic perspective, and therefore the unemployment rate is not considered an appropriate variable in the pooled regressions.

Box 2. Germany: Credit Risk Modeling for Loans to Non-Financial Corporates

We consider quarterly sectoral level and pooled OLS regressions of default rates and loss rates on macroeconomic variables. Default rates and loss rates on domestic exposures were constructed from German credit registry data cleaned and aggregated by the Bundesbank. The period of estimation is 2008:Q1 to 2019:Q4. Hence it includes the macro-financial cycle from the Global Financial Crisis, as well as of the Euro Area crisis of 2011-2012.

For each sector s, the sectoral level specification is as follows:

$$y_t = \beta \cdot y_{t-1} + \alpha \cdot X_t + Q_t + \varepsilon_t \quad (1)$$

Where y_t is either the default rate on loans, computed as the share of outstanding loans for which a default event occurs, or the loss rate on outstanding loans, occurring during a given quarter; X_t is a vector of macroeconomic variables; Q_t is a set of quarterly dummy variables to control for seasonality of the data; and ε_t is a residual.

The pooled sectoral regressions (pooling all sectors together) are specified as follows:

$$y_{s,t} = \beta \cdot y_{s,t-1} + \alpha \cdot X_t + Q_t + \varepsilon_{s,t} \quad (2a)$$

For robustness, we also considered specifications with sectoral fixed effects f_s:

$$y_{s,t} = \beta \cdot y_{s,t-1} + \alpha \cdot X_t + Q_t + f_s + \varepsilon_{s,t} \quad (2b)$$

In specifications (2a) and (2b), error terms $\varepsilon_{s,t}$ are clustered by quarter to control for potential correlations of default rates and loss rates across economic sectors. The economic sectors included in the analysis are the following NACE economic sectors: Agriculture, forestry and fishing (A); Mining and Quarrying (B); Manufacturing (C); Electricity, gas, steam and air conditioning supply (D); Water Supply, sewerage, waste management and remediation activities (E); Construction (F); Wholesale and retail trade, repair of motor vehicles, and motorcycles (G); Transporting and Storage (H); Accommodation and food service activities (I); Information and communication (J); Financial and insurance activities (K); Real Estate Activities (L); Professional, scientific and technical activities (M); Administrative and support service activities (N); Public administration and defense; compulsory social security (O); Arts, entertainment and recreation (R); and Other Services Activities (S).

A set of potential explanatory macro-financial variable that could influence credit risk was considered, and regressions were run with each of the potential explanatory variables entered one at a time. From these variables, only those with the correct sign and statistical significance in the bivariate regressions were selected. If a variable is significant with the correct sign, we will combine it with other significant variables in multivariate regressions. If they all remained statistically significant and with the correct sign, we would keep that specification. If they are not all statistically significant, we would retain the specification with only the significant variables. A sufficiently high R2 would ensure that we have good out-of-sample forecasting properties. The set of potential explanatory variables include year-on-year real GDP growth, an index of financial condition, the unemployment rate, and short-term and long-term interest rates.

Households' Default Probabilities

31. Credit risk for households is estimated from a micro simulation model based on the ECB Household and Finance Consumption Survey (Box 3).[26] The advantage of relying on a micro survey is that the risk of default can be estimated from actual micro data taking into account household's total indebtedness and debt service, other spending on goods and services, their gross financial assets which provide a buffer than can be drawn upon, and the actual wage income of a household, and the remaining LTV on mortgage debt. Hence, the risk of default can be estimated from very precise information. [27] Given that mortgages are full recourse in European countries, the micro-simulations assume that households draw down on their financial assets to repay their debt and default if and only if their financial assets are fully depleted and other income are insufficient to cover debt service and the estimated necessary spending on goods and services. It is assumed that households may default on their debt only if they become unemployed. The simulations take into account the replacement rates of wage income resulting from unemployment insurance and the likelihood that a household may return to employment. For SIs, the evolution of the PD and LGD is benchmarked on the starting point PD and LGD reported by each bank in supervisory templates; for LSIs, it is benchmarked on the 2021:Q3 aggregate PD and LGD published by the EBA on the risk dashboard.

Box 3. Germany: Micro-Simulation Model

A micro simulation model based on the 2017 Household and Finance Consumption Survey and the US PSID is relied upon to estimate credit risk parameters for households. The key equations of the model are the following ones.

First, the probability of default is estimated on the subset of households reporting some mortgage debt. For these households, the model considers the total debt, mortgages and other debts, of a household.

The probability of default is related to the probability of unemployment of a household as follows:

$$PD_{i,t} = Proba[Unemployment]_{i,t} \times conditional\_PD_{i,t} \quad (3)$$

Where $PD_{i,t}$ is the probability of default of household i at date t, $Proba[Unemployment]_{i,t}$ is the probability of unemployment of household i at date t, and $conditional\_PD_{i,t}$ is the probability of default of household i at date t conditional on being unemployed. This equation states that the probability of default is equal to the probability of being unemployed times the probability of default conditional on being unemployed. This assumes that households may default only if they are unemployed (which is implied by the assumption that wage income and other income are sufficient to service household debt interest and principal repayments).

$$Conditional\_PD_{i,t} = (1 - Proba[employment])_{i,t} \times \left[1 \middle| Financial\_Assets_{i,t} < 0\right] \quad (4)$$

[26] We rely on a simplified version of the micro-macro model of Gross, M., Tressel, T., Ding, X., and Terenau, E., 2022, "What Drives Mortgage Default Risk in Europe and the US?", IMF Working Paper No. 2022/065. Data for the US are from the 2017 US Panel Survey of Income Dynamics (PSID).

[27] However, by relying on 2017 data, which are the latest available for European countries, we may underestimate potential risks if more recent waves of mortgages originated are more risky on the margin than the stock of mortgages in the population in 2017.

Box 3. Germany: Micro-Simulation Model (Concluded)

Where $[1|Assets_{i,t} < 0]$ takes the value zero if gross financial assets are positive and the value 1 if gross financial assets are negative, and $Proba[employment]$ is the probability of returning to employment from unemployment by date t. This equation (2) states that conditionally on being unemployed at date t-1, a household will default if it remains unemployed and his stock of financial assets is entirely depleted at date t.

In other words, an unemployed household will default if and only if:

$$Financial\_Assets_{i,t} < 0 \quad (5)$$

If employed, the dynamics of financial assets $A_{i,t}$ of a household is given by:

$$A_{i,t} = (1 + r) \times A_{i,t-1} + other_{inc_{i,t}} + Wage_{i,t} - debt\_services_{i,t} - Spending\_GS_{i,t} \quad (6)$$

If unemployed, it is given by:

$$A_{i,t} = (1 + r) \times A_{i,t-1} + other_{inc_{i,t}} + UB_{i,t} - debt\_service_{i,t} - Spending\_GS_{i,} \quad (7)$$

With unemployment benefits $UB_{i,t}$ given by:

$$UB_{i,t} = Net\_replacement_{t,r} \times Wage_{i,t} \quad (8)$$

Where $Net\_replacement_{t,r}$ is the net replacement rate at date t , r quarters after becoming unemployed.

Debt service, interest and principal is $debt\_service_{i,t}$, and the amount spent on goods and services by a household during each period is given by: $Spending\_GS_i$. This spending is obtained from the survey itself, and is truncated at the 10th percentile of the distribution as a lower bound and the median of the distribution as an upper bound. This truncation is done first to correct for potential errors (the 10th percentile is a few hundred euros monthly) and to allow for compression of spending (to the median which is a few thousand euros) for households with high spending levels.

The LGD is given by: $Max\{0, LTV - 1\}$ at the time of default, where the LTV is computed based on the remaining stock of debt at time of default divided by the value of the property at the time of default. The value of the property at time of default is given by the initial value reported in the survey times the growth rate of real estate prices assumed in the macroeconomic scenario.

Replacement rates and the likelihood of exit from unemployment r quarters after becoming unemployed are estimated from macroeconomic data on net replacement rates and outflows from unemployment published by the OECD.

32. The aggregated default risk implied by the credit risk models for NFCs and for households imply that, in the adverse scenario, default risk doubles by 2024 in the banking system. In the baseline WEO projections, the default risk for NFCs moderately increases while the default rate for households remains broadly stable initially and then declines slightly by the end of the projection horizon. In the adverse scenario, the default risk for NFCs increases by 46-47 percent in 2023 and 2024; for households, the increase in default risk is more important and reaches about 138 percent by 2024. Based on the share of loans to NFCs and to households for the banking system as a whole, these estimates imply an increase in overall default risk for loans to the non-financial private sector of 106 percent by 2024.

Sectoral Germany PD multipliers						
	2021	2022	2023	2024	2025	2026
non-financial corporates						
Baseline	1	1.23	1.04	1.08	1.10	1.12
Adverse scenario	1	1.47	1.47	1.46	1.25	1.10
households						
Baseline	1	0.98	0.93	0.92	0.92	0.92
Adverse scenario	1	1.07	1.62	2.38	2.26	1.82
Aggregated Germany PD multipliers						
	2021	2022	2023	2024	2025	2026
Baseline	1	1.07	0.97	0.97	0.98	0.99
Adverse scenario	1	1.21	1.57	2.06	1.91	1.57

Source: German Credit Registry, WEO and IMF staff estimates

Sovereign and Corporate Bonds' Default Probabilities

33. For the baseline WEO and the adverse scenario, PDs for sovereign and corporate bond exposures are estimated based on projections of sovereign bond yields and short-term rates. A Merton-based transformation is used to convert the spread between 10-year sovereign yields and the repo rate (S_t) into a PD proxy. Based on approximated bank level residual time to maturity T-t, the implied risk neutral PD is given by:

$$PD_t = \frac{1 - e^{-S_t(T-t)}}{LGD_t}$$

The residual maturity of each bank's fixed income securities exposures to sovereign and corporates is obtained from macroeconomic data (Haver). We assume a LGD of 45 percent, as in recent FSAPs (such as France, the Euro Area and the US). As customary in FSAPs, an economic approach is considered, and credit risk is estimated on the total exposure of each bank.

IFRS9 Modeling, RWAs and other Parameters

34. Loss given default (LGDs) and PDs assumptions were informed by the banks' supervisory data. SI**s** report supervisory data on the PiT IFRS9 transition rates (from which PiT PDs can be derived), as well as on TTC PDs LGDs for IRB banks. We considered in the adverse scenario the TTC LGDs and PDs provided by each bank and the TTC LGDs in the baseline scenario, and shocked in the adverse scenario for exposures to households according to the RRE price projections. For LSIs, starting point LGDs and PDs are obtained from the 2021:Q3 EBA Risk Dashboard.

35. Accrual versus non-accrual exposures. Under the FSAP stress testing approach, it is assumed that non-accrual exposures (e.g., non-performing or S3 exposures) do not earn interest income. Hence, net income "before stress" can decline even if other parameters are unchanged due to the net accumulation of the share of non-accrual exposures in the balance sheet of banks.

36. Under the economic approach of the stress tests and following the IFRS9 accounting framework, provisions of SIs are computed based on the expected lifetime loss of new net flows into the Stage 2 and 3 buckets during each period. This involves projecting PDs beyond the scenario horizon, assuming the life-time horizon M is truncated at 5 years maximum:

$$ECL_t = \sum_{s=t+1}^{t+M} \frac{PD_s^* \times LGD_s \times EAD_{s-1}}{(1+r)^s}$$

Where the residual probability of default PD_s^* is the probability of default during period s conditional on not defaulting until period $s-1$ and r is a discount factor (such as short-term interest rate)

$$PD_s^* = PD_s \times \prod_{u=1}^{s-1}(1 - PD_u)$$

For each exposure class, the evolution of the transition matrices over the scenario horizon is linked to the projected PDs based on the beta-linking approach.[28] The approach involves making use of elasticities of transition rates β with respect to PDs. In absence of data to estimate such elasticities, we make use of the same elasticities as relied upon in the France and Canada FSAP (0.5, -0.5), which is consistent with distance to default methodology and equal probability in the absence of any additional information about transition probabilities. For example, considering the transition from Stage 1 to Stage 2, its change over time is linked to the change in the PD during the same quarter:

$$\Delta TR_{12} = \beta_{12} \times \Delta PD$$

For SIs, we constructed bank-by-bank starting point annual transition matrices from FINREP supervisory templates for 2021. Once transition matrices conditional on scenarios are projected, we are able to derive the projected stocks of exposures in Stages 1–3, the required amount of provisions, and the dynamics of the capital stock.

37. Provisions. Flows of provisions are determined based on an expected loss approach. For LSIs under national GAAP accounting, loan loss provisions of bank i for asset class s during year t are given by:

$$Provisions_{i,s,t} = PD_{i,s,t} \times LGD_{i,s,t} \times Exposure_{i,s,t}$$

For SIs under IFRS9 accounting, flows of provisions are determined by the combination of annual expected defaulted S1 exposures, and lifetime expected losses for S2 and S3 exposures (Box 4).

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

Box 4. Provisioning under IFRS9 Accounting

Flows of provisions are determined by the change in the stock of provisions, plus write-offs if any. The stock of provisions, in turn, is given by the expected credit losses (annual or lifetime, depending on whether the exposure is classified as S1 or S2) for each of the S1, S2 and S3 exposures:

$$Provision\_stock_t = Provision\_stock_{S1,t} + Provision\_stock_{S2,t} + Provision\_stock_{S3,t}$$

For S1 exposures, the stock of provisions is equal to the expected losses during the year t:

$$Provision\_stock_{S1,t} = (TR1 - 3) \times LGD \times S1$$

For S2 exposures, the stock of provisions is equal to the lifetime expected credit losses:

$$Provision\_stock_{S2,t} = \sum_{u=t+1}^{t+M} \left((TR2 - 3^*) \times LGD_u \times S2_{u-1}\right)/(1+r)^{u-t}$$

Where M is the horizon at which lifetime expected credit losses are estimated, and r is a discount rate.

For S3 exposures, the stock of provisions is equal to the non-recoverable part of defaulted exposures:

$$Provision\_stock_{S3,t} = LGD_t \times S3_t$$

38. Projections of RWAs are obtained as follows. Once the stock of capital is projected, for exposures booked under the IRB approach, credit risk evolves with the EAD, the PD, and the LGD. Updated weighted average through-the-cycle (TTC) PDs for non-defaulted exposures are used for RWAs calculations (with a smoothing parameter $x = 1/10$), namely:

$$\Delta \text{TTC\_PD} = x \cdot \Delta PiT\_PD$$

For exposures booked under the STA approach, a deterioration in credit risk is reflected in higher specific and collective allowances from higher default rates and lower creditworthiness of performing loans, as well as in higher capital requirements from credit risk downgrades of the underlying exposures.

For SIs, in line with the Basel III framework, RWAs were computed after applying the scaling factor of 1.06 to credit RWAs and using a 1.25 multiplier to the correlation parameter of all exposures to large regulated financial institutions and to all unregulated financial institutions. Difference in granularity of RWAs calculation were considered by applying original scaling factor, i.e., ratio of model calculated RWAs to reported RWAs at time t_0.

For SIs, the dynamics of IRB RWAs of bank i is given by:

$$RWAs_{i,t} = RWAs_{i,t-1} \times (1+g) \times (1+ul)$$

Where g is the growth rate of the assets, and ul is the rate of increase of unexpected losses. For LSIs, the dynamics of STA RWAs is given by:

$$RWAs_{i,t} = \left[RWAs_{i,t-1} - new\_provisions_{i,t} \right] \times (1 + g) + new\_NPLs_{i,t}$$

Where $new\_provisions_{i,t} = \sum_s LGD_{s,i,t} \times PD_{s,i,t} \times Net\_exposure_{s,i,t-1}$, and s is an asset class (household retail non-mortgage, household mortgage, non-financial corporation, financial institution, sovereign).

C. Modeling of Interest Rate Risks and Market Risks

39. Together with assumptions, a satellite model of the NII was developed to assess an upper bound to interest rate risks in the banking book. To ensure we obtain a conservative assessment of interest rate risk in the banking book, the analysis is performed under the assumption that shocks to policy rates/short-term market rates are fully passed through to the funding costs of banks.[29] The NII satellite model developed for the purpose of the FSAP implies that pass-through from deposit rates to lending rates is smaller than one. These assumptions result in very conservative estimates of the shocks to the NII. Using bank level data from Fitch Connect for the period 2006-2019, fixed effect panel regressions were estimated to relate NII of individual banks to macroeconomic variables:

$$\mathrm{NII}_{\mathrm{i,t}} = \alpha \times \mathrm{NII}_{\mathrm{i,t-1}} + \beta \cdot \mathrm{Macro}_{\mathrm{t}} + \mathrm{F}_{\mathrm{i}} + \varepsilon_{\mathrm{i,t}}$$

Where NII is the ratio of net interest income to total assets, $Macro_t$ is a vector of macroeconomic variables, F_i is a vector of bank fixed-effects, and $\varepsilon_{\mathrm{i,t}}$ is an error term clustered by year. Various macroeconomic explanatory variables were considered as explanatory variables, including real GDP growth, the unemployment rate, the inflation rate, the spread between the short-term rate and long-term bond yields, the growth rate of stock prices and a financial condition index. Pooled regressions (excluding bank fixed effects) were also considered as robustness test. Regressions are run for all banks, but also by type of banks, in particular for LSIs and for SIs.

40. NII is statistically and economically positively associated with the slope of the yield curve. The regression analysis finds that the spread between the short-term rate (the repo rate) and the long-term bond yield is positively and statistically associated with the NII, both for LSIs and for

[29] The analysis is performed under the conservative assumption that shocks to policy rates are fully passed through to funding costs of banks, and for SIs, the speed of pass-through is consistent with the supervisory data reporting in the "Interest Rate in the Banking Book" template of the ECB. The FSAP net interest income satellite model implies that pass-through from deposit rates to lending rates is smaller than one. These assumptions result in conservative estimates of the IRRBB.

SIs.[30] The coefficient on the spread variable is larger for LSIs than for SIs but both coefficients are statistically and economically significant. The coefficient of the lagged dependent variable is larger for LSIs than for SIs. This implies that shocks to market rates are much faster transmitted to the NII of SIs than to the NII of LSIs. However, the overall through to the NII of shocks to market rates of LSI (measured by $\alpha/(1-\beta)$) is larger for LSIs (0.37) than for SIs (0.17).

Dependent variable:NII/TA	LSI (1)	SI (2)
Lagged dependent variable	0.509***	0.409*
Spread (long-term-short term)	0.185***	0.104*
Constant	0.836***	0.806***
Observations	18,380	256
R-squared	0.315	0.013
Number of banks	1,284	20

Sources: Fitch Connect, WEO, GFSR and IMF staff

41. Shocks to NII estimated from the empirical model results in a compression of margins in the adverse scenario but also to some extent in the baseline. The spread between the effective lending rate and the effective deposit rate/funding cost is approximated by:

$$(\boldsymbol{r_L - r_D}) \approx \boldsymbol{NII}$$

From the regression model:

$$(\boldsymbol{r_{L,t} - r_{D,t}}) \approx \alpha \times (r_{L,t-1} - r_{D,t-1}) + \beta \times spread_t$$

Hence, considering the complete pass-through over time (assumed to occur in 5 years):

$$\Delta r_{L,t,t-1} = \Delta r_{D,t,t-1} + \beta/(1-\alpha) \times \Delta spread_{t,t-1}$$

This equation provides the pass-through from shocks to deposit rates to lending rates of the bank. It is scenario dependent because it depends on the shocks to the slope of the yield curve. A scenario in which the slope of the yield curve flattens (respectively steepens) will imply that the NII (the spread between lending rates and deposit rates) declines (respectively increases), corresponding to a negative (respectively positive) interest rate risk. The annual shocks to NII implied by these estimates of the pass-through from deposit rates to lending rates for each of the scenarios are reported in the text table.

Δ(rL-rD) (in basis points)				
	LSIs		SIs	
	Adverse scenario	Baseline	Adverse scenario	Baseline
2022	-10	6	-5	3
2023	-37	-23	-17	-11
2024	0	-4	0	-2
2025	20	1	9	0
2026	25	3	12	2

Source: Fitch Connect, WEO and IMF staff estimates

42. The timing of realization of interest rate shocks depends on the maturity transformation gaps from liabilities to assets which may exacerbate the compression of margins in the short-term. Given that interest-bearing assets typically have longer duration than

[30] Other macroeconomic variables turned out to be insignificant.

liabilities, the repricing of assets is slower than of liabilities, and as a result, a funding shock tends to compress the net interest income. In addition, a pass-through from deposit rates to lending rates lower than one results in additional compression of margins. All deposit rates are assumed to evolve with economic conditions and benchmark rates; specifically, in the baseline scenario, the deposit rate is taken from the Article IV projection of the effective deposit rate; in the adverse scenario, shocks to deposit rates are assumed to be fully aligned with shocks to the EONIA.

- **For SIs,** projections of funding and lending rates from the scenarios and the satellite model are mapped to banks' financial assets and liabilities by product and counterparty using the short-term exercise (STE) IRRBB template of the ECB. The IRRBB template provides bank-specific maturity ladder for fixed rate instruments and repricing date for floating rate instruments on portfolio level for both assets and liabilities. The template includes the following categories: (i) the asset side of the banking book comprises generic products related to debt securities and loans and advances underwritten by the banks; and: (ii) the liabilities side comprises retail and wholesale overnight and term deposits, repos as well as debt securities.[31]

- **For LSIs**, in absence of bank level data on the maturity ladder and repricing of interest-bearing assets and liabilities, the FSAP was not able to conduct a complete analysis of interest rate risk in the banking book. As an alternative, aggregate data on the maturity structure of retail deposits and of wholesale deposits were compiled from Haver Analytics and used to estimate the maturity structure of each banks' liabilities and applying the same maturity structure to its interest-bearing assets. This approach effectively neutralizes the impact over time of the maturity transformation between assets and liabilities on the NII. However, it still allows to assess the implication of the maturity of liabilities on how a funding shock and its pass-through to lending rates affects the NII over time.

43. Assessment of market risk for fixed-income securities is based a modified duration approach. The fair value of debt securities can change due to changes in policy rates as well as changes in credit spreads. The assessment is performed for sovereign debt securities for the domestic sovereign, and for domestic corporate bonds and domestic financial institutions bonds. For SIs, exposures to the 5 sovereigns are also included in the analysis. Policy rates and sovereign spreads are obtained from the baseline projections and adverse scenario simulations. Spreads of corporate bonds to sovereign yields are obtained from a satellite model. The formulas are the following:

For repricing risk:

$$Valuation\_change = -duration/(1 + rf + cs) \times \Delta rf$$

For credit spread risk:

[31] The IRRBB does not include options and thus, potential effects of embedded options under the considered scenarios could not be resolved in the calculations. As a result of this effect, the ST could be overestimating the interest rate risk in the adverse scenario. However, this overestimation would likely be partially offset due to the potential increases in the cost of hedging under the adverse market conditions in assumed in the stress test. The FSAP analysis did not factor in these potential increases in hedging costs, instead it assumed that they remain constant as a share of assets as in the starting point of 2021 net income

$$Valuation\_change = -duration/(1 + rf + cs) \times \Delta cs$$

Where rf is the risk-free rate (or policy rate), cs is the credit spread, and $duration$ is the remaining duration of the portfolio of securities considered (sovereign, non-financial corporate, financial).

- **For SIs:** for these banks under IFRS9 accounting, only bonds which were classified as Fair Value through Other Comprehensive (FVOCI) and Fair Value through Profit or Loss (FVPL) were included into market risk scenario. Other bonds classified as Amortized Cost (AC) were subject to PD/LGD expected loss approach and treated under sovereign asset class. Remaining duration of fixed income securities are approximated by aggregate data obtained from Haver, applying the aggregate duration of the fixed income security of a particular class of assets to each bank.

- **For LSIs:** for these banks under national GAAP, Held for Trading (HFT) bonds were included into the market risk analysis. However, for a large number of banks, a breakdown between HFT, AFS (available for sale) and AC (amortized cost) exposures were not available in the FINREP template. For such cases, it was assumed that all exposures were HFT. Data on the remaining duration of fixed-income securities is approximated by aggregate data obtained from Haver, applying the aggregate duration of the fixed income security of a particular class of assets to each bank.

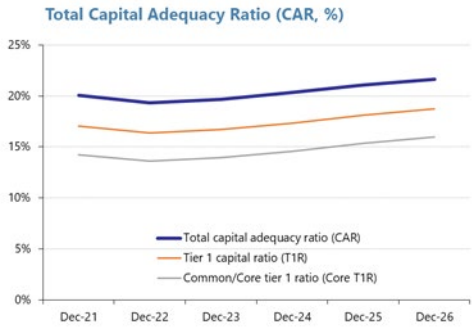
D. Solvency Stress Test Results

Significant Institutions

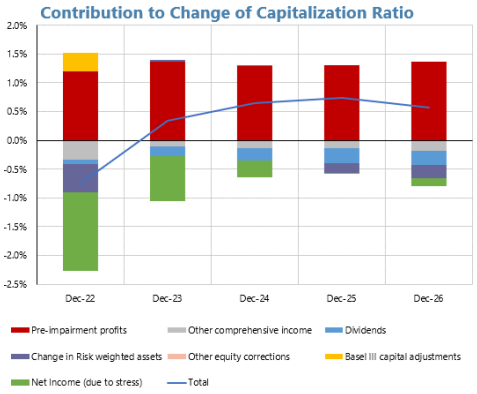
44. The simulations performed under the baseline show that the banking system is well capitalized, conditional on no new adverse shocks materializing (Figure 8). Under the baseline scenario, aggregate capitalization remains high, above 13.6 percent for the CET1 ratio. A moderate decline occurs in 2022 due to interest and market risk, and some losses on FX exposures. The increase in capital is driven by net income despite some moderate near-term losses caused by the interest rate increase (which leads to interest rate risk and repricing risks). Credit risk parameters (aggregate PDs and aggregate LGDs) decline over time, which contribute to net income before provision and to lower provisions. Banks continue to pay dividends of 25 percent if net profit is positive.

Figure 8. Baseline Solvency Stress Test Simulations for SIs

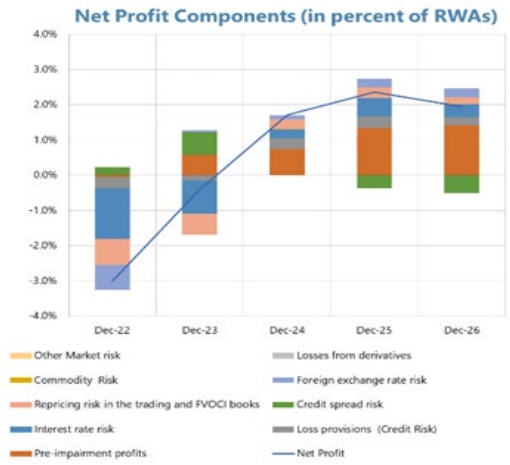
Aggregate capitalization remains strong under the baseline projections.



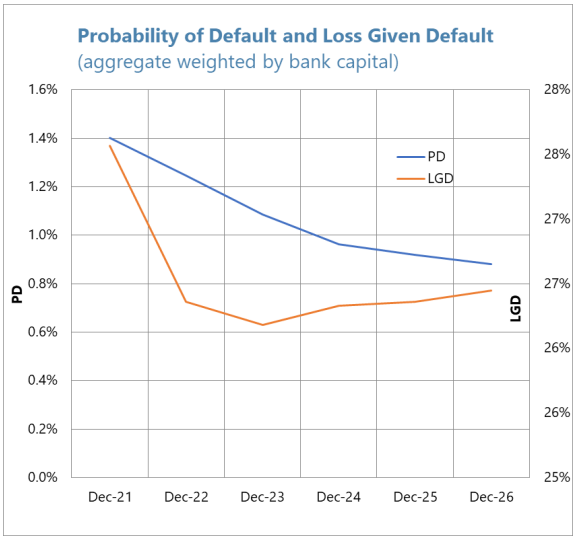
Capitalization reflects solid profits.



As net profit continues to grow.



Credit risk declines steadily.



Source: IMF staff estimates.

45. Under the adverse scenario, capital depletion from interest rate risk, market risk and credit risk results in modest recapitalization needs, while no banks have capital falling below the minimum CET1 ratio (Figure 9). Under the assumption that banks do not write-off non-performing exposures, the aggregate depletion of CET1 capital reaches 5.2 percent of RWAs by the end of 2023 from 14 percent and increases in subsequent years. High funding shocks combined with maturity/repricing gap between assets and liabilities, interest rate risk and market risk, together with higher RWAs and credit risks resulting from the sharp recession drive the decline in capital ratio. Net profits before credit and interest rate risks are also significantly impacted by the sharp drop of fee and commission income.[32] Three banks fall below the hurdle rate in 2022-23, but capitalization

[32] In Figure xxx. For ease of presentation, Fee and Commission Income is accounted in the variable "net profit before loss due to stress".

remains above the minimum CET1 ratio, and the aggregate capital shortfall remains moderate at around euros 20 bn. Under the assumption that banks can write-offs non-performing exposures, the CET1 capital depletion is 5.0 percentage points of RWAs by 2023 and the capital shortfall is euros 18.7 bn (0.52 percent of GDP). Our hurdle rate includes two buffers that could possibly be released under a severe macroeconomic shock: the counter-cyclical capital buffer and the capital conservation buffer. Assuming the CCyB could be released under the adverse scenario, the capital shortfall would become euros 14bn (0.39 percent of GDP) under no write-offs, and very small, at euros 200 mil (0.01 percent of GDP), if banks write-offs non-performing exposures.

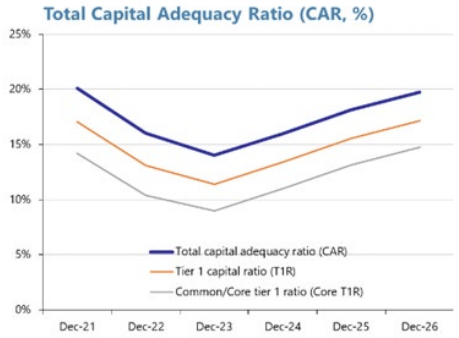
Less Significant Institutions

46. Under the baseline and the adverse scenario, the LSI capitalization ratio remains high (Figure 10). Under the baseline, while the aggregate CET1 capitalization remains strong and continues to rise to 17.7 percent of RWAs, 8-9 banks fail the hurdle rate depending on whether the CCyB is included or not in the hurdle rate. These are banks that are weakly capitalized in 2021. But these banks account for a tiny share of the assets of the LSIs, and the recapitalization needs are small in percent of GDP. Under the adverse scenario, aggregate CET1 capitalization increases very moderately to about 16.3 percent of RWAs. Despite the shocks, only 18-21 banks fail the hurdle rate depending on whether the CCyB is included in the hurdle rate or not, and these banks account for 2.8-3 percent of total LSI assets.

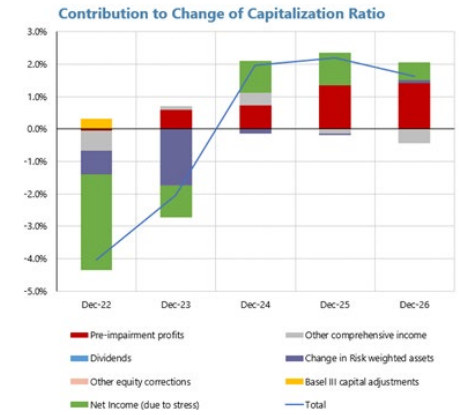
47. Net income remains positive as a result of strong pre-impairment income and relatively limited stress (Figure 11). Under the baseline, negative contributions to internal capital accumulation is the result of provisions, some increase in RWAs, dividends and market risk. Under the adverse scenario, higher provisions and RWAs due to impaired exposures, market risk and compression of interest margins drive the negative contributions to capital accumulation. While pre-impairment income remains strong, it is affected by a decline in accrual loans (non-accrual loans do not earn interest income) and shocks to fee and commission income in 2022.

Figure 9. SIs' Solvency Stress Test Under the Adverse Scenario

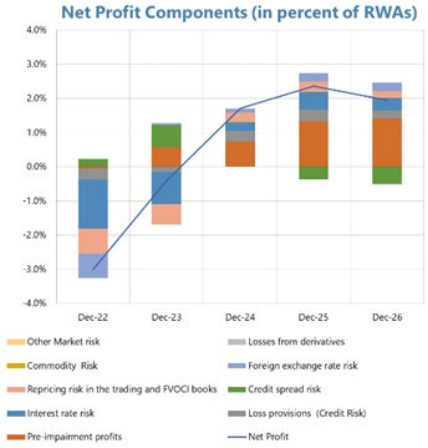
Aggregate capital is depleted in 2022 and 2023…



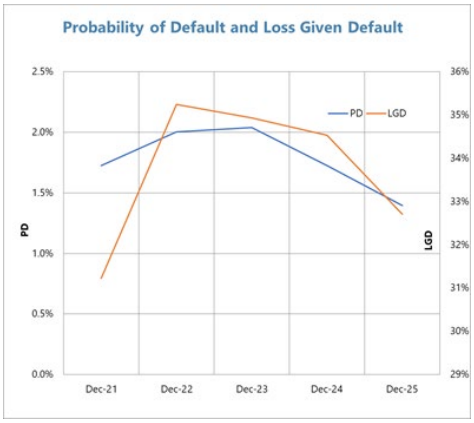
…reflecting stress factors and higher RWAs.



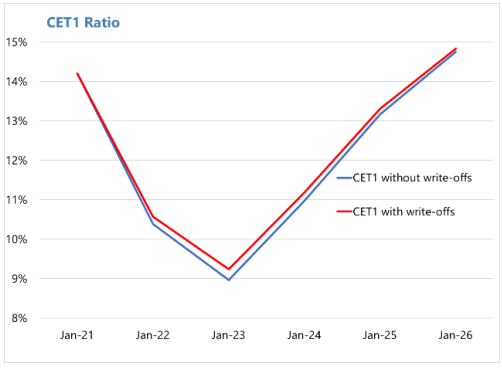
Net profit is eroded by interest rate risk, market risk, credit risk and a fall in fee income.



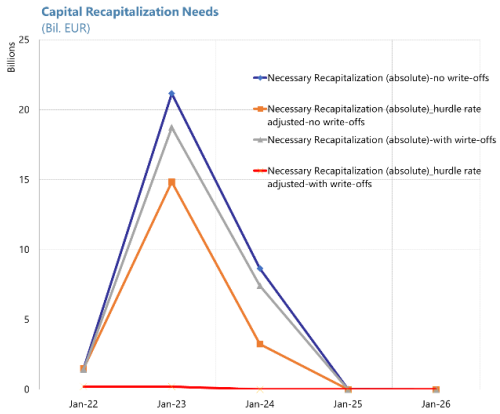
Expected losses increase significantly in 2022…



…allowing for write-offs results in moderately higher aggregate capital.



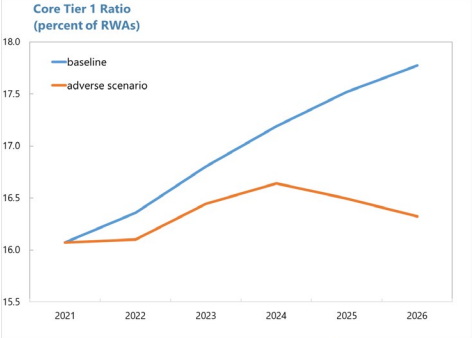
The capital shortfall becomes small if write-offs take place and the CCyB is released.



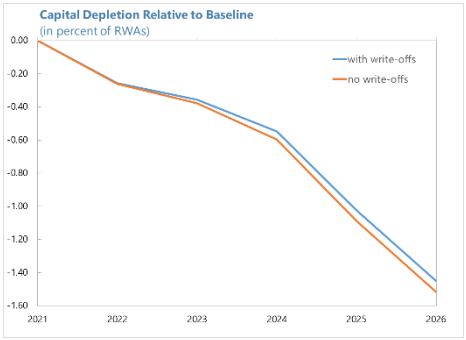
Source: IMF staff estimates.

Figure 10a. Solvency Stress Test of Less Significant Institutions

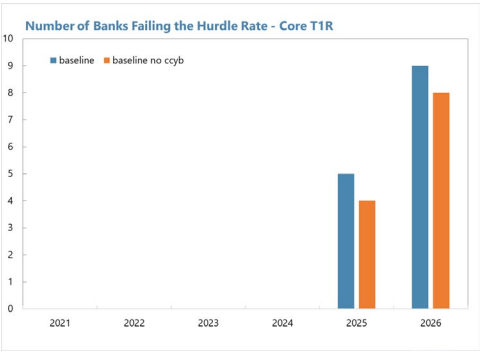
Under the baseline, capitalization of LSIs continues to rise, up to 17.8 percent of RWAs, while under the adverse scenario, it remains at about 16.3 percent of RWAs.



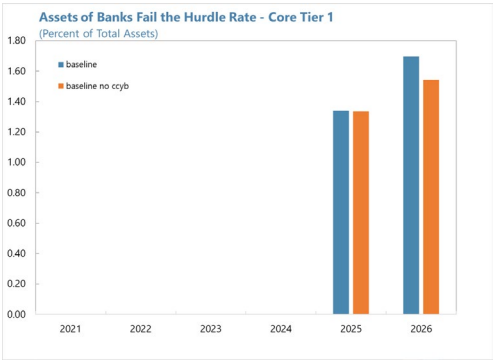
Relative to the baseline, capital depletion reaches -1.45 to -1.52 percent of RWAs depending on whether write-offs are allowed or not.



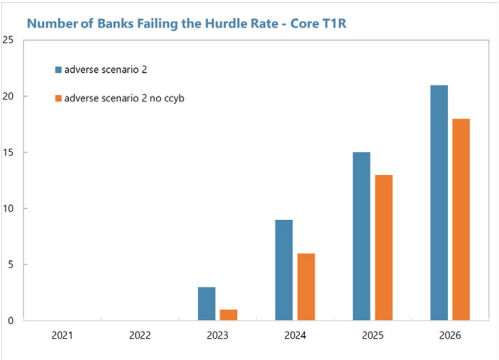
Under the baseline, 8-9 banks fail the hurdle rate depending on whether the CCyB is included or not.



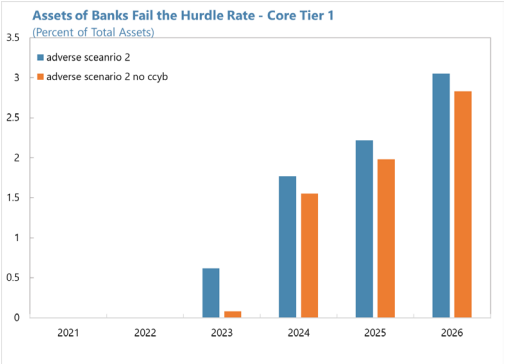
These banks account for 1.55-1.7 percent of total LSI assets.



Under the adverse scenario, 18-21 fail the hurdle rate depending on whether the CCyB is included in the hurdle rate.



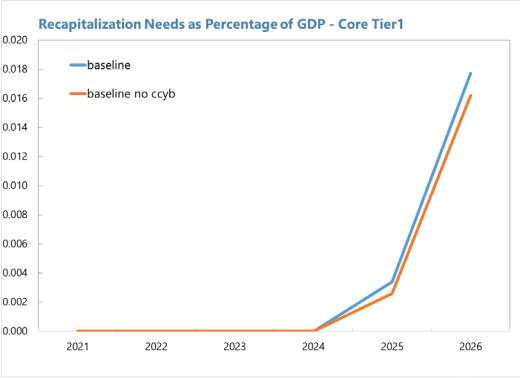
These banks account for 2.83-3.04 percent of total LSI assets.



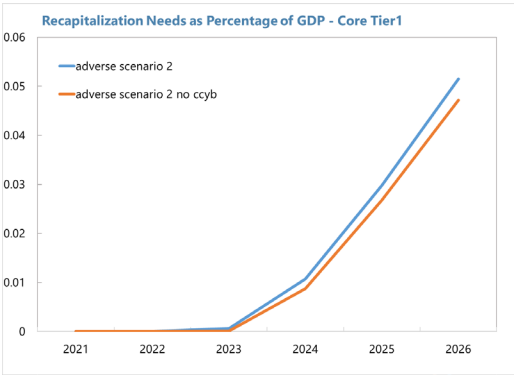
Source: IMF staff estimates.

Figure 10b. Solvency Stress Test of Less Significant Institutions II

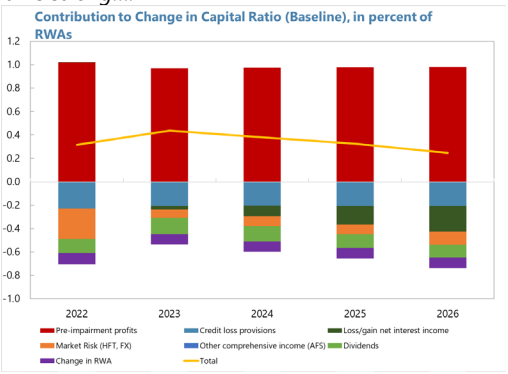
Under the baseline scenario, recapitalization needs reach 0.016-0.018 percent of GDP depending on whether the CCyB is included in the hurdle rate or not….



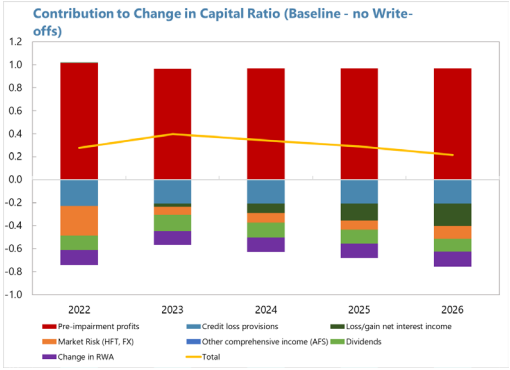
Under the adverse scenario, recapitalization needs reach 0.047-0.051 percent of GDP depending on whether the CCyB is included in the hurdle rate or not….



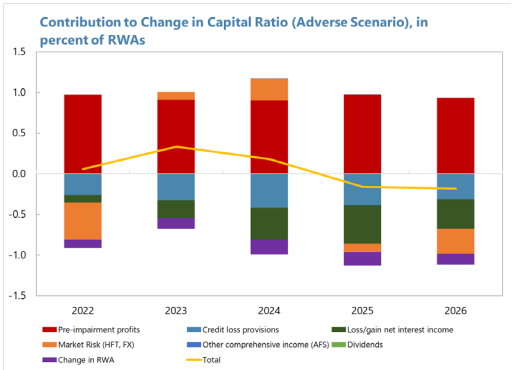
Allowing for write-offs, provisions, market risk and dividends drive capital depletion, but pre-stress profit remains strong….



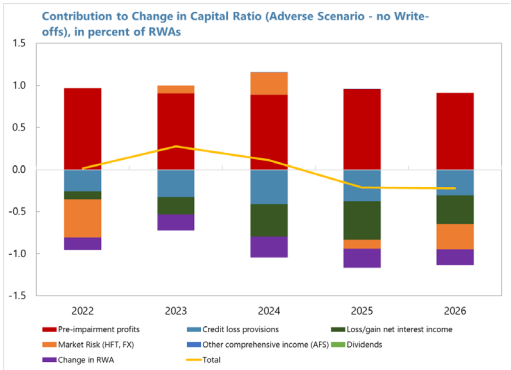
If impaired assets accumulate in the balance sheets, RWAs and non-accrual loans are moderately higher….



With write-offs, provisions, NII compression and market risk are the main drivers of capital depletion…



If write-offs do not take place, pre-impairment profits are lower due to higher non-accrual loans and RWAs are higher….



Source: IMF staff estimates.

LIQUIDITY STRESS TEST OF BANKS

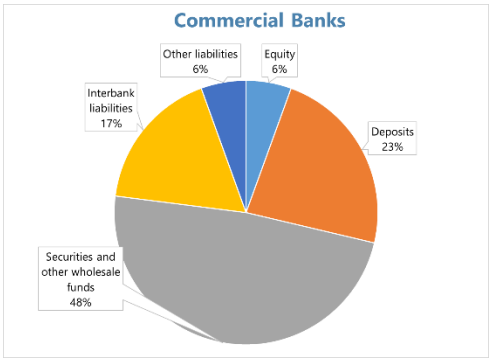
A. Overview

48. An intrinsic challenge for all banks is to invest their funds in high-yield and comparatively low-risk investments (achieving a proper balance between profitability and risk) while maintaining a sufficient buffer of "idle," or comparatively low-yield, assets that can be easily liquidated to honor an unexpected surge in demand for cash. Identifying the proper value of such buffers is complicated by the uncertain extent of a bank's payment obligations, which can surge rapidly and unexpectedly under adverse conditions and "tail" events. Liquidity can be very volatile at times of stress and even apparently large buffers may be inadequate to withstand either a systemic shock or a sudden idiosyncratic intense increase in demands on a bank's liquidity by its client counterparts.

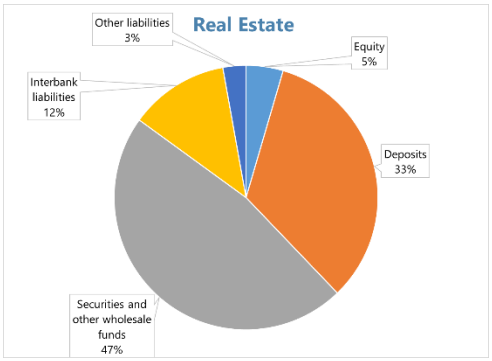
49. The liquidity stress tests discussed in this chapter aim at addressing these issues by analyzing in detail the potential flows and effective liquidity buffers that could materialize, under stress. The analysis aims at determining whether a bank's liquidity buffers would enable it to continue to perform its normal activities ("going concern hypothesis") without resorting to extraordinary liquidity support (ordinary support from the central bank is admitted), even in the face of exceptional demands on its liquidity.

Figure 11. Germany: Funding Mix Profile of the Banking System

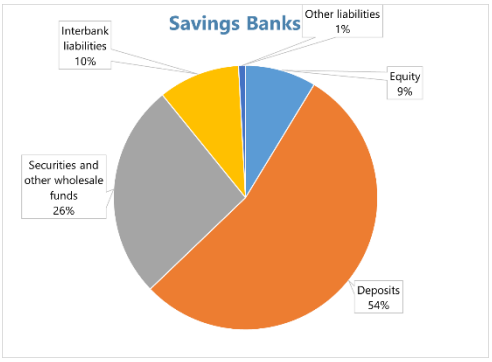
Commercial banks derive half of their funds from wholesale sources…



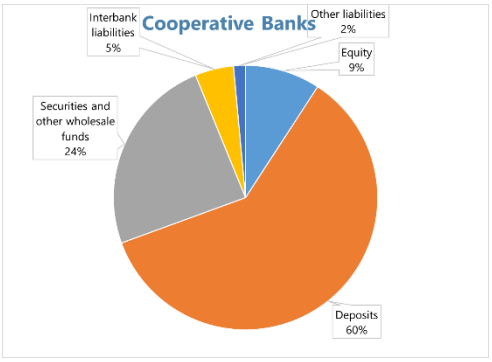
…and real estate banks from Pfandbriefe *(covered bonds).*



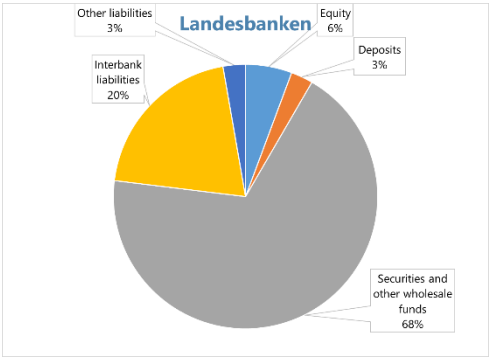
Savings banks and cooperative banks, instead….



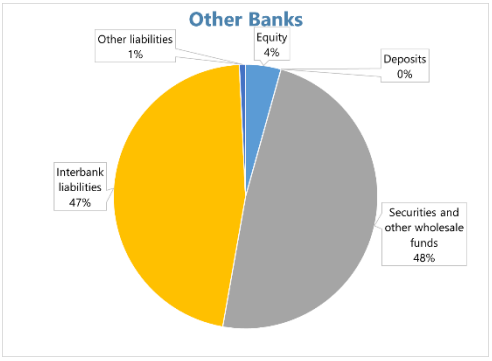
…are funded mainly by customer deposits.



Landesbanken *collect few deposits and rely heavily on wholesale and interbank funds.*



Other banks are a heterogeneous group, but almost all their funding comes from wholesale and interbank sources.



Sources: Authorities' data; and Fund staff elaboration.

B. Funding Profiles and Liquidity Conditions

50. The German banking sector has leaned toward a risk averse approach to liquidity, potentially foregoing some profit opportunities to maintain ample safety buffers. Liquidity indicators appear robust, with an average liquid assets-to-total assets (LATA) ratio of 28.3 percent and LCR (163 percent) and NSFR (125 percent) ratios significantly above the applicable regulatory

floors in September 2021 (Figure 13); while profitability of German banks appears somewhat weaker and has somewhat lagged behind peers.

51. The banking system has significantly increased liquidity buffers since the 2016 FSAP. German banks entered the Covid pandemic crisis with large excess liquidity.[33] At end-2019, before the start of the pandemic, German banks held on average about one-fifth of their assets in liquid form. Commercial banks registered one of the highest ratios of liquid to total asset ratio (LATA) with 30.6 percent, while cooperative and savings banks had a much lower LATA (around 8 percent), having deposited most of their liquidity at their respective network institutions (*Landesbanken and* DZ Bank).[34] Building societies and real estate banks also exhibited a low LATA but benefited from the strong liquidity buffers built in their *Pfandbriefe* funding model (Box K). The average LCR ratios for the sector as a whole stood at 158 percent, well above the regulatory minimum of 100 percent and above the average reported in the 2016 FSAP. In fact, there were concerns that excess liquidity at some banks (especially large commercial banks) might be hurting their profitability.

52. The funding structure of German banks varies across bank categories reflecting their different business models. Commercial banks, which are funded primarily wholesale, bear a higher liquidity risk that they mitigate by holding larger liquidity buffers. Similarly, *Landesbanken* derive two-thirds of their funds from wholesale sources and hold comparatively large buffers. Real estate banks also resort largely to wholesale funds, but primarily in the form of mortgage covered bonds (*Pfandbriefe*), which are a highly regulated and comparatively stable source. Savings and cooperatives banks are primarily funded by customer deposits, a comparatively stable source, and in case of need can rely on support within their network (from peers and network institutions), which reduces the need to hold large amounts of idle liquid assets.

Box 5. Germany: Special Covered Bonds (*Pfandbriefe*)

Mortgage-related covered bonds issued by German banks (*Pfandbriefe*) are more stable than those issued by banks in other countries, because they are subject to more stringent regulations and include *Pfandbriefe* issued by building societies and former mortgage banks, i.e. banks whose operations up to 2005 were restricted predominantly to cover-eligible business.

Pfandbriefe are issued by credit institutions that are specifically authorized to do so (*Pfandbriefbanken*); their legal basis are the German Pfandbrief Act (established 2005) and EU Directive 2019/2162. At present there are about 80 *Pfandbriefbanken* and about 120 *Pfandbrief* programs. Each *Pfandbriefbank* identifies a set of assets ("cover pool") that are set aside as guarantee for the covered bonds. These assets typically include mortgage loans of various vintages (valued at 60% of their Mortgage Lending Value, MLV), ship and aircraft finance loans (also valued at 60% of their MLV), and public sector bonds (valued at 100% of their value).

[33] Liquidity in excess of regulatory requirements.

[34] Since the numerator of the LATA ratio by definition does not include interbank deposits, this ratio tends to underestimate the actual liquidity of the assets of savings and cooperative banks.

Box 5. Germany: Special Covered Bonds (*Pfandbriefe*) (Continued)

The cover pool may also include (up to 20% of *Pfandbrief* circulation) high quality liquid assets and must include a liquidity buffer equivalent to the contractual outflows of the outstanding covered bonds maturing in the following 180 days net of contractual inflows from cover assets falling due during that period (in other words, the cover pool includes sufficient counterbalancing capacity to cover the contractual outflows of the pool up to the 6-month maturity). The liquidity buffer can be used to pay out these outflows but must be replenished as new payment obligations fall into the 180-day maturity window as time passes.

Pfandbriefbanken and their cover pools are subject to special supervision, and cover pools are audited every three years. In case of default, creditors (holders of covered bonds) have double recourse: a general payment obligation of the issuing *Pfandbrief* bank, and, in case of issuer insolvency, on the assets included in the cover pool (with prior claim on other bank creditors); in case of a shortfall (i.e. unpaid *Pfandbrief* claims), *Pfandbrief* creditors would participate on a pro-rated basis with their shortfall amount in the general insolvency estate of the issuer.

The Mortgage Lending Value (MLV) reflects the "long-term, sustainable value of the property being mortgaged," excluding cyclical fluctuations as well as nonsustainable speculative increases. It is assessed conservatively using a double methodology, and if the values returned by the two methods differ by more than 20% the bank must provide an explanation for such differences. If the market value of the asset increases above the MLV, this provides an additional buffer (on top of the 40% haircut on the MLV) for the bondholders in case of default; the MLV, and the value of the pool, however, cannot be revised upward (except for very limited circumstances, especially constructional value-increasing changes to the mortgaged property). Instead, the *Pfandbrief* bank has to monitor market developments for adverse changes potentially affecting the MLV and if the market value falls below the MLV, the latter should be adjusted which might prompt inclusion of additional collateral in the cover pool to back up outstanding *Pfandbriefe*.

The bonds covered by the pool must be issued in such a way that limits liquidity risk (as well as sectoral and regional) concentration. This general rule for instance may be implemented by distributing the payment outflows over time in a way that prevents spikes at specific maturities (e.g. avoiding payment obligations in excess of 50 million euros or some other threshold within a 6-month window). Bonds are issued at different maturities, and there has been a trend to lengthen the average maturity of the outstanding stock as capital market issuers have tried to lock in the low interest rates currently prevailing in the market or to be able to offer positive coupons to real money investors.

About one-third of the aggregate volume of Pfandbrief cover pool consists of public sector debt; the rest are mortgages.

The structure of the cover pool provides strong buffers against solvency risk. Bonds issues against the pool cannot exceed 60% of the MLV of the mortgages, and typically the buffer will be even larger because (a) the market value of the assets backing the underlying mortgages is probably higher than the conservatively assessed MLV, and (b) low-risk public sector bonds are also included in the pool. In order to obtain favorable external ratings, many issuers will also provide "voluntary" over-collateralization.

Box 5. Germany: Special Covered Bonds (*Pfandbriefe*) (Concluded)

Liquidity risk is also mitigated by the required buffer that covers payments for the following 180 days. At banks issuing *Pfandbriefe* key sources of cash outflows include interest rate payments on outstanding bonds, redemptions of maturing covered bonds, and the extension of new loans; cash inflows, in turn, are generated by maturing securities (including those that are part of the cover pool) and interest and repayments of extended mortgages. New mortgages can be added to the cover pool, providing space for issuing new covered bonds and increasing the quality of the outstanding bonds as their overcollateralization would increase.

Potential strains could arise if (a) bonds issued by the pool are maturing in a period of low inflows from maturing assets held by the pool; and (b) there is a low demand for new bonds issued by the pool. For instance, assume that between January and March 100 millions of bonds issued by the pool mature, but only 40 million of mortgages held by the pool mature; this would yield a net outflow of 60 million, but also a net increase in the value of the pool of 60 million, which could be covered by issuing new bonds. If the market absorbs only 25 million of these bonds the pool experiences a net outflow of 35 million. To mitigate this risk, the cover pool includes excess liquidity buffers equivalent to 180 days of payment obligations.

The low solvency and liquidity risk of *Pfandbriefe* suggest that market appetite of such loans might be resilient to adverse conditions; *Pfandbriefe* may continue to be considered as comparatively safe liquid assets even under stress, experiencing lower net outflows than other types of securities. Even in crisis conditions in the past the market for these securities remained strong. At the peak of the global financial crisis, in 2008 and 2009, the volume of [net] issuances of these bonds continued to increase. After the crisis, while the volume of issuance of other types of covered bonds declined as cheaper financing alternatives became more convenient, the issuance of *Pfandbriefe* remained robust.

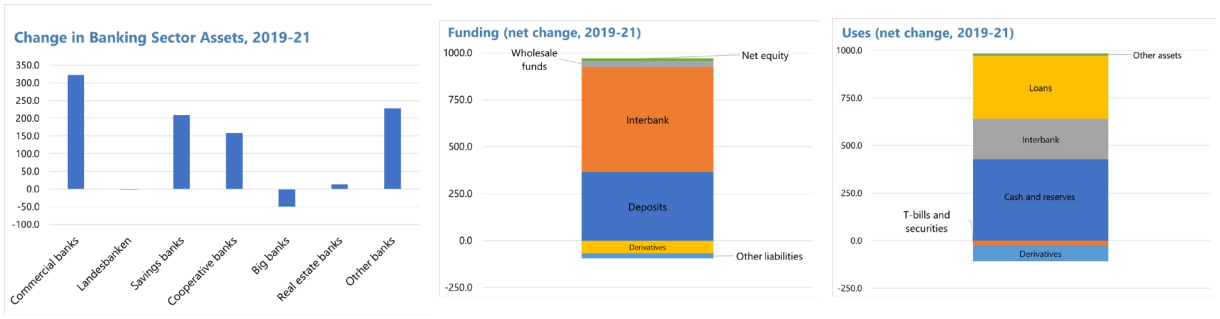
53. All banking groups ended 2019 with an average liquidity coverage ratio (LCR) above 145 percent. Remarkably, banking groups with higher LATA ratios tended to have lower LCRs, with a negative correlation between the two indicators of -0.57, which reflects the above-mentioned fact that the groups of banks that hold the largest share of assets in liquid form typically rely on less stable sources of funds (counted at higher rolloff rates for LCR purposes).

54. Between December 2019 and December 2021, the assets of the German banking system increased by 10 percent (€880 billion), equivalent to 24 percent of GDP. Two-fifths of this increase went into savings and cooperative banks and about one-third into non-systemic commercial banks (Figure 13).[35] This increase was funded mainly with interbank credit, which increased by €560 billion, one-half of which went into commercial banks. Customer deposits (€365 billion) funded most of the remaining increase.[36]

[35] Excluding interbank lending the assets of the banking sector increased by 316 billion, equivalent to 4.5 percent of the initial assets net of interbank credit. In other words, the banking sector claims on the rest of the economy increased by less than 5 percent in 2 years.

[36] About one-third of the increase in deposits went into savings banks and another third into commercial banks

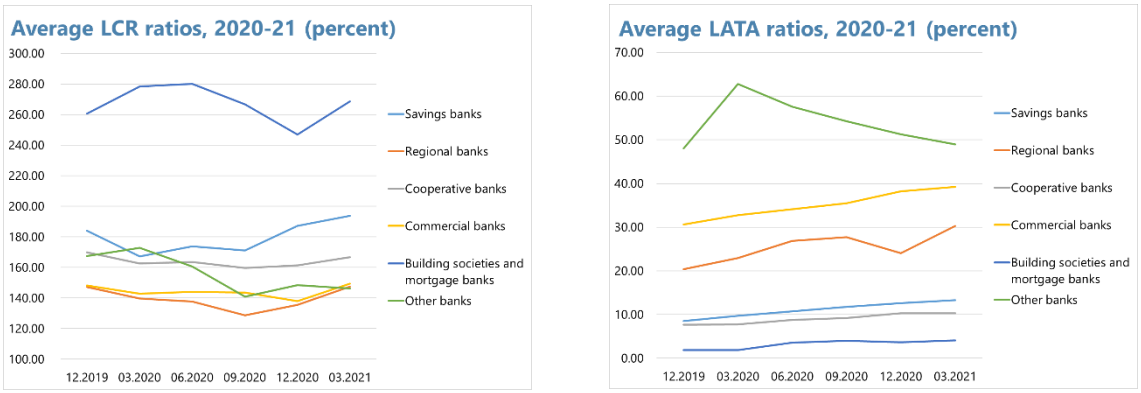
Figure 12. Germany: Net Change in Assets of the Banking Sector, 2019-21 (billions of euros)



Source: Bundesbank; and Fund staff elaboration.

55. Aside for some temporary strains in March and April 2020, German banks, overall, did not experience significant liquidity strains during the pandemic. Since January 2020 liquidity indicators altogether have held up well or even marginally improved as banks sought to strengthen their precautionary liquidity buffers. The average LATA ratio of commercial banks and *Landesbanken* has increased, and only "other" banks (a heterogeneous and in aggregate not particularly significant group) experienced a marked decline in their LCR, which still remains on average comfortably above the 100 percent requirement. The average loan-to-deposit ratio of German banks,[37] which hovers around 80 percent, also signals ample liquidity.

Figure 13. Germany: Selected Liquidity Indicators of the Banking Sector, 2020-21



Source: German Supervisory Authorities; and Fund staff elaboration.

56. Some strains on liquidity emerged in the Spring of 2020 but they eased with public intervention. In March and April some (mostly large commercial) banks experienced some liquidity outflows as nonfinancial corporations drew on their committed credit lines. These demands eased when the government started to provide solvency and liquidity support to enterprises, and most of

[37] This average, taken from the *Monthly Bulleting* of the Bundesbank, includes money market funds.

the liquidity thus mobilized was returned, often to the same bank, in the form of deposits. [38] Likewise, net outflows of liquidity from banks were dampened by the fact that nonfinancial corporations used the drawn credit lines to build up precautionary liquidity buffers. Bank liquidity also came under stress from temporary strain in financial markets. In March 2020 securities issued by sectors most directly hit by the pandemic, such as automobiles, tourism, and energy, started to trade at high-risk premia, and the bid-ask spreads for bonds issued by European high-yield enterprises widened; these developments resulted in higher margin calls for entities - including some banks - holding short positions, raising demand for liquid collateral which eroded banks' effective liquidity buffers . Banks initially responded by mobilizing lower quality collateral (e.g., pledging mortgages with the ECB via covered bonds or securitization), but market conditions rapidly recovered after the ECB injected liquidity through long-term financing operations (TLTRO-III and PELTRO),[39] and when the Eurosystem eased its collateral eligibility constraints and expanded its asset purchase programs (APP and PEPP).[40]

Box 6. Germany: Liquidity Strains in European Financial Markets in the Spring of 2020

Between March and June 2020 European financial markets experienced an episode of liquidity strains, that was most acute mid-March and eased gradually when the ECB intervened to redress the situation.

Strains started at the end of February in the U.S. Treasury market (after Italian authorities imposed severe lockdown restrictions in the failed attempt to prevent the Covid 19 infection to spread in the country) and rapidly extended to other markets. Concerns about the epidemic and government-imposed restrictions spurred a global flight to safety that triggered declines in share and bond prices. Volatility and transaction volumes surged (triggering margin calls on leveraged positions) while liquidity evaporated, especially in derivatives markets such as futures. This flight for safety, and a "dash for cash" for precautionary reasons amid heightened uncertainty about economic prospects, induced massive redemptions (net outflows) from investment and money market funds, which forced them to liquidate assets in a strained financial market, aggravating the downward spiral on asset values.

Most severely strained were the markets for commercial paper and certificates of deposits, as well as the corporate bond market, which hampered corporations' capacity to raise new funds by issuing securities (FSB, 2020). These tensions also spread to the unsecured term money market, where rates on commercial paper are used as a benchmark (Schnabel, 2020).

[38] This operation reduced some liquidity indicators as higher rolloff rates are applied to deposits than to undrawn committed credit lines; the LCR ratios effectively declined in several banks in March and April.

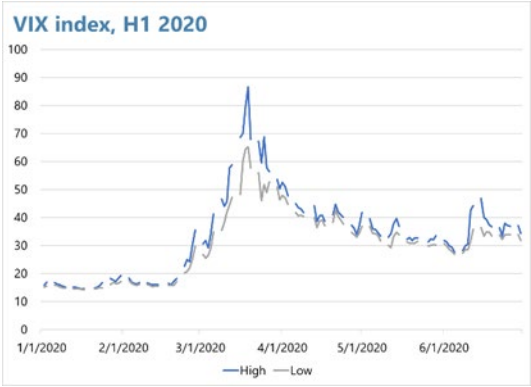
[39] Changes in the TLTRO included an increase in the maximum amount that could be borrowed. In the fourth TLTRO operation in June 2020 banks took about €1.3 trillion. The Pandemic Emergency Long Term Operation (PELTRO) was launched in May 2020 with the aim of ensuring an adequate supply of liquidity and smooth financial market conditions during the pandemic (Bundesbank, *Financial Stability Report 2020*).

[40] During the pandemic, indeed, banks increased their ECB funding, available on better terms than the market. The ECB also responded by easing the LCR requirements, allowing banks to reduce their ratios below 100 percent under stress and temporarily excluding holdings of central bank reserves from the LCR ratio.

Box 6. Germany: Liquidity Strains in European Financial Markets in the Spring of 2020

(Continued)

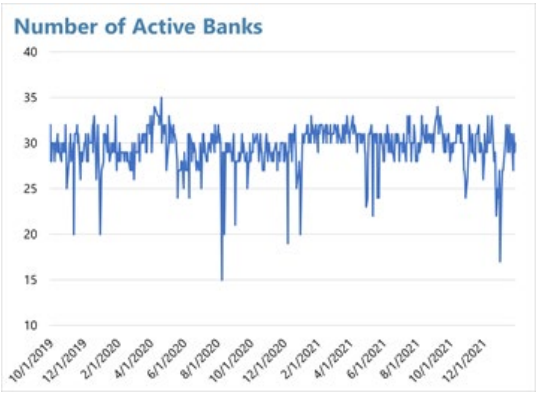
These developments were exacerbated by the fact that many market dealers had limited space on their balance sheet to provide liquidity to a strained market by taking open positions. Operational difficulties as many traders worked from home on imperfectly connected networks also contributed to these problems (Seidner 2021).

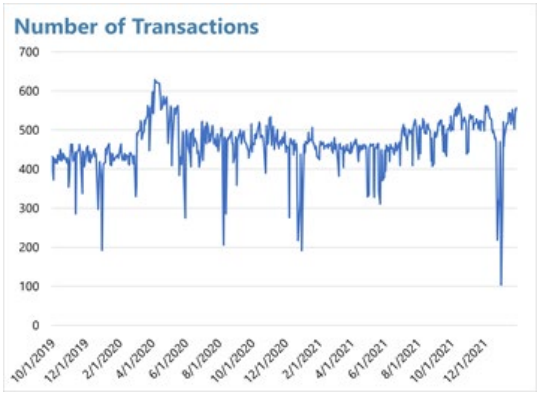


Source: Bloomberg, Jan 2019-Jan 2022.

Conditions became most acute between March 16 and March 23, with sharp drops in asset prices, widening bid-ask spreads, and a decline in depth in several markets. Conditions became calmer when major central banks, including the Fed and the ECB, intervened to inject liquidity through asset purchases, liquid facilities, currency swap arrangements, and by temporarily easing some regulatory requirements.

These strains had repercussions in the European interbank market. Between March and May 2020 the number of active banks, the number and total volume of transactions, and the highest rates applied in this market experienced a temporary surge, signaling - rather than a decline in liquidity – an increase in movements of liquid funds between banks, probably reflecting cross-bank variations in liquidity needs stemming from differences in business models and client composition.





Box 6. Germany: Liquidity Strains in European Financial Markets in the Spring of 2020
(Continued)

Sources: ECB; and Fund staff elaboration.

For banks these liquidity strains entailed a greater use of committed credit lines. Unable to tap the market for commercial papers and corporate bonds, many corporate clients mobilized their outstanding credit lines, transmitting the liquidity strain to banks' balance sheets. Since most of this demand for cash was precautionary, a large share of these funds remained on the balance sheet of banks in the form of corporate deposits, preserving their liquidity stocks but hurting some liquidity indicators. Additional demands came from the need by leveraged investors to post higher margin calls, tapping in part their bank deposit balances and outstanding credit lines; in some cases, the banks themselves had to post these margins, being counterparts in derivative contracts.

Some large commercial banks in Germany also act as dealers in European financial markets, providing liquidity and depth by acquiring large positions when most trade occurs on one side of the market. Their capacity to perform this role depends however on the "balance sheet space" allowed by regulatory capital requirements. In March 2020 most market dealers had very limited space, which contributed to market volatility and accentuated the decline in liquidity. Financial strains also increased funding costs for banks, who shared other borrowers' difficulties in raising wholesale funds through new security issues.

The Eurosystem intervention through massive asset purchases and wider eligibility of collateral for open market operations (TLTRO, PELTRO, APP, PEPP) succeeded in restoring market liquidity, containing volatility and bringing down rates, although it was not equally successful at restoring market depth. After the meeting of the ECB Governing Council on March 12 and the subsequent announcement of the €750 billion PEPP on May 18, benchmark liquidity indicators like the bid-ask spread on European government bonds eligible for futures contracts narrowed significantly but remained above pre-pandemic levels. The total volume of transactions in these bonds, however, did not recover (Moench *et al.*, 2021). Repo Funds Rates (RPRs) on German and French bonds (considered as the safest high-quality Euro-denominated liquid assets) fell by about 15 bps to -0.65 percent between March 12 and March 18, signaling a widening of the "specialness premium" that investors are prepared to pay to obtain this scarce high-quality collateral. This premium declined (and rates bounced back) a few days after the PEPP announcement. RFRs on Italian and Spanish bonds did not exhibit the same behavior, inducing some observers (e.g. Moench *et al.,* 2021) to describe these developments in European markets as a (precautionary) "dash for collateral" rather than as a "dash for cash:" concerned about the financial strains suffered by the Italian government, investors may have fled to "safer" German and French collateral, until the PEPP announcement eased these concerns (Billio *et al.*, 2020).

Box 6. Germany: Liquidity Strains in European Financial Markets in the Spring of 2020
(Concluded)

References

Billio, M.; Costola, M.; Mazzari, F.; and Pelizzon, L. (2020) "The European Repo Market, ECB Intervention and the COVID-19 Crisis," Edizioni Ca' Foscari, pp. 67.

FSB (2020) "Holistic Review of the March Market Turmoil," Financial Stability Board, pp. iv, 56, available online at the link Holistic review of the March market turmoil (fsb.org).

Moench, E.; Pelizzon, M.; and Schneider, M. (2021) "'Dash for cash' versus 'dash for collateral:'" Market liquidity of European sovereign bonds during the Covid-19 crisis," VOX EU/CEPR, available online at the link Market liquidity of European sovereign bonds during the Covid-19 crisis | VOX, CEPR Policy Portal (voxeu.org)

Schnabel, I. (2020) "Shifting tides in euro area money markets: from the global financial crisis to the COVID-19 pandemic," ECB, available online at the link Shifting tides in euro area money markets: from the global financial crisis to the COVID-19 pandemic (europa.eu)

Seidner, M.P.; Cantrill, L.; Chan, R.; and Wilding, T. (2021) "Lessons from the March 2020 Market Turmoil," PIMCO, available online at the link Lessons From the March 2020 Market Turmoil | PIMCO

C. Cash Flow Analysis Set-up

57. The liquidity stress tests performed by the IMF FSAP team are cash-flow based stress tests run on confidential supervisory data provided by the authorities. In line with an established methodology applied in other FSAPs, these tests feature:

(i) A one-year time horizon from a common reference date;[41]

(ii) The application of "behavioral" assumptions (in the form of roll-off rates) on the contractual cash flow entitlements and obligations associated with different categories of assets, liabilities, and off-balance sheet items; and

(iii) Three different stress scenarios (formalized in a set of "rolloff" and "haircut" parameters) entailing exceptional but plausible demands on the bank's liquid resources.

58. Liquidity stress tests were conducted on all SI banks and on a limited, randomly extracted representative sample of LSIs. All 17 SI banks supervised by the ECB under the SSM were included in the sample (4 holding companies that are also supervised by the ECB but not considered credit institutions were not included);[42] these entities account for about 45 percent of

[41] This period was divided in 10 "maturity buckets."

[42] List of supervised entities - Cut-off date 1 October 2021 (europa.eu). SI banks include 5 out of 6 Landesbanken as well as DZ Bank. Consolidated data were used; since "primary" savings and cooperative banks are not subsidiaries of their respective Landesbank or DZ Bank but are independent entities, they are not included in the consolidation. To preserve anonymity and confidentiality, stress test results for Landesbanken and DZ Bank cannot be presented separately but have been pooled together with those of the other SI banks.

the assets of the German banking sector. Out of more than 1,300 LSIs 40 banks were selected.[43] The LSI sample was extracted randomly from a list of about 1300 banks provided by the authorities and includes commercial banks, savings banks, cooperative banks, and building societies and real estate banks. Banks not falling in one of these categories were not included in the sample, as they operate rather heterogeneous and specialized business models. The composition of the sample (Table 3) was chosen to balance the need to include a sufficient number of banks of each category (minimum of five) and to be representative of bank size within each category, broadly reflecting the share of banks in each quintile of the asset distribution of the German banking sector.[44] The total assets of the banks included in the 40-bank sample represent about 3 percent of the total assets of the German LSI sector. The stress tests on dollar-denominated liquidity were run on all 17 SIs and on all LSIs which report dollar-denominated cash flow data (about 40 in number), which are mostly commercial banks. Consequently, the sample used to stress dollar-denominated liquidity differs in part from the sample used to stress liquidity in all currencies.

Table 4. Germany: LSI (Overall Currency) Sample

	Commercial banks	Savings banks	Cooperative banks	Building and mortgage banks	Total	
1st quintile (€0-281m)	3 (29)	0 (4)	4 (227)	1 (3)	**7 (261)**	**+1**
2nd quintile (€281-745m)	2 (17)	1 (25)	4 (218)		**7 (261)**	
3rd quintile (€745-1,610m)	1 (15)	2 (72)	4 (174)		**7 (262)**	
4th quintile (€1.6-3.2b)	1 (17)	3 (122)	2 (116)	1 (6)	**7 (261)**	
5th quintile (€3.2-433b)	3 (36)	4 (145)	1 (70)	3 (11)	**11 (262)**	
Total	**10 (114)**	**10 (368)**	**15 (805)**	**5 (20)**	**40 (1,307)**	

Source: Bundesbank; and Fund staff elaborations.

D. Cash Flow Analysis Scenarios

59. The cash-flow analysis aims to assess whether banks have sufficient liquidity buffers to withstand the net liquidity outflows that could occur under particularly unfavorable conditions, whilst maintaining the capacity to remain operational without the use of exceptional support. The *actual* cash flows experienced by a bank at any period are generally different from the flows that would hypothetically take place on the basis of its existing contractual relations. For instance, the entire stock of sight deposits could, by contract, be withdrawn at any

[43] "Other" LSI banks (not included in the above categories) were not included in the sample because they are typically highly specialized institutions, with idiosyncratic characteristics.

[44] For instance, as indicated in Table 4, four cooperative banks in the 3rd quintile of the asset distribution were drawn randomly from all banks that are both cooperative banks and fall in the 3rd quintile, The same procedure was repeated for all categories and quintile, using the numbers shown in Table 4. The procedure ensures a fair level of representativeness in terms of bank types and asset size. However, it is not necessarily representative in terms of other dimension such as geographical distribution within Germany.

time; in practice, only a small fraction of deposits is withdrawn on any given day, and normally they are largely offset by new incoming flows of deposits not foreseen in existing contracts. In the same way, the *net* cash inflows generated by maturing securities and loans are actually much smaller than those established by contract, because the bank usually re-invests the liquidity generated by maturing contracts into new securities and loans. Under adverse conditions the bank could experience net outflows of liquidity on the funding side (as withdrawals of deposits and other funding liabilities exceed the new incoming flows) and to some extent could cover them by tapping some usable inflows on the asset side (for instance, reducing the extension of new loans), but its capacity to do so is constrained by the need to generate income, maintain good relations with its customers, and protect its reputation. The bank could also use another source of liquidity, by running down its stock of liquid assets, selling less liquid assets in the market, or pledging them as collateral to borrow liquidity from other parties (including the central bank). All these "usable" assets (that are either intrinsically liquid, as cash, or convertible into liquid assets at low cost) constitute the bank's "counterbalancing capacity" (CBC). Under stressed conditions, some CBC assets may however become illiquid, or may be convertible into liquid assets at less favorable prices (so-called "haircuts")[45]

60. Reflecting these considerations. cash-flow stress tests apply specific behavioral assumptions to the hypothetical contractual cash. This is performed by multiplying, for each range of maturity dates ("maturity bucket") and to each category of liability or assets, a multiplicative parameter ("rolloff rate") that represents the share of contractual flow that would actually produce a net liquidity flow at that maturity. A "scenario" consists in a complete set of rolloff rates (and haircut rates for each category of CBC assets) for all flow categories and for all maturity buckets.

61. The analysis is performed on a "going concern" (business continuity) hypothesis. The aim is to assess whether a bank could continue to run its normal business activities without resorting to emergency liquidity assistance. This assumption is consistent with the macroeconomic objective of ensuring a continued credit provision under stress (avoiding a "credit crunch" that could transmit the strains from the financial sector to the real economy).

The assessment considers four different scenarios to explore different sources of funding and liquidity stress relevant to Germany's banking sector groups.[46] Besides a "baseline" scenario

[45] For liquidity stress test purposes, haircuts can be considered as (a) the discount compared to "normal" market prices that would occur in adverse market conditions, e.g. in the wake of a rise in interest rates, a currency devaluation, or other shock to the market price; (b) the "haircut" applied to collateral in repos and other borrowing transactions; or (c) a risk premium applied to a particular bank by investors concerned about counterparty risk (who could thus apply higher-than-normal haircut rates to that particular institution).

[46] For deposits, a scenario-specific time profile is used to determine noncumulative outflows (compared to contractual obligations) in each maturity bucket, assuming that the amounts not rolled off in one bucket would mature "again" (and be subject to partial rolloff) in the next maturity bucket. For all other items cumulative rolloff rates are applied to the contractual values maturing in each bucket, and the amounts not rolled off are assumed to generate no additional cash flows within the one-year horizon.

featuring "normal" conditions that would occur cyclically as a result of "normal" fluctuations under otherwise stable conditions (used as a benchmark), three scenarios were analyzed:

(a) **a "new wave" scenario (A),** representing a new (unexpected) wave of the pandemic and an associated intensification of precautionary measures, inducing a decline in economic activity. This scenario is dominated by **retail funding stress**. The corporate sector faces a strong liquidity strain that induces it to intensify its demand for loans (reducing rollover rates on loans and increasing rollover rates on unused committed credit lines) and reduce its funding of banks (through nonoperational and, to a lesser extent, operational deposits), and banks would experience net outflows of retail deposits as enterprises and households run down their liquid savings to address recurring liquidity needs in the face of a reduction in revenue and income. Haircut rates would increase somewhat compared to the baseline. This scenario is of mild severity and materializes at the shorter horizon.

(b) **a "risk aversion" scenario (B),** where an increase in risk aversion triggers an outflow of funds from some Euro-area sovereign borrowers to which German banks are exposed**.** This scenario is dominated by **market liquidity stress**. Part of the assets on which banks rely to obtain liquidity in case of need become suddenly illiquid, their market prices collapse and haircut rates to use them as collateral increase, triggering a decline in banks' counterbalancing capacity. Some banks' clients also exposed to these assets respond by withdrawing deposits and banks may be unable to roll off some loans. This scenario is of high severity.

(c) **a "persistent inflation" scenario (C),** where an upward shift in inflation expectations leads to continued increases in prices. This scenario is of comparable severity to scenario B but more persistent. The combined significant increase in risk aversion with higher and more sustained inflation leads to correspondingly stronger outflows of nonoperational deposits (reflecting a reduced demand for "discretionary" money balances) peaking at a one year-horizon and implies stronger haircuts to CBC but weaker outflows from downgrades. While scenario design pre-dated the war in Ukraine, scenario C captures potential repercussions stemming from the (economic) risks of a protracted war in Ukraine.

Table 5. Germany: Scenario Assumptions Roll-off Rates and Haircuts

	Scenario A	Scenario B	Scenario C	Baseline	Range in comparable FSAPs
Outflows					
Securities issued	20-30%	20-75%	25-100%	20-30%	
Stable deposits	5-10%	3%	3-5%	2%	0-10%
Operational deposits	5-20%	5-20%	5-10%	5%	0-50%
Nonoperational deposits	20-30%	20-40%	30-50%	10%	15-100%
FX swaps	75%	50%	100%	20%	50-100%
Other derivatives	50%	25%	75%	20%	50-100%
Other outflows	50-100%	20-50%	50-100%	20%	50-100%
Inflows					
Loans to retail	5-10%	10-20%	5-20%	0%	0-60%
Loans to NFCs	5-10%	10-15%	10-20%	0%	0%
Loans to OFIs	30-50%	35-50%	25-75%	10%	30-100%
FX swaps	75%	50%	100%	20%	25-100%
Other derivatives	40%	20%	50%	20%	50-100%
Maturing portfolio	50%	50%	40%	20%	50-100%
Other inflows	15%	10%	20%	10%	20-100%
Counterbalancing capacity					
Level 1	5%	5%	10%	2-5%	5-30%
Level 2a	10%	10-25%	30%	5-10%	11-30%
Level 2b	10-20%	20-40%	30-50%	5-10%	20-40%
Other tradable assets	20-50%	25-65%	75-100%	10-25%	27-70%
Nontradable assets	40%	50%	90%	25%	75%
Commitments and contingencies					
Inflows from undrawn committed facilities	50%	40%	30%	20-50%	0-50%
Outflows from committed facilities	10-15%	5-7%	8-10%	20%	0-55%
Outflows from downgrades	20%	50%	75%	0%	20-100%
Sources: Fund staff estimates and assumptions.					

E. Results

62. Reflecting confidentiality as well as methodological considerations inherent in the use of a representative sample, the results of the stress tests are presented only in aggregate form. In particular, the analysis focuses on the following indicators for each maturity bucket:

(i) Cumulative net outflows (in percent of assets);

(ii) Remaining counterbalancing capacity (in percent of the stock of CBC outstanding at the reference date);

(iii) Cumulative liquidity shortfall (defined as the additional liquidity that would be needed, at the beginning of the period, to prevent the bank becoming illiquid at that maturity bucket), in percent of assets; and

(iv) Number of banks (if any) that become illiquid, completely exhausting their CBC buffer.

63. Contractual data suggest that among LSI banks the potential sources of liquidity risk are concentrated in a few categories, while they are more diversified among SIs (Figure 15). Among LSIs the main source of contractual outflows are retail deposits, followed by NFC deposits, primarily at short maturity (Figure 15). The main inflows are from short-term claims on the central bank and from claims on retail and non-financial sector clients. In the LSI sample contractual outflows amount to about 40, 57 and 68 percent of total assets after 1, 6 and 12 months, respectively. Corresponding contractual inflows amount to 11, 19 and 26 percent of total assets. Hence, there is a large net contractual fundings gap (equal to about 40 percent of total assets at the one-year horizon), which is not unexpected given banks' role in maturity transformation. Among SIs the largest category of contractual outflows are FX swaps (35 percent of total assets), matched by corresponding inflows (Figure 15). Outflows from maturing level 1 tradable assets amount to 12 percent of total assets and are concentrated at maturities up to 1 month. Next to the FX swaps, the main contractual inflows are generated by liquid claims on the central bank (13 percent of total assets), level 1 tradable assets (14 percent) and claims on non-financial corporations (6). SIs have a lower net contractual funding gap than LSIs, amounting, on average to about 14 percent of assets at the 12 months horizon.

Figure 14. Germany: LSI Sample: Contractual Cash Flows

Most contractual outflows derive from open maturity deposits and occur at either very short or long maturities

	Cash outflow	1 day (overnight)	2 days	3 days	4 days	5 days	> 5 days and up to 1 month	> 1 month and up to 2 months	> 2 months and up to 3 months	> 3 months and up to 6 months	> 6 months and up to 1 year	Total flows up to 1 year
	unsecured bonds due	0	0	0	0	0	0	0	0	0	0	0
	regulated covered bonds	0	0	0	0	0	0	0	0	0	0	0
	securitisations due	0	0	0	0	0	0	0	0	0	0	0
	other	0	0	0	0	0	0	0	0	0	0	0
	Level 1 tradable assets	0	0	0	0	0	0	0	0	0	0	0
	Level 2A tradable assets	0	0	0	0	0	0	0	0	0	0	0
	Level 2B tradable assets	0	0	0	0	0	0	0	0	0	0	0
	other tradable assets	0	0	0	0	0	0	0	0	0	0	0
	other assets	0	0	0	0	0	0	0	0	0	0	0
	stable retail deposits	18	0	0	0	0	0	1	3	5	1	28
	other retail deposits	12	0	0	0	0	0	1	1	3	7	24
	operational deposits	0	0	0	0	0	0	0	0	0	0	0
	credit institutions	1	0	0	0	0	0	0	0	0	1	3
	other financial customers	0	0	0	0	0	0	0	0	0	0	1
	from central banks	0	0	0	0	0	0	0	0	0	0	0
Non-oper. Deposits	non-financial corporates	4	0	0	0	0	0	0	0	1	1	7
	other counterparties	1	0	0	0	0	0	0	0	0	0	2
	FX-swaps maturing	0	0	0	0	0	1	0	0	0	0	2
	Derivatives other than t FX swaps	0	0	0	0	0	0	0	0	0	0	0
	Other outflows	0	0	0	0	0	0	0	0	0	0	1
	Total outflows	39	0	0	0	0	2	2	4	10	11	68

Cash inflows stem primarily from short-term claims on the central bank and from claims on retail and NFCs clients.

Cash intflow	1 day (overnight)	2 days	3 days	4 days	5 days	> 5 days and up to 1 month	> 1 month and up to 2 months	> 2 months and up to 3 months	> 3 months and up to 6 months	> 6 months and up to 1 year	Total flows up to 1 year
Level 1 tradable assets	0	0	0	0	0	0	0	0	0	0	0
Level 2A tradable assets	0	0	0	0	0	0	0	0	0	0	0
Level 2B tradable assets	0	0	0	0	0	0	0	0	0	0	0
other tradable assets	0	0	0	0	0	0	0	0	0	0	0
other assets	0	0	0	0	0	0	0	0	0	0	0
retail customers	0	0	0	0	0	0	1	1	2	3	7
non-financial corporates	0	0	0	0	0	1	1	1	1	2	6
credit institutions	1	0	0	0	0	0	0	0	0	0	2
other financial customers	0	0	0	0	0	0	0	0	0	0	0
central banks	7	0	0	0	0	0	0	0	0	0	7
other counterparties	0	0	0	0	0	0	0	0	0	0	1
FX-swaps maturing	0	0	0	0	0	1	0	0	0	0	2
Derivatives amount receivables other t	0	0	0	0	0	0	0	0	0	0	0
Paper in own portfolio maturing	0	0	0	0	0	0	0	0	0	1	1
Other inflows	0	0	0	0	0	0	0	0	0	0	0
Total intflows	9	0	0	0	0	2	2	2	4	7	26

Note: Values in percent of total assets. Color coding reflects respective contribution from out and inflows to (net) inflow: i.e., green = high inflows or no/low outflows; red = high outflows or no/low inflows and yellow in between.

Sources: Bundesbank and IMF staff calculations.

64. The cash-flow based analysis suggests that LSIs are broadly resilient to liquidity shocks up to the conventional 3-month horizon (Figure 17). Under Scenario A only four LSI banks out of 40 would become illiquid within three months, and their number would rise to 5 and 8 under Scenarios B and C, respectively. At a 12-month horizon, however, 12 banks out of 40 would become

illiquid under Scenario C.[47] The liquidity shortfall implied by the scenarios is very limited up to the three month horizon and appears also manageable beyond that horizon: the cumulative liquidity shortfall in the worst case contemplated by the test (Scenario C at the 12-month horizon) amounts to less than 1 percent of the total assets of the banks included in the sample. While the affected banks are primarily small and mid-sized LSIs, the type of bank groups affected is heterogenous. Main reasons for the shortfall vary from bank to bank, and include inadequate initial CBC, loss of CBC due to haircuts and significant outflows from either non-operational NFC, other credit institutions, or financial customer deposits

Figure 15. Germany: Counterbalancing Capacity

(Percent of Assets in the Respective Sample)

In the LSI sample about 2/3 of CBC is held in the form of cash, reserves, or level 1and 2 tradeable assets.

Total CBC	19.4
Coins and banknotes	0.8
Central bank reserves	7.1
Level 1 tradable assets	3.9
Level 2A tradable assets	0.3
Level 2B tradable assets	0.4
Other tradable assets	6.8
Others	0.1

Among SIs central bank reserves account 60 percent of CBC and together with level 1and 2 assets constitute more than ¾ of the CBC buffers.

Total CBC	21.5
Coins and banknotes	0.1
Central bank reserves	13.1
Level 1 tradable assets	3.9
Level 2A tradable assets	0.5
Level 2B tradable assets	0.5
Other tradable assets	3.0
Others	0.4

Note: Values in percent of the total assets of the respective sample.

Sources: Bundesbank, ECB, and IMF staff calculations.

65. Counter-balancing capacity buffers appear fairly strong (Figure 17). Banks in the sample hold on average about 20 percent of their assets in liquid form usable as counterbalancing capacity; this amount exceeds the net average contractual funding gap (excluding outflows of retail deposits) even up to the one-year horizon. Cash, reserves at the central bank and level 1 tradable assets account together for about two thirds of the CBC in the LSI sample and for about 80 percent in the SI sample. Most of the level 1 and level 2 tradable assets are of highest credit quality (CQ1) and thus can be turned into cash or used as collateral quickly even under stressed conditions. In banks with dollar-denominated counter-balancing capacity, level 1 and level 2 USD assets are almost exclusively of highest credit quality (Figure 6).

66. These liquidity buffers provide important protection against potential net cash outflows (Figure 18). There is significant heterogeneity across LSI banks; on average, under the least favorable conditions of Scenario C, LSI banks would use, on average, about one-half of their initial counterbalancing capacity to cover the net outflows that could materialize in the first month; by the end of the year, three-fourths of the initial buffers would be used under Scenario C, and about one-half under Scenario A. Average asset-weighted CBC declines by 5 percentage points in the first week under Scenario A and by 9-10 points under Scenarios B and C; at the 12-month horizon this decline

[47] Coops and savings banks account for the entire increase in the number of banks with shortfalls.

widens to 10 percentage points under Scenario A and to about 14 points under Scenario C. While these ratios vary from bank to bank, under stress their distribution narrows (for instance, while under the baseline scenario at the one-month horizon the interquartile range of the remaining CBC in the sample is equivalent to about 12 percent of assets, it narrows to 7 percent in scenario C). This suggests that banks subject to larger outflow risks tend to hold higher CBC buffers.

Figure 16. Germany SI Sample: Contractual Cash Flows

Aside from large FX swap-related flows, contractual outflows for SIs are spread across various categories

		Maturity bucket										
	Cash outflow	1 day (overnight)	2 days	3 days	4 days	5 days	> 5 days and up to 1 month	> 1 month and up to 2 months	> 2 months and up to 3 months	> 3 months and up to 6 months	> 6 months and up to 1 year	**Total flows up to 1 year**
	unsecured bonds due	0	0	0	0	0	0	0	0	0	1	2
	regulated covered bonds	0	0	0	0	0	0	0	0	0	0	1
	securitisations due	0	0	0	0	0	0	0	0	0	0	0
	other	0	0	0	0	0	0	0	0	0	0	0
	Level 1 tradable assets	0	0	5	3	1	2	0	0	0	0	12
	Level 2A tradable assets	0	0	0	0	0	0	0	0	0	0	0
	Level 2B tradable assets	0	0	0	0	0	0	0	0	0	0	0
	other tradable assets	0	0	0	0	0	0	0	0	0	0	2
	other assets	0	0	0	0	0	0	0	0	0	0	0
	stable retail deposits	8	0	0	0	0	0	1	1	0	1	12
	other retail deposits	4	0	0	0	0	0	0	0	0	0	4
	operational deposits	6	0	0	0	0	0	0	0	0	0	6
Non-oper. Deposits	credit institutions	1	0	0	0	0	0	0	0	0	0	2
Non-oper. Deposits	other financial customers	2	0	0	0	0	0	0	0	0	0	3
Non-oper. Deposits	from central banks	0	0	0	0	0	0	0	0	0	0	1
Non-oper. Deposits	non-financial corporates	4	0	0	0	0	0	0	0	0	0	6
Non-oper. Deposits	other counterparties	1	0	0	0	0	0	0	0	0	1	2
	FX-swaps maturing	0	0	2	2	1	10	7	5	4	4	35
	Derivatives other than t FX swaps	0	0	0	0	0	0	0	0	0	0	1
	Other outflows	3	0	1	0	0	0	0	0	0	0	5
	Total outflows	30	0	9	6	2	15	10	8	7	9	96

Cash inflows for Sis match outflows closely at maturities beyond day 1.

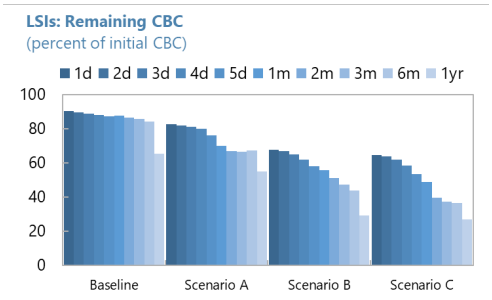
	Maturity bucket										
Cash intflow	1 day (overnight)	2 days	3 days	4 days	5 days	> 5 days and up to 1 month	> 1 month and up to 2 months	> 2 months and up to 3 months	> 3 months and up to 6 months	> 6 months and up to 1 year	**Total flows up to 1 year**
Level 1 tradable assets	1	0	5	3	1	3	1	0	0	0	14
Level 2A tradable assets	0	0	0	0	0	0	0	0	0	0	0
Level 2B tradable assets	0	0	0	0	0	0	0	0	0	0	0
other tradable assets	0	0	1	1	0	0	0	0	0	0	3
other assets	0	0	0	0	0	0	0	0	0	0	0
retail customers	0	0	0	0	0	0	0	0	0	1	2
non-financial corporates	0	0	0	0	0	1	1	1	1	1	6
credit institutions	1	0	0	0	0	0	0	0	0	0	2
other financial customers	0	0	0	0	0	0	0	0	0	0	1
central banks	13	0	0	0	0	0	0	0	0	0	13
other counterparties	0	0	0	0	0	0	0	0	0	0	1
FX-swaps maturing	0	0	2	2	1	10	7	5	4	4	35
Derivatives amount receivables other t	0	0	0	0	0	0	0	0	0	0	1
Paper in own portfolio maturing	0	0	0	0	0	0	0	0	0	1	1
Other inflows	1	0	1	0	0	0	0	0	0	0	2
Total intflows	17	0	9	6	2	16	9	7	7	9	82

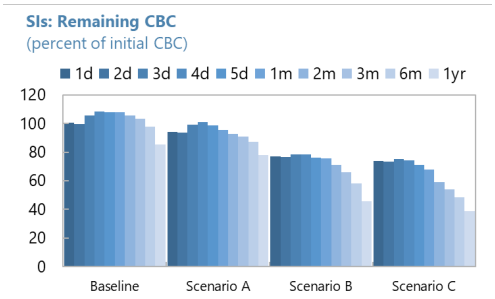
Note: Values in percent of total assets. Color coding reflects respective contribution from out and inflows to (net) inflow: i.e., green = high inflows or no/low outflows; red = high outflows or no/low inflows and yellow in between.
Sources: ECB and IMF staff calculations.

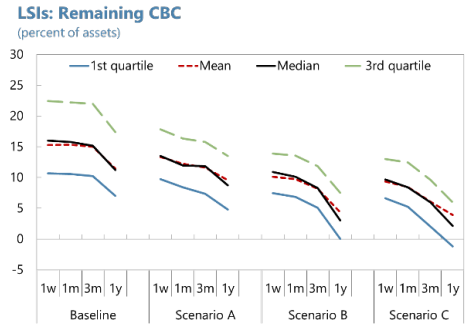
67. These liquidity buffers provide important protection against potential net cash outflows (Figure 18). There is significant heterogeneity across LSI banks; on average, under the least favorable conditions of Scenario C, LSI banks would use, on average, about one-half of their initial counterbalancing capacity to cover the net outflows that could materialize in the first month; by the end of the year, three-fourths of the initial buffers would be used under Scenario C, and about one-half under Scenario A. Average asset-weighted CBC declines by 5 percentage points in the first week under Scenario A and by 9-10 points under Scenarios B and C; at the 12-month horizon this decline widens to 10 percentage points under Scenario A and to about 14 points under Scenario C. While these ratios vary from bank to bank, under stress their distribution narrows (for instance, while under the baseline scenario at the one-month horizon the interquartile range of the remaining CBC in the sample is equivalent to about 12 percent of assets, it narrows to 7 percent in scenario C). This suggests that banks subject to larger outflow risks tend to hold higher CBC buffers.

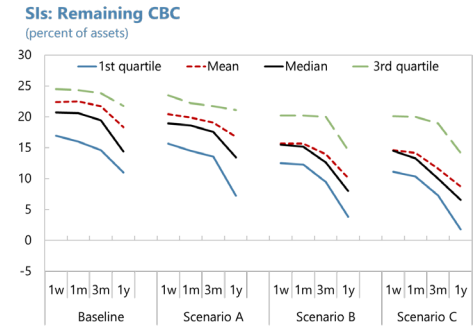
68. Liquidity shortfall risks are further mitigated by existing backstop arrangements. Most notably, "primary" banks of the public and cooperative pillar centralize their liquidity management at the regional (savings banks) or central (credit cooperatives) level of their network, re-depositing part of the funds they receive from their depositors in the form of interbank deposits and other claims (such as securities) at the *Landesbanken* and at DZ Bank, respectively. Besides their capacity to draw on these claims, these banks can rely, in case of stress, on additional support from other primary banks in their network. Such support, being of an extraordinary nature, is not included in the stress tests, but mitigates the risk that a particular bank may become illiquid as a result of idiosyncratic liquidity strains. A more integrated stress test assessment of the cooperative and savings/*Landesbank* networks could not be implemented as part of this FSAP owing to data limitations and confidentiality constraints but would provide important quantitative evidence on the resilience of these networks.

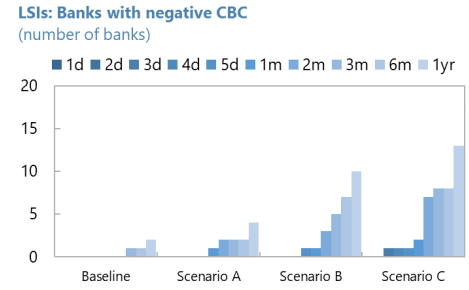
Figure 17. Germany: Cash Flow Analysis Results

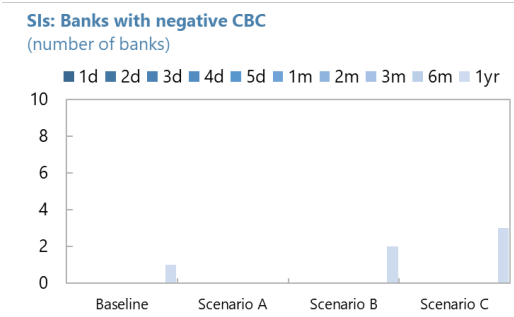


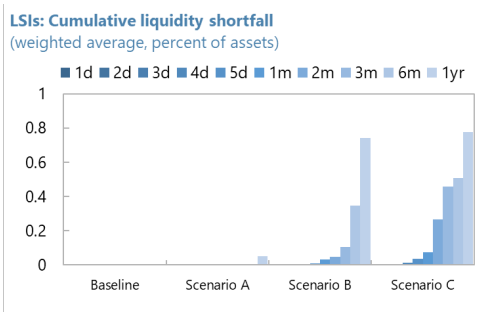


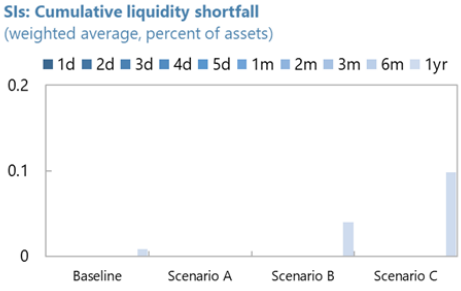












Sources: Bundesbank, ECB and IMF Staff Calculations.

69. SI banks' liquidity also appears resilient to shocks. No SI bank would become illiquid before six months under any of the stress test scenarios, and only two (three) banks would exhaust their liquidity buffers within one year under Scenario B (C); none under Scenario A. The liquidity shortfall in these cases would amount to about 0.1 percent of sample assets and 1-2 percent of

equity.[48] On average, banks would maintain most of their initial counterbalancing capacity under Scenario A (using less than one-fourth of it in 12 months) but would use, on average, more than one-half under Scenario B and about 60 percent under Scenario C. Hence, compared with LSIs, SI banks appear to have stronger buffers to withstand the liquidity outflows they could experience under stress – which is appropriate, given the larger absolute size of these flows and therefore the more limited capacity to mobilize extraordinary support in case of need.

70. While only relevant for selected banks, thin US dollar liquidity buffers expose a few banks to foreign exchange liquidity risk. Most SIs, and about 40 LSIs (some of which foreign-owned), report the US dollar as significant currency.[49] Dollar-denominated flows originate primarily, of course, from FX swaps and, among SIs, from other derivative contracts, and level 1 tradable assets and, among LSIs, from bank exposures to NFCs. The dollar-denominated liquidity buffers held by some of these banks (Figure 6) are insufficient to cover the potential net outflows that could occur, even within a few days, under stressed conditions. Indeed, a few small banks do not hold any CBC denominated in US dollars. Stress tests based on the same rollover rates and haircuts used to assess liquidity in all currencies, and abstracting from the possibility of converting euro denominated CBC, suggests that within 5 days, under Scenario C, the US dollar liquidity shortfall could reach 0.3 percent of assets for affected SIs and as much as 1 percent of assets for affected LSIs. After one month these values would rise to about 1½ percent of assets.

71. These risks are mitigated by the high depth and liquidity of the euro-dollar currency market and by some existing arrangements (Figure 19). While US dollar liquidity risk is relevant only for a limited number of banks, and regulatory requirements for LCR and NSFR exist only for the overall currency exposure, a few banks rely on the possibility to convert euro-denominated liquid assets into US dollar rapidly and at low cost. This is usually possible in the efficient euro-dollar currency market, but in very stressed conditions this possibility could fail, at least temporarily. The experience of the Global Financial Crisis shows that even these markets can become illiquid for some periods under stress. Banks owned by a foreign parent could rely on resources provided by their holdings in case of stress, and the ECB has euro-dollar swap line arrangements with the Federal Reserve. All these arrangements could provide liquidity support of an extraordinary nature under stressed conditions and are not, therefore, contemplated in the stress tests.

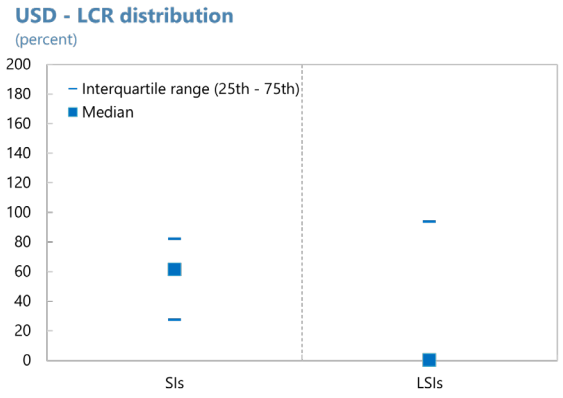
[48] For the affected SI banks, it amounts to an average of 1.5 percent of assets.

[49] Other significant currencies in the sample include the British pound, the Swiss France, the Polish Zloty and the Russian rubble. Except for the pound only very few banks have significant exposures in these currencies.

Figure 18. Germany: US Dollar Liquidity

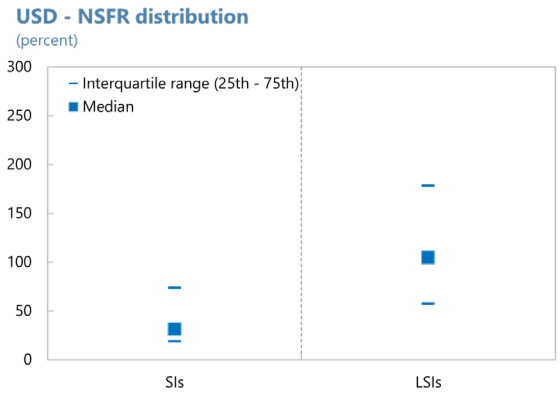
(percent)

About ¾ of reporting banks have a USD LCR below 80 percent, in some cases much lower.



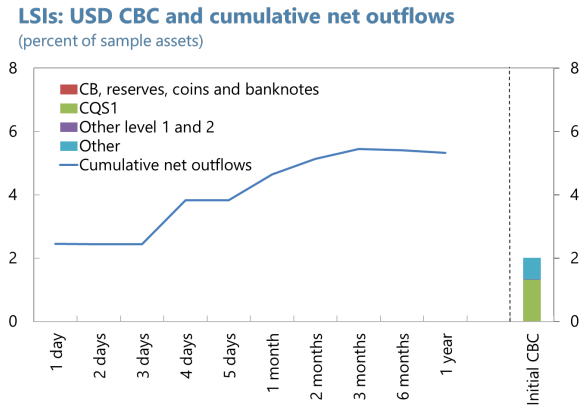
Sources: Bundesbank, ECB and IMF staff computations.

Most SIs and about one half of LSIs have an USD NSFR ratio below 100 percent.



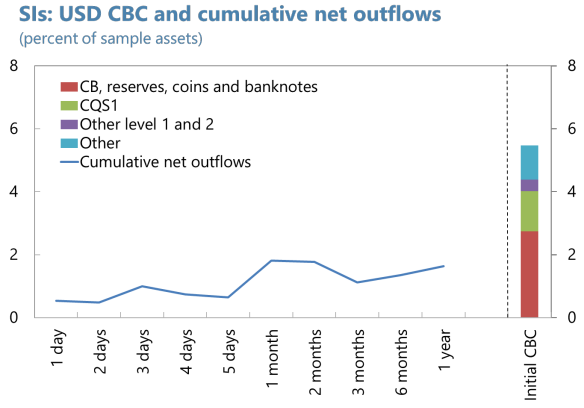
Sources: Bundesbank, ECB and IMF staff computations.

While mostly composed of HQLA, among LSIs USD-denominated CBC does not cover cumulative dollar-denominated net outflows even from day 1.



Sources: Bundesbank and IMF staff calculations

On the contrary, among SIs, in aggregate, initial USD-denominated CBC exceeds net cumulative dollar-denominated outflows over the entire horizon.



Sources: ECB and IMF staff calculations

Note: Values for the LSI sample as of Sep. 2021 and for the SI sample Dec. 2021. Less than 40 out of about 1,300 LSIs have significant USD transaction that require reporting. Most SIs report USD liquidity flows. There is no formal requirement to maintain 100 percent LCR or NSFR for foreign currencies. CB = Central Bank; CQS = Credit Quality Step.

Box 7. Germany: LSI Cash-flow Based Liquidity Stress Results and LCR and NSFR Ratios

Several tests were performed to analyze to which extent LCR and NSFR ratios provide indication about LSI banks' performance in the cash flow-based liquidity stress test. The tests included (i) simple median regressions of dummies indicating whether a bank passed the cash flow liquidity test on LCR and NSFR, respectively (ii) simple OLS regressions relating banks' remaining CBC in the respective stress scenarios to their LCR or NSFR and (iii) median LCR and NSFR comparison of passing and failing banks. The tests were performed separately for LCR and NSFR for the various horizons and scenarios and applied to the sample of 40 LSI banks.

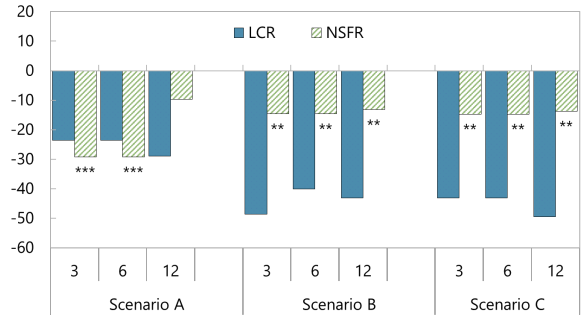
This analysis highlights a strong correlation between the supervisory LCR and NSFR and the outcome of the cashflow-based liquidity stress tests. In particular,

- Banks which remained liquid in the cash-flow based stress test at horizons of 3 months or longer were found to have a median LCR that is about 20 percentage points lower than that of the other banks in scenario A and about 40-50 percentage points lower in scenarios B and C, but these estimates were not significant at conventional levels. For the NSFR, the difference was smaller, in line with the lower variance across banks, but almost always significant: For scenario A the estimated median difference between liquid and illiquid banks was up 30 percentage points in scenario A and about 15 percentage points in scenario B and C, across horizons.

- Correspondingly, banks with higher LCR or NSFR generally used a lower share of their initial CBC than other banks in all three scenarios, especially at longer horizons. For instance, under scenario C, a bank with an NSFR of 160 is estimated to have used after 12 months 5 percent less of its initial CBC than a bank with an NSFR of 120.

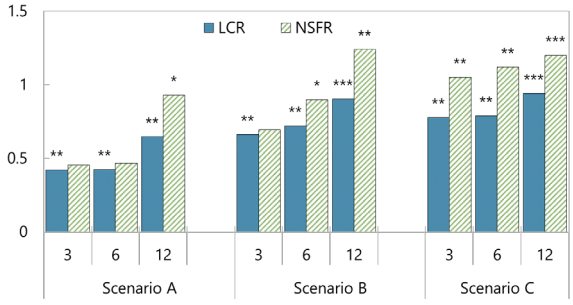
- Finally, banks with an LCR above the median of the sample were less likely to become illiquid under the stress tests, and the median LCR of banks that became illiquid was significantly lower than the median LCR of other banks. Interestingly, these results hold true not only at the shorter horizon of 1 month, but also for the extended 1-year horizon. The relevance of the NSFR ratio for passing or not the test increases with the horizon.

Median Comparison of LCR and NSFR by Scenario
(y-axis = coefficient estimates, x-axis = horizon in months)



Sources: Bundesbank and IMF staff calculations.
Notes: Values correspond to coefficient estimates from separate regressions of LCR and NSFR, respectively, on a dummy indicating if a bank failed the test, in the sample of LSIs. *** p<0.01, ** p<0.05, * p<0.1

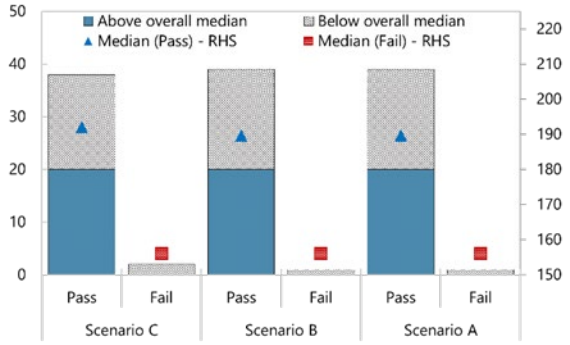
Sensitivity of Remaining CBC to Liquidity Ratios
(y-axis = coefficient estimates, x-axis = horizon in months)



Sources: Bundesbank and IMF staff calculations.
Notes: Values correspond to coefficient estimates from separate regressions of remaining CBC on LCR and NSFR, respectively, in the sample of LSIs. Values are scaled to reflect responses to a 100ppt change in the LCR and a 10ppt change in the NSFR, respectively. *** p<0.01, ** p<0.05, * p<0.1

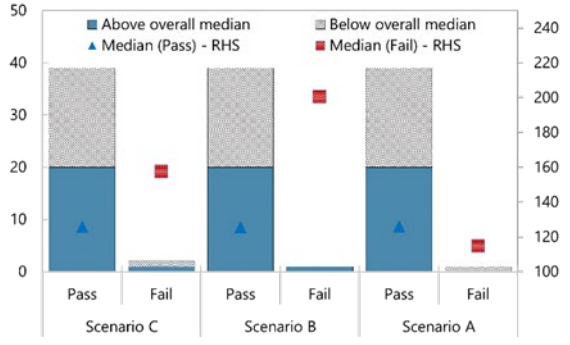
Box 7. Germany: LSI Cash-flow Based Liquidity Stress Results and LCR and NSFR Ratios
(Concluded)

LCR: Median comparison, 1 month horizon
(LHS = Number of banks, RHS = LCR in percent)



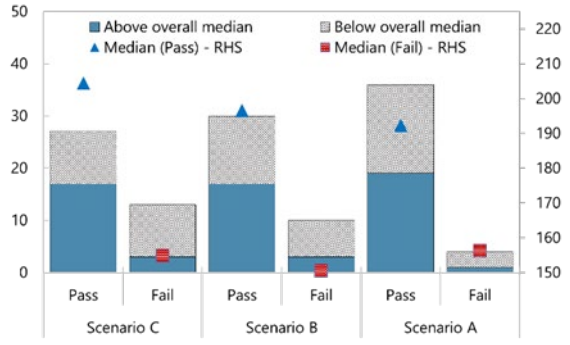
Sources: Bundesbank and IMF staff calculations

NSFR: Median comparison, 1 month horizon
(LHS = Number of banks, RHS = NSFR in percent)



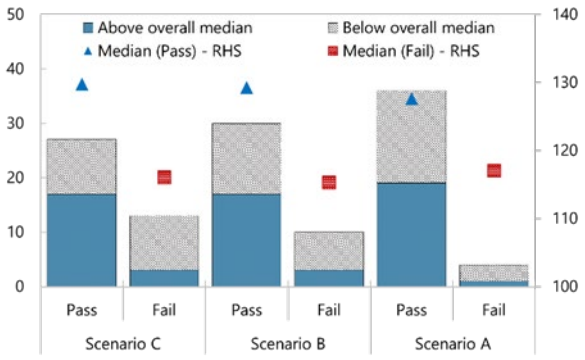
Sources: Bundesbank and IMF staff calculations.

LCR: Median comparison, 1 year horizon
(LHS = Number of banks, RHS = LCR in percent)



Sources: Bundesbank and IMF staff calculations

NSFR: Median comparison, 1 year horizon
(LHS = Number of banks, RHS = NSFR in percent)



Sources: Bundesbank and IMF staff calculations.

F. Conclusions

72. German banks have robust liquidity buffers, which on average after some temporary stress in the initial phase of the pandemic have increased further in recent months. The weighted average liquidity coverage ratio stands at about 160 percent, and the vast majority of banks have liquidity indicators (LCR and NSFR ratios) well in excess of the regulatory minimum of 100 percent. Average counter balancing capacity stands at about 20 percent of assets and is mostly composed of highest quality assets.

73. Cash-flow based stress tests confirm that these liquidity buffers are generally adequate to withstand shocks, although a few banks could experience strains in a sustained severe adverse scenario. Under the least favorable scenario only eight LSI banks in a randomly selected sample of 40 appear at risk of becoming illiquid and no SI bank would become illiquid before the conventional three-month horizon. Within 12 months 12 LSI banks out of 40 and three SI banks out of 17 could become illiquid. However, even in this extreme case shortfalls would be manageable, amounting on average to less than 1 percent of assets in the LSI sample and to less than 0.1 percent of assets among SIs. Nevertheless, selected banks may consider improving their

resilience by lengthening the tenors of deposits from non-financial corporations, adjusting the composition of their CBC and increasing it.

74. Risks are mitigated by the particular structure of the German banking sector, where cooperative and savings banks centralize their liquidity management at network level. Cooperative banks redeposit part of the liquidity collected from their clients in the form of interbank claims on DZ Bank, and savings banks engage in similar arrangements with their respective *Landesbank*. In addition, both types of banks would receive support, in case of idiosyncratic shock, from other banks in their networks, and their deposits benefit from sector-specific insurance schemes (IPS) which reduce the likelihood of rapid withdrawals even in conditions of stress.

75. Thin US dollar liquidity buffers for a few banks highlight the importance of maintaining swap lines among central banks. A few banks with exposures in US dollars have inadequate buffers to cover potential net outflows in that currency in a severe stress scenario. While US dollar liquidity risk is relevant only for a limited number of banks, and regulatory requirements for LCR and NSFR exist only for the overall currency exposure, a few banks rely on the central bank swap line in such an adverse scenario in which access to the usually highly liquid and efficient euro-dollar currency market may be limited or entail high cost.

INTERCONNECTEDNESS AND CONTAGION ANALYSIS

A. Interconnectedness

76. Germany's financial system is interconnected, and a relatively small number of banks account for large share of interconnections. The interbank market appears to be segmented among SIs, and among LSIs. Also, a small number of banks are very interconnected and account for a very large share of interbank volumes. Significant intersectoral linkages exist, especially from monetary financial institutions (MFIs) to households and among MFIs and non-bank financial institutions. Significant institutions, savings bank, and credit cooperatives' lending account for over 90 percent of the total exposure of the domestic banking sector(the 21 SIs account for close to half of the total exposures) (Table 6 and Table 7).The major lending source for investment funds are from savings banks. Household deposits account for the bulk of banks' liabilities, whereas non-financial corporates are largely funded by banks. MFIs[50] increased their position on domestic government (8.53 percent of total assets in 2015 to 10.46 percent in 2021[51]). This increase is mainly attributable to the Eurosystem's asset purchase programs where Deutsche Bundesbank increased its exposure to domestic sovereign. The exposures of German MFIs excluding Deutsche Bundesbank to domestic government decreased (7.5 percent of their total assets in 2015 to 4.3 percent in 2021)[52]. Insurance companies and pension funds have reduced their positions with banks, and slightly increased their exposures to investment funds 36 percent of total assets in 2015 to 42 percent in 2021)[53]

[50] Include Deutsche Bundesbank, banks (excluding Deutsche Bundesbank), and money market funds (MMFs).

[51]Source: Bundesbank MFI balance sheet (S.121/122/123).

[52]Source: ECB.

[53] Source: ECB Insurance corporations and Pension Funds (ICPFs) database.

Table 6. Germany: Interbank Interconnectedness Sample Size		
	Lending Banks	**Borrowing Banks**
Banks with Special Development and other Central Support Task	4	4
Building and Loan Association	13	13
Credit Cooperatives	778	783
Mortgage Banks	4	4
Reginal Banks and other Commercial Banks	110	86
Savings Banks	367	366
SIs	21	21
Total	**1297**	**1277**
Sources: Bundesbank and IMF staff calculations.		

Table 7. Germany: Matrix of Interbank Linkages by Type of Banks

(In percent of domestic banking sector exposure)

		Debtor						
		Savings banks	SIs	Credit cooperatives	Banks with special, development and other central support task	Building and loan associations	Regional banks and other commercial banks	Mortgage banks
Creditor	Savings banks	0.67	20.55	0.00	0.08	0.29	0.09	0.02
	SIs	13.48	6.56	17.51	10.25	0.37	0.79	0.00
	Credit cooperatives	0.04	22.15	0.20	0.02	0.03	0.05	0.01
	Banks with special, development and other central support task	0.00	0.01	0.00	0.01	0.00	0.00	0.00
	Building and loan associations	0.81	1.35	0.04	0.12	0.01	0.01	0.01
	Regional banks and other commercial banks	0.04	2.21	0.04	1.93	0.04	0.15	0.03
	Mortgage banks	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sources: Bundesbank and IMF calculations.

Notes:

1. Calculation is based on 2021 Q3 total debt data (in millions of euros) reported by Bundesbank.

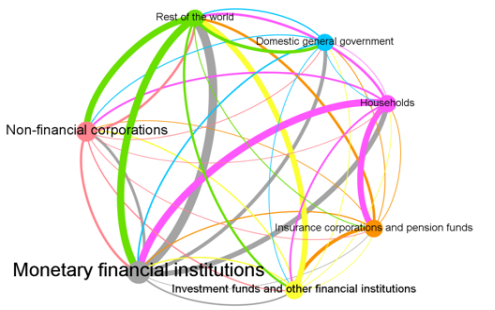
2. Domestic banking sector exposure is calculated as the sum of transactions among all types of banks, excluding intra-banking-group exposures. Total numbers from this table add up to 100 percent.

3. Landesbanken (exclude SIs) and Branches of foreign banks are excluded from this exercise given limited number of banks data available.

77. Germany is interconnected across borders through financial claims and liabilities (Figure 19b). German banks' total foreign exposure (as percent of total assets) is moderate compared to peer countries, which account for approximately a fifth of total assets. Top 20 countries that German banks have exposure to include countries in Europe, North America, and Asia, with the largest exposure to European countries. German banks exposures are higher against U.S. NBFIs (52.5 billion USD) and U.K. banks (82.6 billion USD) relative to peers. On the other hand, U.K. banks have comparably larger claims on German banks than peer countries. France, Netherlands, and Italy have more than half of their banks claims on Germany are for Germany's non-bank private sector.

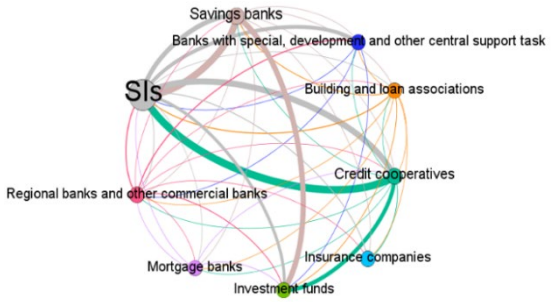
Figure 19a. Domestic Exposures of Financial Institutions

Financial market Intersectoral linkages are significant ….



Note: data is from Bundesbank "Direct financial linkages between the sectors in Germany" 2021 Q3 table, reported as a percentage of GDP.

… as well as linkages among MFIs and non-bank financial institutions

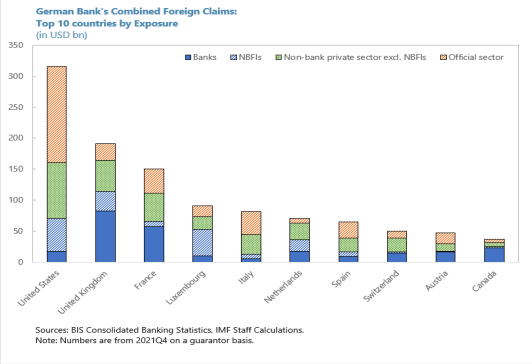


Note: FSAP team estimation is based on Bundesbank 2021Q3 total debt data reported in million euro, and applying equal weight for chart purpose.

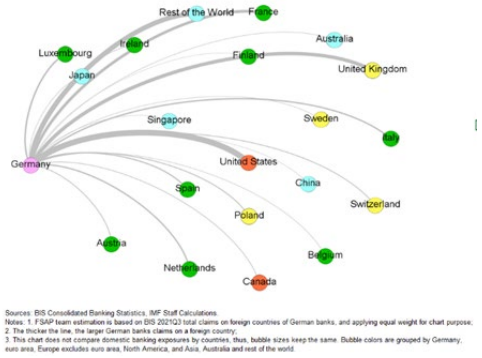
Sources: Bundesbank and IMF Staff Calculations.
Note: Node size proportionally represents transaction within a sector; edge width proportinally reflects finanical linkages between sectors; edges have the same color as the node for which the edge represents an exposure. Right graph: Claims of insurance companies and investment funds to bank nodes are not included.

Figure 19b. Cross-Border Exposures of Financial Institutions

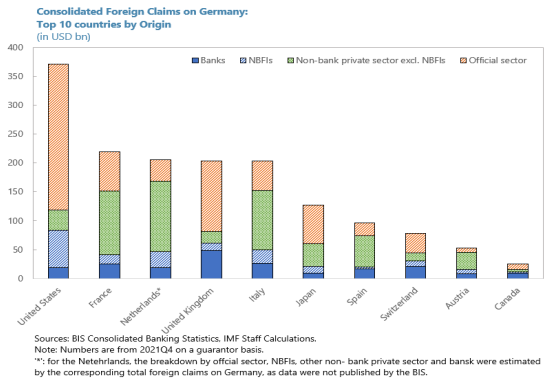
Banks have significant exposures outside of Germany.



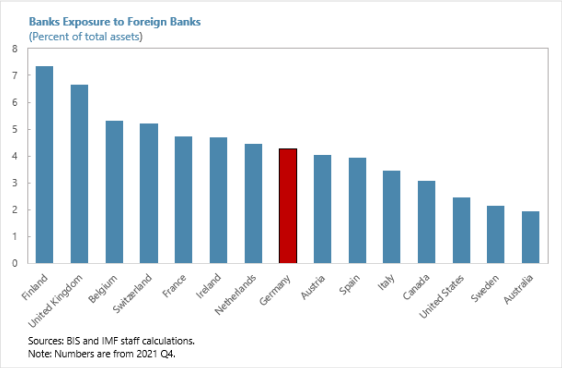
Top 20 countries German banks have exposure to are predominantly in Europe and North America, to a lesser extent, Asia.



Half of France, Netherlands, and Italy's claims on Germany are on the German non-bank private sector



German banks' exposure to foreign banks is moderate compared to other developed economies.



B. Bank Contagion Analysis

78. Approach: The interbank contagion analysis is assessed using a network model of contagion based on Espinosa-Vega, M., and Sole, J. (2010) and Covi, G., Gorpe, Z.M., and C. Kok (2021).[54] The analysis consists of simulations of cascades of bank failures, following hypothetical failures of individual banks, due to credit or funding shocks, occurring through interlinkages in the domestic interbank market (see top right panel chart in Figure 22). Note that this analysis does *not* assess the likelihood that a particular bank failure would materialize; instead, it assesses the contagion consequences of that failure, would it happen. Each bank in our sample of 1309 banks is assumed to fail. The interbank model next quantifies the failures of other banks, due to default by the failing bank, under various assumptions regarding the LGD when an exposure defaults, and the haircut occurring when banks execute fire sales of securities to repay an interbank loan. Each simulation corresponds to the quantification of the number of defaulting banks and the associated default costs of 1309 bank failures each of them happening one at a time. The *Contagion Index* aggregates the total default costs scaled by the CET1 capital of all or a subset of recipient banks: $\boldsymbol{Contagion\_Index = Total\_Losses/Total\_CET1}$. Results are aggregated for all bank failures (each happening one at a time), and for the top 10 most contagion banks (each happening one at a time).

Simulation #	Loss given Default	Haircut on fire sales
1	0.1	0.1
2	0.2	0.2
3	0.3	0.3
4	0.4	0.4
5	0.5	0.5
6	0.6	0.6
7	0.7	0.7
8	0.8	0.8
9	0.5	0.2

79. Data. The analysis is based on the network of domestic interbank exposures at the group level and constructed from the German credit registry by the Bundesbank as of 2021:Q3. The interbank exposure data are matched with balance sheet information (assets, including marketable securities, liabilities, and capital) for each individual bank. Balance sheet information for LSIs are from supervisory files as of 2021:Q3 and for SIs from the EBA Transparency exercise as of June 2021. For LSIs, in absence of more precise information for all banks, the stocks of marketable assets (securities) are approximated as a residual between total assets and loans. For SIs, marketable assets are Level 1 Financial Assets and cash balances as published by the EBA.

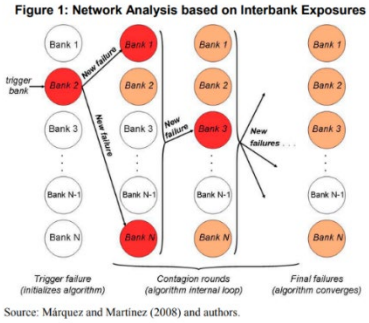
80. Key findings: (1) Risks of interbank contagion flow mostly from SIs to LSIs and from LSIs as a group to SIs, (2) a few large banks account for most of the contagion risks (Figure 21). The results suggest the interbank market may be segmented among SIs, and among LSIs. Indeed, when grouping contagion losses in two groups of banks (SIs/LSIs), one notes that about 51 percent of contagion losses are caused by contagion from SIs to LSIs and 36.06 percent by contagion from LSIs to SIs (top right panel chart). In contrast, only 9.66+3.37=13.03 percent of losses are caused by contagion among SIs or among LSIs. As shown in the middle left panel chart, most of the contagion losses are accounted by the top 10 most contagious banks, consistent with the stylized fact that a small number of banks are very interconnected and account for a very large share of interbank

[54] Espinosa-Vega, M., and J., Sole, 2010, "Cross-Border Financial Surveillance", IMF WP 10/105, and Covi, G., Gorpe, Z. M., and C. Kok, 2021, "CoMap: Mapping Contagion in the Euro Area Banking Sector", Journal of Financial Stability.

volumes. The analysis also found that while losses from the 1st round tend to dominate, as the severity of shocks increase, 2nd and other rounds account for a higher share of the total losses, especially for simulations where a small bank is the trigger bank (middle right panel chart). However, amplification effects remain very small when the 10 most contagious banks are the trigger banks. Both SIs and LSIs are impacted by contagion losses as a share of their own capital (bottom left panel chart); credit cooperatives, savings banks and Landesbanken, are significantly exposed to contagion risks in the interbank market, would a bank failure happen (bottom right panel chart). A very large share of contagion losses (44.7 percent) goes from Credit Cooperatives to Credit Cooperatives, from Landesbanken to Savings Banks (21.3 percent) and from Savings Banks to Landesbanken (15.2 percent), as shown in Table 8.

Figure 20. Bank Contagion Analysis

The bank contagion model simulates cascades of default and estimates resulting losses ….



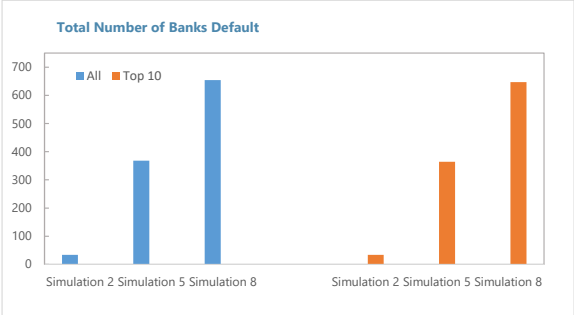
Source: Márquez and Martínez (2008) and authors.

Most contagion losses occur from SIs to LSIs, but as a group LSIs also cause significant losses to SIs ….

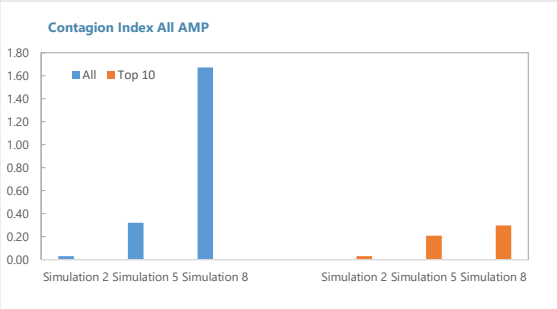
		Recipient of the shock	
Source of the shock	*(In percent of total losses)*	Less Significant Institutions	Significant Institutions
	Significant Institutions	50.91	9.66
	Less Significant Institutions	3.37	36.06

contagion losses by type of trigger bank/recipient bank

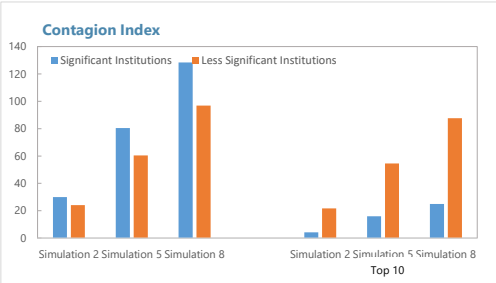
A small number of banks account for most of the contagion losses….



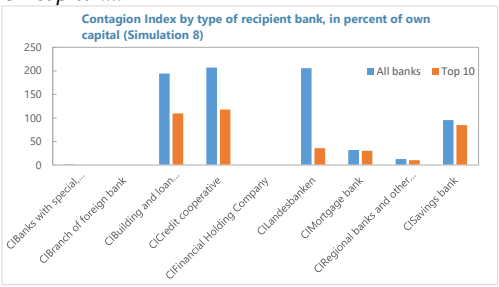
As severity of the shocks increase, 2nd round and other rounds account for increase share of total losses….



Both SIs and LSIs are impacted by contagion losses as a share of their own capital…



Credit cooperatives, savings banks, Landesbanken and other banks potentially bear significant losses as a share of their capital….



Sources: Bundesbank and IMF staff calculations

Table 8. Germany: Matrix of Contagion Losses by Type of Banks

		Recipient of the shock						
	(In percent of total losses)	Credit cooperative	Savings bank	Landesbanken	Regional banks and other commercial bank	Building and loan association	Mortgage bank	Banks with special, development and other central support task
Source of the shock	Credit cooperative	44.69	0.31	0.29	0.37	0.09	0.06	0.00
	Landesbanken	2.05	21.31	1.53	1.63	1.09	0.11	0.00
	Savings bank	0.07	0.95	15.17	0.09	0.70	0.00	0.00
	Regional banks and other commercial bank	1.68	1.40	1.56	0.98	0.24	0.17	0.00
	Mortgage bank	1.24	0.82	0.19	0.21	0.15	0.00	0.00
	Building and loan association	0.07	0.31	0.29	0.04	0.01	0.00	0.00
	Banks with special, development and other central support task	0.01	0.02	0.07	0.02	0.00	0.00	0.01

Note: Credit cooperatives include central institutions, specialized institutions and local cooperative banks of the association of cooperative banks.

Source: Bundesbank, EBA and IMF staff estimates

SPECIAL TOPIC: CORPORATE RISK ANALYSIS

81. This section applies tools developed in Tressel and Ding (2021) to analyze the impact of the pandemic on the NFC sector and policy responses. The first part employs sensitivity analysis to illustrate that the German NFC sector's comfortable pre-pandemic liquidity and solvency buffers alongside enterprises' adjustments to the shock and the timely, expansive, and flexible government policy response account for the resilience shown by the NFC sector amid the pandemic. The second part uses scenario analysis to show that the recovery of the German economy projected in the baseline should allow most firms to return to profitability, contain debt-at-risk, and rebuild buffers, despite challenges posed by supply chain disruptions. In an adverse scenario with a contraction of economic activity in 2022-24 amid rising inflation, solvency and liquidity indicators show somewhat less benign but still broadly favorable trends.

A. Impact of the COVID-19 Pandemic: Sensitivity Analysis

82. The pandemic caused a large shock to enterprises' sales. For this analysis, the sales shock *x*% is calibrated industry by industry. Specifically, for each of the 263 firms in our sample for which it is available, market analysts' 12-month forward forecasts of firm sales at the end of January 2020 (pre-pandemic) and in June 2020 (after the initial shock of the pandemic) were used to compute the shock parameter as the percent change in the sales' forecasts.[55] The shock is next aggregated at the industry level using each firm's 2019 total assets as weight. The industry shock thus obtained (reported in the middle column of Text Table 1 for each sector) is then

Text Table 1. Shock to 2020 sales: Mid-2020 prediction and outturn

Sector (# of listed firms in sample)	Share in 2019 total sales (percent)	Predicted shock to 2020 sales 1/ (percent)	Actual change in 2020 sales (percent)
Agriculture (2)	0.1	-3	15
Air transport (2)	2.2	-53	-62
Amusement and Recreation (6)	0.1	-55	-61
Business services (46)	2.5	-7	4
Communication (10)	7.1	-2	8
Construction (3)	1.6	-19	-12
Electricity, gas, water supply (8)	7.8	-22	4
Hotels & restaurants (1)	0.0	-45	14
Manufacturing (145)	60.2	-19	-10
Mining excluding oil (3)	0.2	-13	-38
Other private services (7)	0.3	-11	-36
Social, health, education services (5)	3.0	-4	2
Transportation excl. air transport (6)	5.2	-21	-8
Wholesale & retail trade (19)	9.8	-11	-9
Total (263 listed companies)	100.0	-17	-8

Source: Datastream, Capital IQ and IMF staff estimates.

1/ Difference between analysts' January 2020 and June 2020 sales forecasts for individual firms for 2020.

[55] The IBES (The institutional broker's estimate system) dataset provides rich information on the historical evolution and forward-looking projections of company balance sheet and risk indicators, sourced from over 18, 000 analysts.

used as the shock parameter in the sensitivity analysis and is applied to end-2019 sales of each firm.[56] [57]Taken together, by mid-2020, market analysts' forecasts of individual listed firms' sales implied that 2020 overall sales for our sample of 263 listed firms would be 17 percent lower than they had predicted at the start of the year, with important differentiation across sectors (Text Table 1).[58] Expectedly, sectors such as air transportation, amusement and recreation, and hotels and restaurants were perceived to be the most impacted by the pandemic.

83. A sensitivity analysis proposed in Tressel and Ding (2021) illustrates the potentially large impact of the expected decline in sales on the NFC sector's ICR, liquidity and equity.[59] The impact on individual firms' ICR and cash flows of shocks to their sales, allowing for a range of behavioral responses, is assessed as follows:

$$EBIT_{post\_shock} = EBIT_{pre\_shock} - x\% \times [\text{Net sales} - y\% \times \text{Costs of goods sold}]$$

Where $EBIT_{post\_shock}$ is the earnings before interest and taxes after the shock, $EBIT_{pre\_shock}$ the earnings before interest and taxes before the shock, x is the share of sales lost as a result of the shock, and y is the share of productions costs adjusted for each unit of sales lost as a result of the shock. This parameter y reflects both firm level decisions (such as to fire workers or keep them on the payroll) and policies (such as labor subsidies). With this simple indicator, the impact of the shock on the ability to service debt is assessed as follows:

$$ICR_{post\_shock} = EBIT_{post\_shock} / \text{Interest expenses}$$

The impact of the shock on the end of period cash balance of firms is derived from initial cash buffers and cash inflows and cash outflows during the period:

$$\text{Cash balance}_{post\_shock} = \text{Initial cash balance} + EBIT_{post\_shock} - [z\% \times \text{STD/TD} \times \text{Interest payments} + (1 - \text{STD/TD}) \times \text{Interest payments}] + (z - 100)\% \times \text{Short-term debt} + (\text{Depreciation} + \text{Amortization}) - \text{CAPEX}$$

Where, the Initial cash balance is adjusted for working capital commitments, STD/TD is the share of short-term debt and long-term debt maturing during the year in total debt, z represents the issuance of new debt during the year expressed as a share of the short-term debt and long-term debt maturing during the year, Interest payments are total interest payment on the initial debt of the firm. Specifically, $z > 100\%$ means that short-term debt increases by $(z - 100)\%$; $z = 100\%$ means

[56] Ebeke et al. (2021) perform a sensitivity analysis broadly conceptually similar for a sample of European firms with a focus on the cash balance and the equity position.

[57] IMF (2020) calculated that about 11 percent of German firms—mostly smaller ones—would have become illiquid and insolvent had no policy measures been taken.

[58] A September 2020 KfW survey found that one in two SMEs – some 2 million enterprises – expected turnover to be down in 2020 with the expected declines adding up to around 12 percent.

[59] This paragraph draws on Section IV.B. of Tressel and Ding (2021).

that the short-term debt and long-term debt maturing are rolled-over; and z <100% means that new debt issued during the year is smaller than the maturing stock of short-term debt and long-term debt. For this analysis, it is assumed that, under a stress scenario, firms do not initiate new fixed capital investments and invest only to maintain their initial stock of capital (depreciation + amortization = CAPEX). The initial stock of cash is defined as: cash and equivalents + short-term investments + receivables – (accrued payables + accrued payrolls and other short-term liabilities).[60] [61]

Four possible behavioral responses of firms are considered: (i) no reduction in the cost of goods sold (y = 0%); (ii) 50 percent reduction in the cost of producing goods (y = 50%); (iii) 75 percent reduction in the cost of producing goods (y = 75%); and: (iv) full offset and reduction in the cost of production (y = 100%). The sensitivity analysis assumes that all short-term debt and long-term debt maturing during the year is rolled over.

Aggregated results of the sensitivity analysis of the ICR, of cash balances, and of equity, each performed separately, are summarized in Figure 23.

- The "Pre-shock" bars show the calculated share of firms or share of debt meeting the relevant ICR<1 or cash balance<0 or equity<0 criteria at the end of 2019. For instance, 23 percent of listed firms in our sample had an ICR below 1. These were mostly relatively small firms as they accounted for 4 percent of total debt.

- The impact of the shock to sales predicted by financial analysts was very severe:

    - From an ICR perspective, even if listed firms would have been able to offset the decline in sales by cutting all costs related to the production of the missed sales (y = 100%), the share of firms at risk would have risen from 23 percent pre-pandemic to 60 percent. If firms had been unable to cut production costs, the shares of firms at risk would have risen to 85 percent. From a debt-at-risk perspective, with a full pass-through of the sales shock to cost reduction, the increase in corporate vulnerabilities would also have been very substantial, to 41 percent. If firms had been unable to cut production costs, debt-at-risk would have risen to 83 percent.
    - Turning to the impact of the shock on cash balances, even if listed firms would have been able to fully offset the decline in sales by cutting production costs, 38 percent of firms would have been unable to maintain positive cash balances in the absence of new borrowing, compared to 26 percent pre-shock, with important differences across

[60] Not including short-term debt and the current portion of long-term debt.

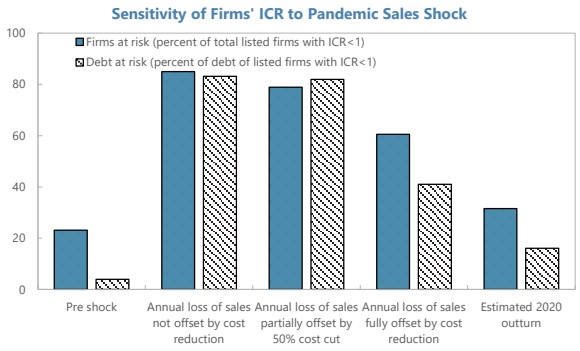
[61] The initial stock of cash and equivalents and accrued receivables are net of accrued short-term liabilities (such as payables and accrued payroll and other short-term liabilities excluding debt). This means that (i) the initial stock of cash and equivalents is not fully free cash and part of it may already be tied to working capital; (ii) accrued receivables are collected and accrued short-term liabilities are paid out. A similar adjustment is applied to the initial 2019 cash balances in the scenario-based stress test.

sectors.[62] In the absence of adjustments to production costs, 54 percent of firms would have negative cash balances in absence of an increase in borrowing.

- Even if enterprises had been able to fully offset the decline in sales by cutting production costs, more than 5 percent of firms could have ended up with equity below zero.

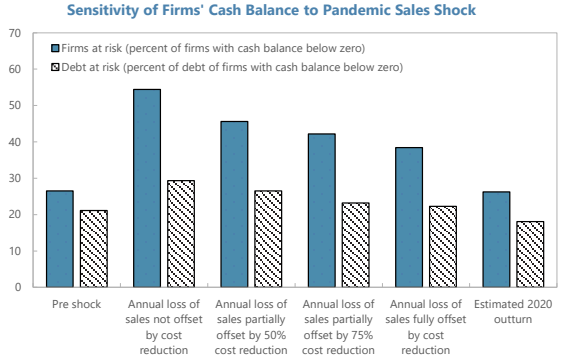
Figure 21. Aggregated Results of the Sensitivity Analysis of the ICR, Cash Balances, and Equity.

With no offsetting cost reductions, the sales shock would have raised debt-at-risk to 83 percent of total NFC debt.



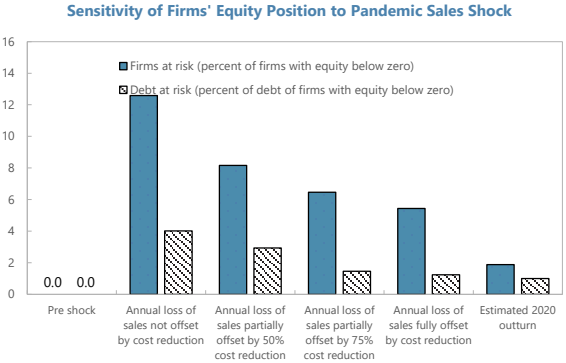
Sources: Datastream, Capital IQ and IMF staff estimates.

With no offsetting cost reductions, 54 percent of firms would have negative cash balances in absence of an increase in borrowing, up from 26 percent before the shock



Sources: Datastream, Capital IQ and IMF staff estimates.

With no offsetting cost reductions, the sales shock would have caused more than 12 percent of listed firms to end up with equity below zero.



Sources: Datastream, Capital IQ and IMF staff estimates.

In the end, the median ICR declined modestly, from 7.2 in 2019 to 5.7 in 2020.

Sources: Datastream, Capital IQ and IMF staff estimates.

[62] The baseline is computed from 2019 balance sheets by netting out from cash balances payables and other short-term liabilities (other than short-term debt) and adding receivables

84. The sensitivity analysis illustrates the critical importance of the authorities' and firms' responses to cushion the impact of the pandemic on NFCs' balance sheets. In the end, the decline in sales of the 263 listed firms for which we have data for both 2019 and 2020 was contained to 8 percent (column on the right in Text Table 1) and debt at risk only rose to 16 percent of total debt. The median ICR declined modestly, from 7.2 in our sample of 294 firms for 2019 to 5.7 in our sample of 320 firms for 2020. However, enterprises operating in sectors highly affected by the pandemic (e.g., air transport, amusement and entertainment, and other private services) recorded large declines in sales, causing the 25th percentile of the ICR to turn negative.

Interest Coverage Ratio (ICR)

	2019	2020
Weighted mean	5.9	2.9
Unweighted mean	20.3	15.5
Median	7.2	5.7
25th percentile	1.5	-0.9
75th percentile	19.2	19.0
# of firms in sample	294	320

Sources: Datastream, Capital IQ and IMF staff estimates.

B. Dynamic Scenario-Based Liquidity and Solvency Stress Test

85. The scenario-based liquidity and solvency stress tests on listed NFCs impose macroeconomic scenarios on the end-2020 firm-level data.[63] At the heart of the approach in Tressel and Ding (2021) are firm-level OLS and Probit panel regressions that relate firm-level indicators to past firm level structural and cyclical characteristics, industry fixed effects, and macro-financial conditions. The regressions cover the period 2003-2019. They are to a large extent estimated country-by-country, hence ensuring that the estimated relationships between firm-level indicators and macro-financial conditions are specific to Germany, reflecting past statistical relationships.

86. The baseline scenario envisages a further recovery from the pandemic in 2022-23 and growth averaging about 1.4 percent in the subsequent three years (Figure 23). In this scenario, ICRs improve over time and both the share of debt in firms with an ICR<1 and the share of debt in firms with cash<0 fall over time, allowing firms to face the new challenges highlighted in the previous section.

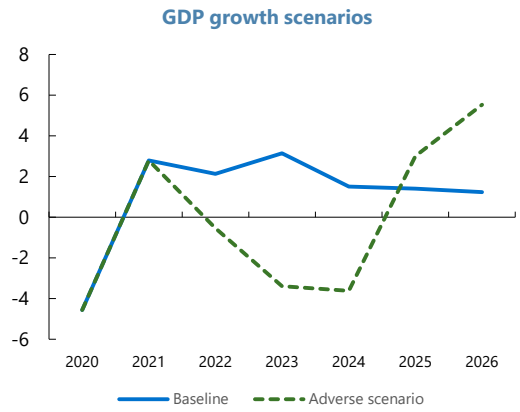
87. The adverse scenario envisages a renewed economic slowdown in 2022 and a significant contraction of economic activity in 2023-24 amid rising inflation. Given the central role of economic growth for the profitability and viability of companies in the regression models estimated in Tressel and Ding (2021), ICRs deteriorate in this adverse scenario and the share of debt in firms with an ICR<1 starts to rise again in 2023. The share of debt in firms with cash<0 remains more elevated than in the baseline and the probability of default rises in 2023, albeit from a low base.

[63] Therefore, like the numbers for 2022 and 2023, the numbers for 2021 are model-based estimates. Also, the macro scenarios implicitly incorporate the effects of broad macroeconomic and monetary policy interventions, including interest rate cuts, unconventional monetary policies, fiscal measures, social safety net packages, and other policies that support real economic activity and financial markets, and contain corporate borrowing costs. However, the scenarios do not incorporate the impact of specific liquidity and solvency support policies implemented by the German authorities on individual firms.

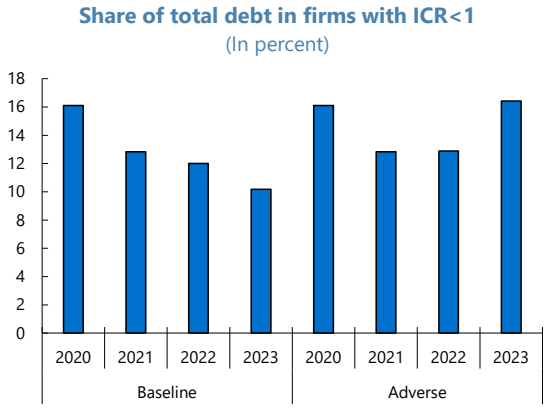
88. Germany's sustained strong export performance is testimony of the competitiveness and resilience of its NFC sector. These strong attributes, in combination with the authorities' strong policymaking capacity, as displayed also during the pandemic, should serve the sector well and help contain negative implications for financial stability in case an adverse scenario was to play out. Moreover, Germany's corporate insolvency and restructuring regime is ranked among the most effective and efficient in a 2018 OECD Economics Department Working Paper. And a cross-country study in a 2022 IMF Departmental Paper favorably assesses the crisis preparedness of Germany's insolvency and restructuring regime.

Figure 22. Corporate Sector and Dynamic Scenario-Based Stress Test

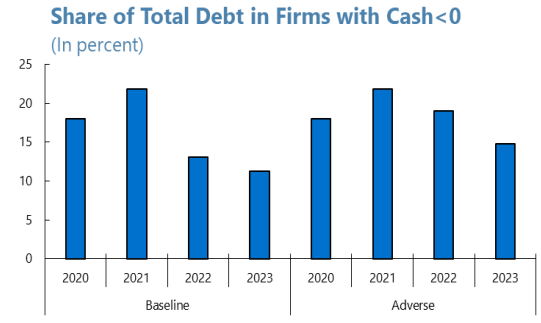
Growth settles at 1¼ percent in the baseline. In the adverse scenario, the economy contracts during 2022-24.



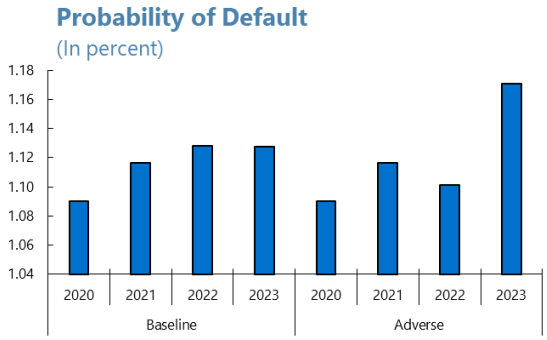
Debt at risk falls steadily in the baseline. In the adverse scenario a more muted initial decline is followed by an uptick.



Firms' cash situation improves in the baseline. In the adverse scenario a larger share of firms faces negative cash balances in absence of an increase in borrowing.



The strong contraction of activity in 2023 in the adverse scenario is associated with a rise in the probability of default.



Sources: Bundesbank and IMF staff calculations.

SPECIAL TOPIC: REAL ESTATE MARKET

89. Historically low interest rates, combined with stable income growth, have supported housing demand over the last decade. A strong economic outlook reinforced the demand for real estate, while immigration and urbanization increased the demand in urban areas. Low interest rates due to expansionary monetary policy since the Global Financial Crisis (GFC) have spurred housing demand. More recently, work-from-home arrangements may have also added some demand for RRE in suburban areas.[64] The long-term trend of changing German preferences toward more space and a growing share of single-person households have also increased the demand for living space.

90. The strong house price growth has largely been driven by supply shortages. Housing supply has been inhibited by the construction sector labor shortages and capacity constraints, with capacity utilization at high levels in the construction sector.[65] During 2009-20, the number of construction sector employees increased by almost 40 percent, but the estimated housing backlog grew by 240 percent (from 232 thousand in 2009 to 779 thousand in 2020). Limited land availability in larger cities, and, more recently, shortages of construction materials due to supply disruptions[66], along with time-consuming construction approval processes, have also slowed housing supply. Meanwhile, rising house prices, amid low returns on alternative investment instruments, have led to some reluctance on the part of landlords to sell second properties, further reducing supply in the market.

91. Rising housing demand, coupled with supply bottlenecks, has led to surging housing backlog and house price growth. Dwelling completions (306 thousand dwellings in 2020) continue to lag the issuance of building permits (369 thousand in 2020), resulting in a housing backlog, estimated at about 779 thousand dwellings at end-2020.[67,68] These patterns, however, differ substantially by region, with declining vacancies observed in growth regions and larger cities, and increasing vacancy rates in regions with shrinking population.

92. CRE performance is linked to economic growth. CRE price growth has historically been correlated with the GDP and employment growth, but with some variation among sub-sectors. Corporate insolvencies also play a role in office demand and office property pricing. Due to comprehensive measures, the expected rise in corporate insolvencies during the COVID-19

[64] This is supported by the findings of a survey of over 18,000 people in Germany conducted by the ifo Institute and real-estate portal immowelt. According to the survey, 13 percent of respondents from large cities with more than 500,000 residents were planning on leaving in the next 12 months. Nearly half (46 percent) of all respondents with short-term plans to move said that the coronavirus pandemic had influenced their decision. For details, see https://www.ifo.de/en/node/64264

[65] Capacity initialization for construction of building was reported at 82 percent at end-2021. Source: Haver Analytics.

[66] According to Ifo survey of obstruction of residential construction activity, material shortages have become an acute issue in 2021.

[67] Source: vdpResearch.

[68] Since not every application is given a permit, housing backlog may be even greater.

pandemic had not materialized by end-2021. But bottlenecks in materials and labor continued to drive up construction costs.

93. The COVID-19 crisis has intensified the lack of profitable investments, making CRE and RRE more attractive than the bond market. Despite the declining net initial yield, CRE and RRE continue to constitute an attractive investment opportunity for institutional investors in search for yield. For instance, despite some decline over the last decade, the net initial yield for CRE was 2.9 (4.9) percent in the 7 largest cities (127 towns and cities) in 2021, substantially above the -0.2 percent yield on the 10-year government bond.

94. Tail risks in real estate have increased since the onset of the pandemic, particularly in CRE. Based on staff's property price-at-risk assessment, tail risks in RRE and CRE increased since before the COVID-19 pandemic. Under the estimated conditional distributions, as of 2021Q3, the probability of a negative real price growth one year ahead increased to 2.2 and 66 percent (from 0.7 and 24 percent at end-2019) for RRE and CRE, respectively. Results also indicate that under severe adverse scenarios, there is a 5 percent chance that RRE and CRE could fall by 14 and 30 percent, respectively, in real and cumulative terms over the medium-term (Figure 24).[69,70]

95. High RRE valuations suggest price misalignments in the residential sector, with pockets of vulnerabilities in larger cities. Strong RRE price growth and analytical models point to overvaluation, increasing the risk of price corrections. Standard indicators of overvaluation, such as the price-to-rent and price-to-income ratios, suggest a 21 and 37 percent deviation from long-run averages as of end-2021, respectively.[71] Also, an econometric model at the country-level that takes account of real interest rates suggests RRE overvaluation of about 10-15 percent as of 2021Q3, while a city-level panel data points to larger overvaluation estimates at end-2020.[72] Bundesbank's estimates, based on the latest data and several methodologies, suggest an overall overvaluation in RRE prices of 20-35 percent, with overvaluation in cities in the range of 15-40 percent in 2021.[73]

[69] For RRE, the counterfactual ("adverse scenario") scenario is calibrated as a simultaneous 2 standard deviations shock to leverage (change in household debt-to-GDP, interest payments-to-disposable income), affordability measure (house price-to-gdp per capita ratio (misalignment)), and financial conditions index. For CRE, the counterfactual ("adverse scenario") is calibrated as a 2 standard deviations shock to employment. This is a tail risk event, as reflected in the design of the adverse scenario and by taking the 5th percentile of the distribution of future real property price growth rates under the adverse scenario.

[70] The availability of relatively short real estate price statistics with no recent history of boom-bust episodes inhibits a more accurate assessment of the impact of shocks in empirical modeling.

[71] Price-to-rent ratios, however, need to be read cautiously in Germany due to rent controls.

[72] City-level panel data is based on 127 cities. It relies on a combination of city-, region-, and country-level data, with population, real GDP, credit, residential construction growth, and interest rates as independent variables. For the largest seven cities, house price overvaluation at end-2020 was estimated at about 20-35 percent for Berlin, Hamburg, Stuttgart, Frankfurt, Cologne, and Dusseldorf, and at about 50 percent for Munich. These estimates may be somewhat overestimated due to the use of regional- and country-level data when city-level series were not available.

[73] Bundesbank relies on three types of indicators: i) standard indicators (e.g., deviation of price-to-rent and price-to-income from the long-run average), (ii) time-varying reference using an econometric model; and (iii) regional panel model.

96. RRE price overvaluations suggest potential pockets of vulnerabilities in bank exposures to real estate (Figures 9, 30). Most loans for house purchases in Germany are granted by banks. A small share (about five percent) of outstanding mortgage loans is also held by insurance companies – which occasionally also grant loans to households.[74] At 2021Q3, outstanding bank loans for house purchases exceeded EUR 1.6 trillion (46 percent of GDP and about half of total loans to domestic enterprises and households). The growth of housing loans to domestic enterprises and resident individuals reached 7.1 percent year-on-year in 2021Q3 – the highest growth in about two decades. Banks' exposures to CRE sectors (construction, housing corporations, and other real estate activities) constituted about EUR 602 billion (6 percent of assets and 19 percent of total loans to enterprises and households).[75] Lending to CRE sectors remained strong in 2021Q3 but slowed marginally to 6.4 percent y/y after peaking at 8.3 percent y/y in early 2019, also a two-decade high. On aggregate, CRE and RRE risks on banks' balance sheets have not materialized, and the Bundesbank's Bank Lending Survey does not point to any reported relaxation of lending standards at end-2021.[76] However, the authorities could underestimate risks due to a lack of comprehensive borrower-based information (e.g., LTV, DSTI). Immediate risks may stem from sub-sectors—e.g., non-food retail and potentially hotel businesses. Potential risks in real estate include COVID outlook uncertainties and their impact on economic growth and rising interest rates in conjunction with higher inflationary pressures.

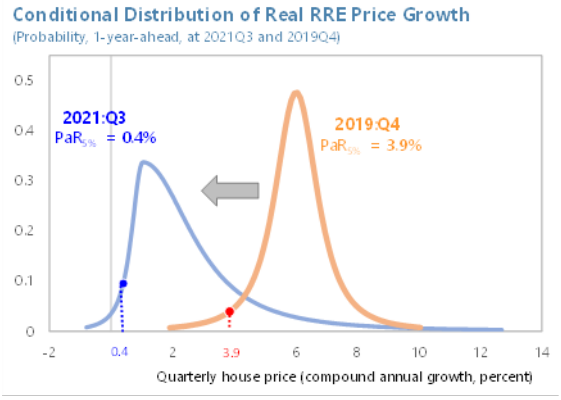
[74] The exposure of Germany's life insurers to real estate is only about 3 percent of assets if including both direct and indirect investments.

[75] Bank exposures to CRE sectors defined as the sum of lending to construction, housing enterprises, and other real estate enterprises by all categories of banks.

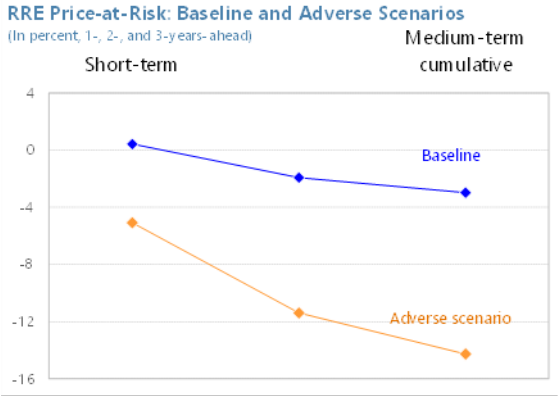
[76] Reference to the Bank Lending Survey, which provides information on the changes in banks' internal guidelines (loan approval criteria) and not hard data implied by lending standards. Representative hard data on lending standards are not available on a regular basis. The latest special survey on lending standards was conducted by BaFin and Bundesbank in 2019, and by the ECB in 2019. Current data gaps on lending standards regarding housing loans are expected to be closed through regular data collection by Deutsche Bundesbank starting in 2023Q1.

Figure 23. Residential and Commercial Property Price-at-Risk 1/

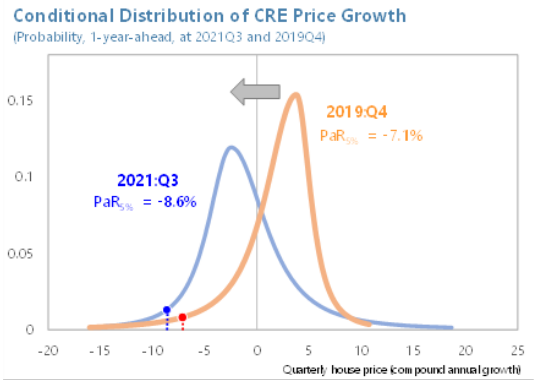
Residential property PaR analysis points to increased tail risks in 2021Q3 compared to pre-pandemic at end-2019.



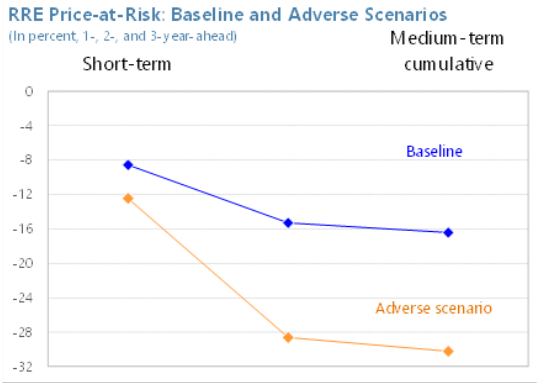
Under an adverse scenario, RRE prices could fall by some 14 percent (in cumulative terms) over 3 years.



Commercial property PaR models also suggest increased tail risks in 2021Q3 compared to pre-pandemic at end-2019.



Under an adverse scenario, CRE prices could fall by 30 percent (in cumulative terms) over 3 years.



Source: IMF staff estimates and calculations.

1/ RRE = residential real estate, CRE = commercial real estate, PaR = price-at-risk. Panel 1 shows the conditional one-year-ahead probability distributions of RRE price growth based on a parametric, t-skew density, fitted over quantile regression estimates in the period 2021:Q3 (blue line) and 2019:Q4 (orange line). Real house price volatility and worsening macro-financial conditions during COVID-19 largely account for the leftward shift in the distributions between 2019:Q4 and 2021:Q3. Figures are annualized growth rates. Panel 2 shows the point estimates of predicted RRE PaR as of 2021:Q3 in the short-term (one-year-ahead) and the medium-term (two- and three-years-ahead) projections at the 5th percentile (at compounded growth rates). Two- and three-year-ahead estimates show compounded figures. The counterfactual ("adverse scenario") scenario is calibrated as a simultaneous 2 standard deviations shock to leverage (change in household debt-to-GDP, interest payments-to-disposable income), affordability measure (house price-to-gdp per capita ratio (misalignment)), and financial conditions index. Panel 3 shows the conditional one-year-ahead probability distributions of CRE price growth based on a parametric, t-skew density, fitted over quantile regression estimates in the period 2021:Q3 (blue line) and 2019:Q4 (orange line). Figures are annualized growth rates. Panel 4 shows the point estimates of predicted CRE PaR for 2021:Q3 in the short-term (one-year-ahead) and the medium-term (two- and three-years-ahead) projections at the 5th percentile (at compounded growth rates). Two- and three-year-ahead estimates show compounded figures. The counterfactual ("adverse scenario") is calibrated as a simultaneous 2 standard deviations shock to employment.

Table 9. Germany: Banking Sector Soundness Indicators (September 2021, in percent)

	Solvency and Liquidity				Profitability				Asset Quality		
	Tier 1 Capital Ratio to RWA	Total Capital Ratio (CAR) to RWA	Liquid assets to total assets	Liquid assets to short term liabilities	ROE	ROA	Interest margin to gross income 2/	Noninterest expenses to gross income	NPL to gross loans	NPL net of provisions to capital	Provisions to NPLs
Commercial Banks	17.4	20.1	39.5	160.9	4.4	0.4	34.9	71.4	1.8	8.3	37.9
Big banks1/	16.2	18.4	38.4	124.1	2.7	0.2	41.1	79.0	1.8	10.8	35.7
Saving Banks											
Landesbanken	15.9	20.0	24.3	152.6	3.8	0.3	39.4	62.3	0.9	6.1	37.4
Saving Banks	15.7	16.7	12.6	174.4	3.1	0.5	54.9	63.0	1.2	6.0	33.7
Cooperative Banks											
Regional institutions of credit cooperatives	19.5	21.1	27.9	171.3	7.4	0.6	21.1	56.1	1.0	6.2	43.4
Other cooperative banks	15.0	16.5	11.0	166.8	3.7	0.5	61.9	59.4	1.4	7.0	29.5
Real estate and mortgage banks	20.1	25.0	9.0	222.3	4.4	0.1	76.8	69.8	0.9	12.4	26.0
All banks	16.8	18.8	26.1	170.9	3.9	0.4	40.7	65.6	1.4	7.0	35.4

Source: Bundesbank and FSAP team

1/ The three big banks are: Deutsche Bank, Commerzbank, and UniCredit Bank AG (considered a host SI with the highest level of consolidation in the SSM being in Italy). They are part of the 21 systemically important institutions supervised by the ECB.

2/ Interest margin is the net interest income.

Table 10. Germany: Financial Soundness Indicators (2008-2021)[1/]

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Capital Adequacy														
Regulatory capital to risk-weighted assets	13.6	14.8	16.1	16.4	17.9	19.2	18.0	18.3	18.8	19.4	18.9	18.6	19.2	18.8
Regulatory Tier I capital to risk-weighted assets	9.5	10.8	11.8	12.1	14.2	15.6	15.4	15.7	16.3	16.9	16.6	16.5	17.2	16.8
Capital to assets	4.5	4.8	4.3	4.4	4.7	5.5	5.6	5.9	6.0	6.3	6.5	6.3	5.9	5.9
Credit Risk														
NPLs net of provisions to capital	25.3	36.9	34.2	31.6	27.4	23.8	21.3	17.4	14.7	11.9	9.1	6.8		5.4
NPLs to gross loans	2.9	3.3	3.2	3	2.9	2.7	2.3	2.0	1.7	1.5	1.2	1.1		1.5
FX loans to total loans	12.2	11.5	11.5	11	10.5	10.0	11.5	11.4	11.2	9.8	9.7	9.4	7.6	8.1
Spread between reference loan and deposit rate	273	342	343		324	326	319	301	280	260	242	225	208	193.0
Sectoral Distribution of Total Loans														
Loan to households	24.4	26.3	26.2	26.2	26.8	28.5	28.7							
Loans to non-financial corporations	14.5	14.8	14.6	14.6	14.9	15.6	15.2	15.2	14.9	15.1	15.7	16.1	15.4	15.1
Geographic Distribution of Total Loans														
Germany	71.2	72.9	74.9	75.7	76.8	76.8	74.6	80.6	81.0	82.5	82.0	81.7	83.2	82.7
Profitability														
Return on average assets (after-tax)	-0.3	-0.1	0.2	0.3	0.2	0.2	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.3
Return on average equity (after-tax)	-8.1	-2	3.7	6.5	5.6	3.5	7.2	7.5	6.6	6.3	5.1	4.1	3.8	2.8
Interest margin to gross income	84.6	72.5	73.2	72.9	71.5	71.9	74.4	75.0	71.2	69.6	72.3	69.5	67.3	
Noninterest expenses to gross income	73.4	65.1	63.7	63.9	64.2	69.1	69.5	70.4	69.3	71.9	73.1	76.0	72.3	
Trading income to gross income	0	0	4.5	3.7	5.5	4.9	27.6	26.7	25.6	29.4	27.4	28.4	29.6	
Personnel expenses to noninterest expenses	53.4	54.7	52.7	52	52.9	51.9	51.5	51.1	50.3	50.4	50.2	49.3	50.8	
Liquidity														
Liquid assets to total short-term liabilities	120.3	144.1	137	137.9	144.2	140.5	145.5	146.5	146.6	151.3	151.7	161.3	169.6	170.9
Customer deposits to total (non-interbank) loar	77.7	76.5	73.6	73.6	75.7	84.5	86.9	85.0	82.1	80.6	81.8	82.1	82.2	81.1
FX Risk														
Net open positions in FX to capital	6.6	5.3	4.4	4.5	3.9	3.8	4.0	4.62	4	3.67	3.19	3.72	3.4	4.4

Source: Deutsche Bundesbank.

[1] Spread in basis points.

Table 11. Credit Risk Panel Regression

Panel A: Default Frequencies

	Dependent Variable: Default Frequency					
	FE	no FE	FE	no FE	FE	no FE
Lagged dep var	0.521***	0.629***	0.455***	0.591***	0.465***	0.602***
Real GDP growth	-0.00830**	-0.00912**			-0.00486	-0.00689*
FCI			0.0421***	0.0305**	0.0382**	0.0254
Quarter 1	0.0878***	0.0675**	0.102***	0.0800**	0.0948***	0.0705**
Quarter 2	-0.130***	-0.151***	-0.103***	-0.129***	-0.112***	-0.141***
Quarter 4	0.126***	0.120***	0.129***	0.125***	0.125***	0.119***
Constant	0.0934***	0.103***	0.0900***	0.0993***	0.0941***	0.105***
Observations	680	680	680	680	680	680
R2	0.551	0.512	0.565	0.515	0.568	0.520

Sources: German credit registry, WEO, GFSR and IMF staff calculations

Panel B: Loss Rate

	Dependent Variable: Loss Rate					
	FE	no FE	FE	no FE	FE	no FE
Lagged dep var	0.560***	0.659***	0.494***	0.620***	0.502***	0.628***
Real GDP growth	-0.00328**	-0.00352**			-0.00183	-0.00252*
FCI			0.0172***	0.0130**	0.0158**	0.0111
Quarter 1	0.0330***	0.0259**	0.0384***	0.0307**	0.0358***	0.0272**
Quarter 2	-0.0513***	-0.0587***	-0.0408***	-0.0500***	-0.0442***	-0.0544***
Quarter 4	0.0493***	0.0473***	0.0503***	0.0488***	0.0488***	0.0469***
Constant	0.0367***	0.0361***	0.0359***	0.0346***	0.0375***	0.0368***
Observations	687	687	687	687	687	687
R2	0.588	0.556	0.603	0.561	0.605	0.565

Sources: German credit registry, WEO, GFSR and IMF staff calculations

Table 12. Germany: Sectoral Credit Risk Regressions

Panel A: Default Frequencies

Default Rate Sectoral Regressions

	1	2	3	4	5	6	7	8	9	10
Sector:	Agriculture	Mining and quarrying	Manufacturing	Electricity	Water supply; sewerage; waste management and remediation activities	Construction	Wholesale and retail trade; repair of motor vehicles and motorcycles	Transporting and storage	Accommodation and food service activities	Information and communication
coefficient:										
Real GDP growth	**-0.00242**	**-0.000732**	**-0.0118*** **	**-0.00542***	**-0.00460**	**-0.00775**	**-0.0384*** **	**-0.0233** **	**-0.00951**	**0.000101**
FCI	-0.000132	0.00600	0.0266	0.00529	0.0416*	0.0387	0.106*	0.0312	0.0209	0.0442
Unemployment rate	0.0197*	-0.0133	0.0708**	-0.00309	0.0556***	0.0998***	0.112***	0.00817	0.110***	0.0506***

	11	12	13	14	15	16	17	18	19
Sector:	Financial and insurance activities	Real estate activities	Professional	Administrative and support service activities	Public administration and defense; compulsory social security	Education	Human health and social work activities	Arts	Other services activities
coefficient:									
Real GDP growth	**-0.00343**	**-0.00362**	**-0.0114** **	**-0.0162** **	**0.00917**	**-0.0247**	**-0.00799**	**-0.000279**	**-0.0127** **
FCI	0.0389*	0.0802**	0.0632**	0.0782**	-0.0153	-0.00140	0.0455**	0.0500	0.0551***
Unemployment rate	0.0316*	0.111***	0.0884***	0.0877***	-0.00353	0.0286	0.0680***	0.103***	0.0916***

Sources: German credit registry, WEO, GFSR and IMF staff calculations

Panel B: Loss Rate

Loss Rates Sectoral Regressions

	10	20	30	40	50	60	70	80	90	100
Sector:	Agriculture	Mining and quarrying	Manufacturing	Electricity	Water supply; sewerage; waste management and remediation activities	Construction	Wholesale and retail trade; repair of motor vehicles and motorcycles	Transporting and storage	Accommodation and food service activities	Information and communication
coefficient:										
Real GDP growth	-0.00103	-0.000304	-0.00532***	-0.00226*	-0.00191	-0.00255	-0.0154***	-0.00817**	-0.00284	0.00
FCI	0.000	0.00250	0.00641	0.00221	0.0172*	0.0362**	0.0426*	0.0110	0.00623	0.0189
Unemployment rate	0.00840*	-0.00553	0.0154	-0.00129	0.0231***	0.0452***	0.0449***	0.00287	0.0327***	0.0217***

	105	110	120	130	140	150	160	170	180
Sector:	Financial and insurance activities	Real estate activities	Professional	Administrative and support service activities	Public administration and defense; compulsory social security	Education	Human health and social work activities	Arts	Other services activities
coefficient:									
Real GDP growth	-0.00142	-0.00125	-0.00444**	-0.00580**	0.00384	-0.00988	-0.00296	-9.59e-05	-0.00423**
FCI	0.0161*	0.0276**	0.0246**	0.0280**	-0.00641	-0.000559	0.0169**	0.0172	0.0184***
Unemployment rate	0.0131*	0.0383***	0.0343***	0.0314***	-0.00148	0.0114	0.0252***	0.0352***	0.0306***

Sources: German credit registry, WEO, GFSR and IMF staff calculations

Table 13. Germany: Aggregated Sectoral Credit Risk Coefficients by Type of Banks

Panel A: Default Frequencies

	All banks	Big banks	Branches of foreign banks	Commercial banks	Credit cooperatives	Foreign banks
Real GDP growth	-0.009	-0.006	-0.010	-0.010	-0.009	-0.010
FCI	0.05	0.03	0.03	0.04	0.05	0.04
Unemployment rate	0.07	0.06	0.05	0.06	0.07	0.06
	Landesbanken	Mortgage banks	Saving banks	Savings and loan association	Special purporse banks	Regional
Real GDP growth	-0.007	-0.003	-0.009	-0.023	-0.010	-0.010
FCI	0.04	0.05	0.05	0.07	0.04	0.04
Unemployment rate	0.06	0.07	0.07	0.09	0.05	0.06

Source: German credit registry, WEO, GFSR, Haver and IMF staff estimates

Panel B: Loss Rate

	All banks	Big banks	Branches of foreign banks	Commercial banks	Credit cooperatives	Foreign banks
Real GDP growth	-0.004	-0.002	-0.004	-0.004	-0.004	-0.004
FCI	0.018	0.013	0.013	0.017	0.019	0.016
Unemployment rate	0.024	0.019	0.018	0.022	0.026	0.021
	Landesbank	Mortgage banks	Saving banks	Savings and loan association	Special purporse banks	Regional banks
Real GDP growth	-0.003	-0.001	-0.003	-0.009	-0.004	-0.004
FCI	0.015	0.019	0.020	0.034	0.014	0.017
Unemployment rate	0.020	0.026	0.027	0.040	0.018	0.022

Source: German credit registry, WEO, GFSR, Haver and IMF staff estimates

A. Banking Sector Solvency Test		
Domain		**Framework**
1. Institutional Perimeter	Institutions Included	16 SIs under IFRS9 accounting and 1293 LSIs.
	Market Share	87 percent of banking system assets. Total assets for SIs (16 banks using IFRS) is €7,603.186 billion. Total assets for LSIs (1295 banks) is €3,200 billion.
	Data Source and Baseline Date	• Sources: Supervisory data provided by the ECB for the SIs and by the Bundesbank for the LSIs. For both SIs and LSIs: FINREP, COREP files. For SIs only: STE files, in particular Interest Risk in the Banking Book files; and EBA (2021) stress tests submissions. • Other data sources: public sources (EBA Transparency Exercises), commercial databases (Fitch, Moody's KMV, Bloomberg, Haver Analytics), IMF Global Assumptions (GAS) and IMF WEO. • Effective date: Q4 of 2021 for SIs and Q3 of 2021 for LSIs. • Scope of Consolidation: consolidated.
2. Channels of Risk Propagation	Methodology	• Credit risk parameter (PD, LGD, EAD) projections generated by geographical breakdown (5 jurisdictions) and product (6 asset classes: retail unsecured, retail secured, corporate institutions, and central banks and central governments). Loan growth paths consistent with static balance sheet for SIs and LSIs.

A. Banking Sector Solvency Test		
Domain		**Framework**
		• SIs' credit risk modeling relied on IFRS9 modeling and transition matrices; LSI credit risk modeling relied on traditional approaches, given their reliance on domestic GAAP accounting standards. The SIs analysis used as starting points the PDs and LGDs reported by banks in the COREP templates and considered the geographical exposures (i.e., Germany, the U.S., the U.K., France, Italy, and Spain) for each. The LSIs analysis used the PDs and LGDs published by the EBA in the risk dashboard for the German banking system to benchmark the starting point. Nonfinancial corporates' credit risk elasticity parameters (PDs and LGDs) were derived from an empirical model of default rates and loss rates using supervisory data (German Credit Registry) and with 2021 as the benchmarked starting point. Households' default rate elasticities were constructed from a micro-macro model and households' defaults simulations based on the ECB Household Finance and Consumption Survey under the full recourse mortgages assumption (i.e., households' default only if they become unemployed and fully deplete their financial savings).
	Satellite Models for Macrofinancial Linkages	• Credit risk for non-financial corporates: (1) panel regressions of default rates and of loss rates at the sectoral level with macro-financial determinants; (2) sector-by-sector regressions of default rates and of loss rates with macro-financial determinants; sectoral LGDs derived from default rates and loss rates. Data source: German credit registry and Bundesbank. • Household default risk modeled based on a micro-macro structural model using micro household survey data (Household Finance and Consumption Survey) based on Gross, M., Tressel, T., Ding, X., and Terenau, E., 2022, "What Drives Mortgage Default Risk in Europe and the U.S.?", IMF Working Paper No. 2022/065.

A. Banking Sector Solvency Test		
Domain		**Framework**
		• Interest rates and Net Interest Income: Projections were estimated from an empirical regression model covering the period 2006-2019 and using individual bank data from commercial databases. The NII model linked NII to the spread between the short-term rate and the long-term yield on government securities, implying a pass-through from bank funding costs to lending rates smaller than one. The analysis assumed very conservatively a 100 percent pass-through from policy rates/short-term market rates to funding costs of banks. The stress test also assumed static balance sheet. The adverse scenario included a 10 percent loss in fee and commission income in 2022-23. The stress test included funding shocks and interest risk analysis for the SI banks, drawing on the contractual and notional maturities of interest-bearing assets, retail deposits, wholesale deposits and borrowing data reported in the supervisory template IRRBB by each bank. For LSI, the maturity structure was proxied from aggregate data on the loans' contractual maturity and of retail and wholesale deposits and it was assumed that interest bearing assets and liabilities had the same maturity structure. • Net Fees and Commission income and other income/expenses: constant share of assets, except for SI adverse scenario where a 10 percent loss in assumed in 2022 and aligned with static asset growth from 2023 onwards. • Sovereign credit risk and market risk: Merton model combined with baseline and adverse scenario projections of the short-term interest rate and the long-term yield on securities. It considered a shock to sovereign exposures to Italy and Spain (and exposures to Russia) and an additional shock of 25 percent to real estate valuations. • For SIs only: Evolution of IFRS9 transition matrices based on beta-linked models from Gross, Laliotis, Leika, and Lukyantsau (2020).
	Stress Test Horizon	• 5 years (2022-2026).

A. Banking Sector Solvency Test		
Domain		**Framework**
3. Tail Shocks	Scenario Analysis	• Baseline from the revised Spring WEO. • An adverse scenario with severity benchmarked based on a 3 standard deviation shock to real GDP growth relative to baseline over 2022-2023 and closing of output gap at the end of the simulation horizon Macro-financial simulations realized based on MCM GFM macro-financial DSGE model by Vitek, 2018, "The Global Macrofinancial Model", IMF WP 18/81. • Macro-financial scenarios for exposures to U.S., U.K., France, Italy, and Spain for the 16 SIs. • The adverse scenario is characterized by a V-shape path for real GDP growth, tightening of global financial conditions, uncertainty about the economic environment and renewed Covid infections, lockdown measures, and 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.
	Sensitivity Analysis	• Sensitivity analysis considers shocks to exposures to Russia.
4. Risks and Buffers	Risks/Factors Assessed	• Credit risk (corporates, households and real estate, sovereigns of high debt countries). • Interest rate risk in the banking book. • Market risk (interest rate, spreads).

A. Banking Sector Solvency Test		
Domain		**Framework**
	Behavioral Adjustments	• Static balance sheet assumption for LSIs and for SIs. • Base simulations assume no write-offs, while robustness simulations consider write-offs aligned with bank-asset class level write-off rates observed in recent data. • Portfolio composition unchanged over time.
5. Regulatory and Market-Based Standards and Parameters	Calibration of Risk Parameters	• TTC and Initial PiT PDs and LGDs obtained from supervisory files for SIs, or estimated at the asset class level from the EBA risk-dashboard 2021:Q3 for LSIs. • Dynamic from model estimated PDs in line with the scenario considered (WEO baseline, adverse scenarios).
	Regulatory/Accounting and Market-Based Standards	• Regulatory capital ratios for IRB and STA portfolios, and IFSR9 or national GAAP accounting standards. • For SIs and LSIs, the hurdle rate includes the minimum CET1 ratio, the conservation buffer and the CCyB of 0.75 percent starting Q1 of 2023. A systemic risk buffer of 0.5 percent of RWAs is also added to the hurdle rate of SIs.
6. Reporting Format for Results	Output Presentation	• Aggregate results and contributions to evolution of capital ratios.

B. Liquidity Banking Sector Stress Testing Matrix (STeM)		
Domain		**Framework**
		Top-down by FSAP team
1. Institutional Perimeter	Institutions Included	• 17 SIs, and 40 randomly selected German LSIs of four different groups: commercial, savings, cooperative, and building societies and mortgage banks. The composition of the LSI sample was chosen to balance the need to include a sufficient number of banks of each group and to reflect, within this constraint, the different number of entities belonging to each group and quintile of the banking sector's asset distribution. • Excludes branches of non-German banks.
	Market Share	• 17 SIs (out of 21), account for about [45] percent of banking sector assets. • 40 LSI (out of >1300 LSIs), randomly chosen to be representative of bank type and size distribution. The sample accounts for about 3 percent of LSIs (in terms of banks and assets).
	Data and Baseline Date	• ECB/SSM and Bundesbank: Liquidity Coverage Ratio and the Net Stable Funding Ratio and Cash flow table from the COREP data repository. • Data as of September 2021 for LSIs and December 2021 for SIs. • Scope of financial consolidation: 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, contractual cash inflows and outflows, and behavioral flows. • For the cash-flow analysis, relevant second-round effects could be considered, including margin calls for existing collateral positions, non-emergency liquidity provision by the central bank, additional asset haircuts due to fire sales, additional repo haircuts due to limited collateral supply, and wholesale funding market freezes because of banks' solvency and liquidity concerns.

B. Liquidity Banking Sector Stress Testing Matrix (STeM)		
Domain		**Framework**
		Top-down by FSAP team
		• The test was repeated for US dollar liquidity for the relevant reporting banks. • The analysis is complemented with LCR and NSFR statistics.
	Stress Test Horizon	• For the cash-flow analysis, the horizon of stress events varies by scenario and can extend up to a period of 1 year).
3. Tail Shocks	Scenario Analysis	• Baseline and three scenarios are considered, with varying intensity of adverse liquidity conditions and reflecting different liquidity risks (funding and market liquidity). The three stress scenarios were formulated in terms of roll-on/roll-off rates and haircuts to CBC and were designed to capture risks from: • (a) a new wave of covid cases, characterized by net outflows of retail deposits of households drawing down their savings (peaking up at the one-month horizon) and increased use of credit lines. • (b) a significant increase in risk aversion, with higher haircuts on counterbalancing capacity assets due to financial market stress and some outflows of wholesale funds; outflows related to rating downgrades and some deposit outflows peaking at the 2-month horizon. • (c) combined significant increase in risk aversion with higher and more sustained inflation with correspondingly stronger outflows of nonoperational deposits peaking in a one year-horizon and stronger haircuts but weaker outflows from downgrades.
	Sensitivity Analysis	• A range of alternative scenarios was applied to the entire set of LSIs.

B. Liquidity Banking Sector Stress Testing Matrix (STeM)		
Domain		**Framework**
		Top-down by FSAP team
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 related to non-renewal of maturing assets. • 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. • 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	• The cash-flow analysis may incorporate relevant second-round effects. • Stress funding run-off rates, asset roll-over rates, and asset haircuts are calibrated based on empirical evidence and relevant international experiences.
	Regulatory/Accounting and Market-Based Standards	• LCR per Basel III; the hurdle at 100 percent (at the aggregate currency level). • Net cash balance for the cash-flow analysis; to pass, a non-negative net cash balance is required, where the balance reflects net funding outflows and counterbalancing capacity. • NSFR per Basel III; limit of 100 percent applied.

B. Liquidity Banking Sector Stress Testing Matrix (STeM)		
Domain		**Framework**
		Top-down by FSAP team
6. Reporting Format for Results	Output Presentation	• Changes in the system-wide liquidity position, including important drivers for cash outflows, cash inflows and counterbalancing capacity. • Distribution of banks' liquidity positions. • Number of institutions with LCR/NSFR below 100 percent and/or negative net cash balance. • Amount of liquidity shortfalls (scaled).
7. Infrastructure		• Infrastructure developed by IMF staff with FINREP/COREP data input.