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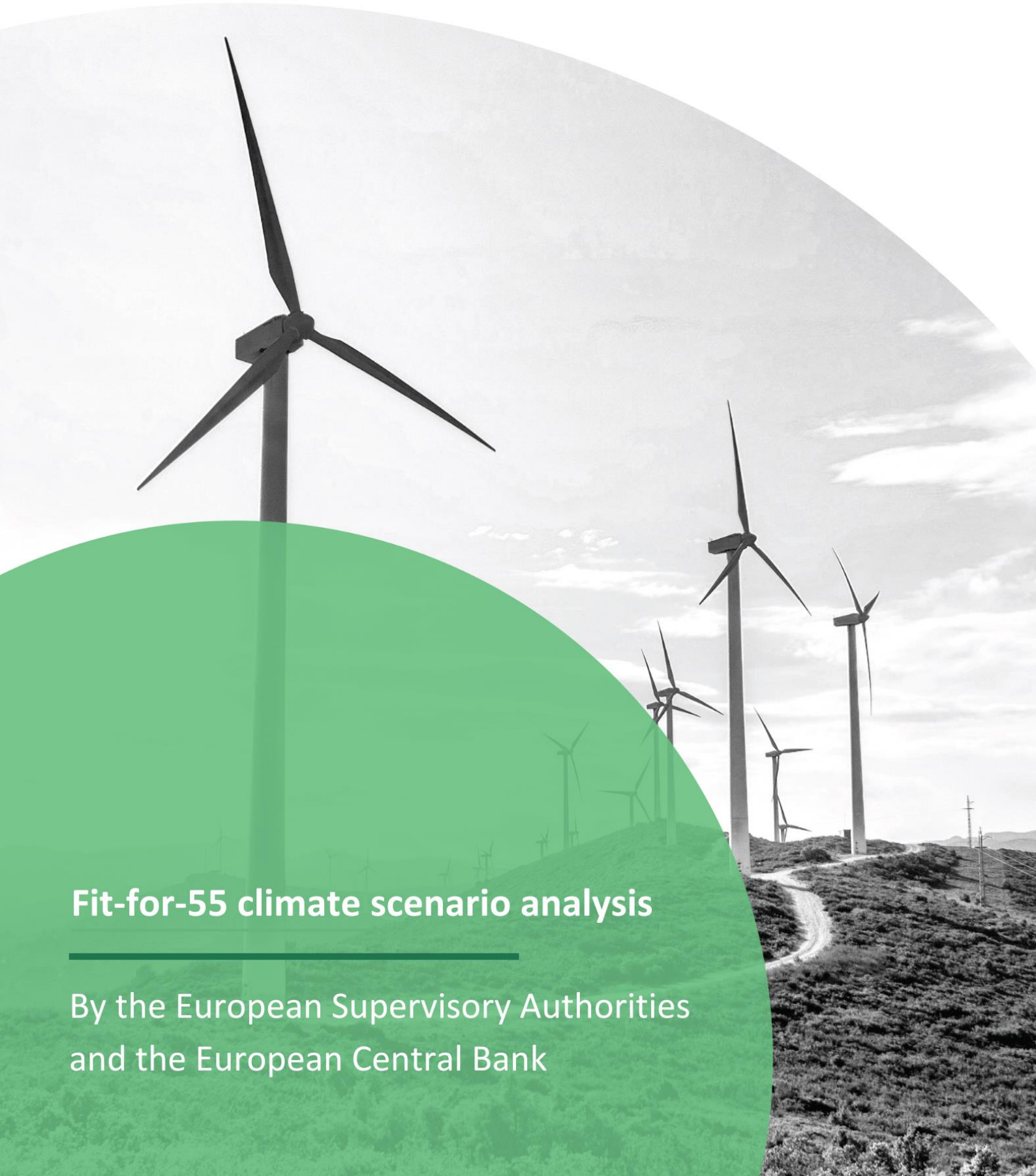

Fit-for-55 climate scenario analysis

By the European Supervisory Authorities and the European Central Bank

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Abbreviations

AIF	Alternative investment fund
AnaCredit	Analytical credit datasets
AuM	Assets under management
BEAST	Banking euro area stress test
CET1	Common Equity Tier 1
CIC	Complementary Identification Code
CIU	Collective investment undertaking
COREP	Common Reporting Framework
CQS	Credit quality step
CR	Credit risk
CRE	Commercial real estate
CSDB	Centralised Securities Database
DB	Defined benefit
DC	Defined contribution
DD	Distance to default
EA	Euro area
EAD	Exposure at default
EBA	European Banking Authority
ECB	European Central Bank
ECCL	Expected cumulative credit loss
EEA	European Economic Area
EFAMA	European Fund and Asset Management Association
EIOPA	European Insurance and Occupational Pensions Authority
EPC	Energy performance certificate
ESA	European Supervisory Authority
ESMA	European Securities and Markets Authority
ESRB	European Systemic Risk Board
EU	European Union
FC	Financial company

FINREP	Financial Reporting Framework
GDP	Gross domestic product
GVA	Gross value added
HtM	Held to maturity
IORP	Institution for occupational retirement provision
IL	Index-linked
ISA	Interconnected System-wide stress test Analytics
ISIN	International Securities Identification Number
LAC	Loss-absorbing capacity
LCR	Liquidity Coverage Ratio
LDI	Liability-driven investment
LGD	Loss given default
LGL	Loss given loss
LT	Look-through
LTLR	Lifetime loss rate
LTV	Loan to value
NACE	*'Nomenclature statistique des activités économiques dans la Communauté européenne'*: statistical classification of economic activities in the European Community
NAV	Net asset value
NFC	Non-financial company
NFCI	Net fee and commission income
NGFS	Network for Greening the Financial System
NII	Net interest income
NOI	Net operating income
NPL	Non-performing loan
NSFR	Net Stable Funding Ratio
QRT	Quantitative Reporting Template
PD	Probability of default
P&L	Profit and loss
RFR	Risk-free rate
RoA	Return on assets

RoE	Return on equity
SCR	Solvency Capital Requirement
SFDR	Sustainable Finance Disclosures Regulation
SHS-G	Securities holdings by banking groups
SHS-S	Securities holdings by sectors
SR	Sales ratio
SSM	Single Supervisory Mechanism
TLTRO	Targeted longer-term refinancing operation
UCITS	Undertaking for collective investment in transferable securities
UL	Unit-linked
UR	Unemployment rate

1. Executive Summary

Context and objective of the exercise

1. In accordance with the Strategy for Financing the Transition to a Sustainable Economy[1], the European Commission invited the European Supervisory Authorities (ESAs), the European Central Bank (ECB) and the European Systemic Risk Board (ESRB) to conduct a one-off climate risk scenario analysis to assess the resilience of the EU financial sector to withstand climate-related shocks and to support the green transition even under conditions of stress.

2. The exercise assumes throughout that the Fit for 55 package will be fully implemented as planned and that its objectives will be achieved by 2030. 'Fit for 55' refers to the commitment of all EU Member States to transition to a climate-neutral economy by 2050 and to reduce emissions by at least 55% by 2030, compared to 1990 levels. The exercise is the first EU-wide climate stress test for the financial sector. This broad scope recognises the importance of interlinkages across the entire financial system and the real economy, which can amplify financial stress. At the same time, other economy-wide effects, not considered in the analysis here, may help mitigate vulnerabilities. The cross-sectoral EU-wide joint exercise is therefore an important tool for understanding how climate-related risks can affect financial stability and the financing of the transition.

3. The exercise is run in a top-down fashion, covering thousands of EU financial institutions in the banking, insurance, institutions for occupational retirement provision (IORPs) and investment fund sectors. It goes beyond assessing individual sectoral vulnerabilities (first-round losses) and considers the EU financial system as a whole, including modelling of contagion and amplification effects across firms and sub-sectors of the financial system (second-round losses). The exercise focuses on the assets held by financial entities, while noting that the interpretation of the results should bear in mind the potential for additional effects on liabilities, including technical provisions for insurance and IORPs.

4. As foreseen by the Commission, the exercise required coordination among all parties involved, namely the European Systemic Risk Board (ESRB), the European Banking Authority (EBA), the European Insurance and Occupational Pensions Authority (EIOPA), the European Securities and Markets Authority (ESMA) and the European Central Bank (ECB). Acknowledging the distinct areas of competence, this setting has promoted collaboration among EU financial authorities and institutions, providing a tangible opportunity to assess climate risk from a joint perspective that aligns methodologies and analytical tools while leveraging sector-specific expertise.

[1] COM/2021/390, 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Strategy for Financing the Transition to a Sustainable Economy', July 2021.

Three scenarios in line with the Fit for 55 package

5. The scenarios of the exercise, which comprise a baseline and two adverse scenarios, were developed by the ESRB Task Force on Stress Testing and finalised by the ESRB General Board. They represent potential future pathways of the economy and not 'forecasts' with an assigned probability, in line with the approach followed by the Network for Greening the Financial System (NGFS)[2]. In turn, not all scenarios, nor all severities, are considered – meaning that more severe scenarios could emerge, potentially leading to more severe impacts on the capital position of the individual sectors and the financial system as a whole.

6. The scenarios reflect the Commission's request to assume that the objectives of the Fit for 55 package will be fully achieved by 2030, as the EU will follow through on its implementation. The baseline scenario itself includes upfront costs associated with the transition that are needed to avert the most extreme economic, societal and ecological damage further in the future. Over the time horizon modelled, i.e. 2023-2030, these necessary costs are reflected in the results for each scenario. Moreover, it is assumed that the energy-related investments in the EU are the same across scenarios. In addition, the two adverse scenarios incorporate severe but plausible transition risk shocks that could negatively affect the financial system until 2030.

7. Under the baseline scenario, the Fit for 55 package is implemented in an economic environment that reflects the baseline economic forecasts. The economy and financial system develop according to macroeconomic and financial conditions that facilitate an orderly green transition in line with the Fit for 55 package, with a 11% cumulative GDP growth over the eight-year horizon and relatively stable energy prices. Nevertheless, the structural changes necessary to align the economy with the Fit for 55 objectives require firms to allocate almost EUR 3.7 trillion to energy-related investments over the same period, temporarily increasing their leverage and financial expenses and, in turn, financial risk for their counterparties. These large-scale investments are collectively needed to mitigate the most extreme costs of climate change further in the future, beyond the modelling horizon of the exercise.

8. The first adverse scenario focuses on short-term climate-related risks in the form of asset price corrections triggered by a sudden reassessment of transition risk (known as the 'run on brown'). The stress factors are assumed to be exogenous, i.e. stemming from climate risks or how the economic and financial players perceive them, while Fit-for-55 implementation progresses as planned. The second adverse scenario combines the same climate-related risks with additional macroeconomic stress factors. The non-climate-related stress factors represent a selection of the main financial stability risks considered in the EBA's 2023 EU-wide stress test, including geopolitical risk.

9. The Fit for 55 baseline differs from a baseline scenario in regular banking stress tests not only in its time horizon (eight years vs. three years), coverage of variables and granularity, but also

[2] NGFS climate scenarios are a key building block of the three scenarios applied in this exercise.

in terms of assumptions on the implementation of Fit for 55 policies. For instance, the baseline scenario in the EBA EU-wide stress test coincides with the economic forecast, although the current policies included in the forecast are unlikely to be sufficient to fully meet the EU targets. The Fit for 55 baseline should thus be interpreted as a 'reference trend' which, while generating somewhat higher losses with respect to the 'current policies trend' in regular stress tests, keeps the world on a safer global temperature trajectory and reduces physical risk in the long run. In other words, unlike baseline scenarios typically used in non-climate-related stress testing, it assumes that necessary policy action will be taken, thereby incurring short-term costs in order to avert the most catastrophic long-term economic, social and ecological costs of global warming.[3]

Assumptions and limitations

10. Four important methodological assumptions should be noted. First, the impact of the scenarios on banks' income components, insurers' liabilities and IORPs' liabilities is not considered here. Especially during high interest rate periods, this could mitigate losses.[4] This assumption results in an overestimation of losses, in the baseline scenario and in the adverse scenarios for banks, insurers and IORPs. The significant increase in interest rates would lead to a notable decrease in liabilities of insurers and IORPs, partially offsetting the losses in the market value of the investment assets. Second, part of the impact is borne by policyholders, meaning that the total financial impact on the sector will be less pronounced than what the investment declines indicate in isolation.[5] Third, hedges are considered only for banks due to their relevance for the banking sector. Finally, the analysis in Chapters 3 to 5 for each individual sector is performed under a static balance sheet assumption without considering any reactions by financial institutions or other market participants to mitigate losses. This is partially relaxed for banks in Box 1 to show how they might adjust their lending in response to the macroeconomic environment and transition risks. Some dynamic effects are included in the cross-sectoral analysis (Chapter 6), which estimates how the reactions of market participants and economic agents to the initial shock may amplify losses. Although the cross-sectoral analysis considers a range of reactions, there are inherent methodological challenges in capturing all potential transmission channels of climate-related shocks, which might lead to an underestimation of losses especially in the adverse scenarios. Therefore, proactive measures and strategies need to be designed to address potential risks not covered in the initial analysis.

[3] For the long-term impact of physical risks in the 'current policies' scenario, i.e. without additional policy intervention, see (a) NGFS Climate Scenarios, Phase IV, November 2023; and (b) ECB economy-wide climate stress test, ECB Occasional Paper Series, September 2021.
[4] Insurers and IORPs are liability-driven businesses with the primary objective to meet long-term obligations, such as paying out insurance claims or pension benefits. Across all scenarios, positive shocks to swap rates through discounting would lead to a significant decrease in liabilities, partially offsetting the drop in market value of investments (see Box 2 in Chapter 4).
[5] For the insurance sector, around 20-30% of losses would be absorbed by unit-linked products, while for the IORP sector around 10% of the losses are absorbed by beneficiaries in defined contribution (DC) schemes (see Box 3 in Chapter 4).

Ensuring the resilience of financial institutions against unforeseen shocks will be crucial for maintaining stability during implementation of the Fit for 55 package.[6]

11. As with all forward-looking projections, the outcomes are subject to inherent uncertainty, especially given the novelty of the climate stress testing approaches. As detailed in the report, heterogeneity in the data coverage and data quality adds to this uncertainty. The results should thus be understood as relating only to certain classes of assets held by financial entities. Indeed, compared to other stress tests, the calculation of losses is performed at a much more granular level, but in some cases limiting the scope in terms of portfolios (e.g. banks' residential mortgage portfolios are not included in the assessment). Overall, the exercise assesses the impact of the three scenarios on 110 banks, 2 331 insurers, 629 IORPs and around 59 000 funds (of which 22 000 in the EU), accounting however for less than half of their total assets at aggregate level. In particular, the share of assets covered for each sector is: 35% of total credit risk exposures and 26% of total market risk exposures for banks, 81% of total investments for insurers, 76% of total investments for IORPs and 77% of total assets for investment funds. Market risk exposures represent the largest share of total assets modelled, while credit risk exposures are unique to the banking sector. These differences in coverage may explain some of the differences in the first and second-round results across sectors.

Main results

12. The results show that first-round losses stemming from a potential run on brown scenario have a limited impact on the financial system, indicating that perceived changes in climate risks would not be a concern for financial stability per se during the green transition. However, adverse macroeconomic developments could disrupt the evolving transition and substantially increase financial institutions' losses, thereby impairing their financing capacity. The results are compared to a baseline scenario, which also produces losses as in typical banking stress testing exercises. In addition, this baseline scenario is particularly related to the up-front investments urgently needed to prevent the most severe long-term costs of global warming.

13. Looking at the magnitude of the results (Table 1 and Figure 1), total system-wide first-round losses amount to 3.86% of total exposures in scope (EUR 945 billion), and 5.98% (EUR 1 463 billion) under the baseline and the first adverse scenario, respectively. Under the second adverse scenario, the financial system faces 15.80% of total first-round losses (EUR 3 866 billion). Moreover, second-round losses under the baseline, the first and second adverse

[6] Some features of the modelling are suited to top-down analysis but do not permit inference about individual financial institutions. For example, the scenarios are specified at the level of economic sectors, and hence do not reflect idiosyncratic climate risks of individual NFCs. Additionally, the scenarios are specified at NACE 1 sector level, which is not granular enough to distinguish between different sources of electricity generation.

scenarios amount to 1.34% (EUR 305 billion), 2.77% (EUR 628 billion) and 5.37% (EUR 1 218 billion), respectively.[7]

14. The banking sector records first-round credit and market losses amounting to 5.8% of total exposures in scope, equivalent to EUR 343 billion, under the baseline scenario. In the first adverse scenario, the run on brown results in total losses of 6.7% relative to total exposures in scope, bringing total losses to EUR 393 billion. The second adverse scenario leads to total losses of 10.9% relative to total exposures in scope, totalling EUR 638 billion. These losses are mainly driven by the adverse macroeconomic environment, while the impact resulting from climate factors alone, as translated into the run on brown mechanism, remains contained. By the end of the horizon, annual losses in the second adverse scenario are still almost 1.5 times higher than under the baseline scenario. While the banking sector is expected to be resilient enough to withstand the selected adverse shocks, the magnitude of the results highlights that banks need to integrate climate risks into their risk management frameworks as promptly and extensively as possible. Finally, the application of the dynamic balance sheet framework indicates that, under the assumptions made, banks could potentially contribute to financing the transition, for what concerns the private sector share of investment needed. However, under challenging macroeconomic conditions, additional funding from other financial intermediaries and sectors, including capital markets and the public sector, will be necessary to finance the green transition.

15. In the baseline scenario, the insurance and IORP sectors, respectively, experience a mild decline in investment values of 2.2% and 3.0% of investments in scope due to first-round losses. This amounts to EUR 153 billion for insurers and EUR 54 billion for IORPs. The run on brown under the first adverse scenario more than doubles the impact. Yet, the impact relative to exposures in scope at the end of 2022 remains manageable also in the first adverse scenario at a 5.2% decrease (EUR 356 billion) for insurers and a 6.4% decrease (EUR 113 billion) for IORPs. While both sectors remain resilient across all scenarios, a more significant impact arises under the second adverse scenario due to the deterioration of the macro-financial environment. In this scenario, insurers experience a decrease in the value of their investments of 18.8% (EUR 1 285 billion), while for IORPs investment values drop by 21.5% (EUR 379 billion). This can be attributed to a strong increase in swap rates and credit spreads that leads to significant decreases in market value, especially for corporate and sovereign bonds, which account for a large share of both insurers' and IORPs' investments. The impact is amplified by typically long durations held in the portfolio of insurers and IORPs, which tend to be longer-term investors. If the significant reduction in the liabilities of insurers and IORPs had been accounted for, it would partially mitigate the losses on the assets side.

[7] The cross-sectoral model used to compute second-round losses does not include IORPs. Only credit losses registered in the first year of the projection horizon are considered for the calculation of second-round losses.

16. EU investment funds undergo a fall in value of 4.0% of initial total exposure in the baseline scenario, or around EUR 396 billion, driven largely by declines in the values of equities held by the funds. The magnitude of the decline increases to 6.1% (EUR 602 billion) in the first adverse scenario, as the run on brown shock leads to a further decline in market values. This decline increases with the scenario severity, driven by higher default risk premia for bonds issued by companies. In the run on brown component of the adverse scenarios, for instance, this jump in default risk premia is driven by a shock in energy costs. In the second adverse scenario, the additional effect of a sharp, exogenous deterioration in the macroeconomic environment drives an overall immediate decline of 15.8% (EUR 1 563 billion). EU funds experience similar overall declines in asset values to the rest of the global investment fund sector in all scenarios.

17. In general, second-round amplification effects can lead to further losses when triggered liquidity stress compounds with bad market conditions. Nevertheless, and while the estimation is subject to the aforementioned limitations and uncertainty, the scenarios modelled in this exercise do not appear to pose a substantial threat to the overall stability of the financial system. Major financial institutions are likely to cope with the estimated first and second-round losses, given their strong capitalisation, high liquidity levels and diversification, which mitigate the effects from the shocks. Smaller investment funds, however, face larger adverse impacts, resulting in notable losses when aggregated across the EU.

18. The exercise marks a significant advance in the field of climate stress testing, particularly in terms of its complexity and the integration of interconnected features. Nonetheless, the estimates depend on a number of important assumptions, especially with regard to the second-round effects. Modelling uncertainty is also a significant factor from the outset, as the construction of the scenarios themselves involves highly detailed macroeconomic modelling. Heterogeneity in the data coverage and reliance on different data sources heighten the overall level of uncertainty in the results. Despite inevitable limitations, the exercise strives to maintain consistency across sectors as far as possible in both scope and approach.[8] In responding to the Commission's request, the ESAs and the ECB have benefited from this climate scenario analysis in several ways. First, the results – available to the ECB and the ESAs at a very granular level – provided valuable insights into key vulnerabilities, their concentration and potential contagion effects, enabling targeted future initiatives to monitor climate-related risks. However, given its nature and the above-mentioned limitations, this exercise is not conceived as a solvency stress test and, therefore, identified losses will not lead to recapitalisation actions. Second, the exercise served as a valuable learning opportunity for all institutions, requiring them to consolidate, enhance and compare the respective modelling toolkits to fulfil the mandate. Third, it facilitated the exchange of ideas, data and analysis across institutions and the formulation of a common view on the findings.

[8] A detailed description of all limitations related to the exercise is provided in the introduction (see paragraphs 22 and 23) as well as in the sector-specific chapters.

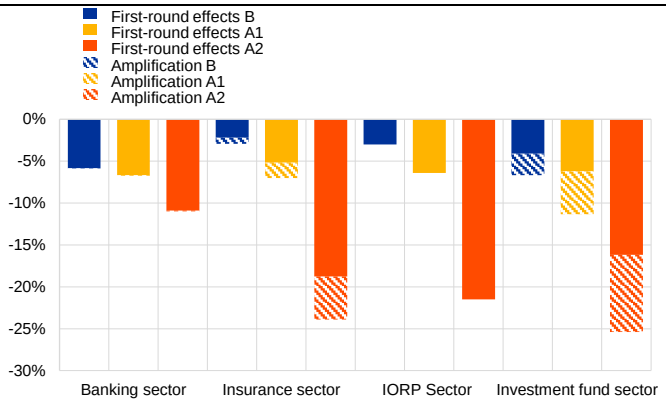
Table 1: Summary of the results of the exercise

	First-round losses			First and second-round losses (including cross-sectoral amplification)		
	Baseline	**Adverse 1**	**Adverse 2**	**Baseline**	**Adverse 1**	**Adverse 2**
Banking sector	-5.8	-6.7	-10.9	-5.8	-6.8	-11.0
Insurance sector	-2.2	-5.2	-18.8	-2.9	-6.9	-23.3
IORP sector	-3.0	-6.4	-21.5	-	-	-
Investment fund sector	-4.0	-6.1	-15.8	-6.6	-11.2	-25.0
Total (financial system)	-3.9	-6.0	-15.8	-5.3	-8.7	-20.7

Notes: i) Results presented as total losses relative to exposures in scope in percentages. ii) For the banking sector, the scope for credit risk exposures considered is the one from the banking chapter (please refer to Chapter 3 for further details), and in particular it does not include the first-round losses for non-NFCs that are provided in the cross-sectoral chapter (please refer to Chapter 6 for further details). First-round losses are estimated under a static balance sheet assumption. In addition, the cross-sectoral module considers only credit losses registered in the first year of the projection horizon. iii) IORPs are not included in the model employed to assess cross-sectoral amplification. Differences in results between sectors may reflect differences in data coverage.

Figure 1: Total losses relative to exposures in scope by sector

(2023-2030, percentages)



Source: EBA, EIOPA, ESMA and ECB calculations.

2. Introduction

Overview of the exercise

19. Under the European Green Deal, all 27 EU Member States committed to turning the EU into the first climate-neutral jurisdiction by 2050 and pledged to reduce emissions by at least 55% by 2030, compared to 1990 levels. 'Fit for 55' refers precisely to this target. The Fit for 55 package aims to bring EU legislation in line with the 2030 goal with a set of policies that include – among others – the EU emissions trading system, the carbon border adjustment mechanism, sector-specific emissions targets, and revisions to the Renewable Energy Directive and Energy Efficiency Directive.

20. In this context, on 8 March 2023, the Commission issued a letter that invited the ESAs, the ECB and the ESRB to conduct a one-off Fit for 55 climate risk scenario analysis.[9] As specified in the letter, the objective of the exercise is to assess the resilience of the financial sector in line with the Fit for 55 policy package, while gaining insights into the capacity of the financial system to support the transition to a lower-carbon economy even under conditions of stress. The purpose of this exercise is not to set microprudential or macroprudential requirements for financial institutions, but rather to assess the overall availability of capital and the financial sector's vulnerabilities, to be ready to react swiftly in the event of adverse shocks.

21. The exercise is run in a top-down fashion for the period between 2023 and 2030 with sector-specific results (first-round losses) and a cross-sectoral perspective (second-round losses) covering a large part of the EU financial system. As with all forward-looking projections, this assessment is subject to inherent uncertainty, especially with the current economic outlook: global markets continue to adjust to the change in the interest rate environment; inflation is at levels not experienced in over thirty years and there are heightened geopolitical tensions and risks. Hence the outcomes of the exercise need to be carefully considered within the bounds of the designed scenarios.

22. The focus is on transition risk in the EU. Three scenarios (one baseline and two adverse) are considered. The scenarios have been provided by the ESRB in line with the high-level narrative indicated by the Commission. Ad hoc data collection was launched by the EBA and the ECB to support the banking module of the exercise. EIOPA and ESMA relied on internally available data (including commercial data) for insurers, IORPs and investment funds.

23. The analysis is performed under a static balance sheet assumption, meaning that reactive management actions from financial institutions are not allowed. This assumption is relaxed in Box 1 to show how banks could adjust their lending in response to the macroeconomic environment and transition risks. It is also relaxed to a lesser extent in Chapter 6, covering the

[9] See 'Request for a one-off scenario analysis exercise to be conducted jointly by the European Supervisory Authorities, the ECB and the ESRB in accordance with the Communication from the Commission of 6 July 2021 "Strategy for Financing the Transition to a Sustainable Economy"', March 2023.

cross-sectoral amplification, as financial institutions can sell assets in the short term to accommodate liquidity needs. The exercise further focuses only on financial institutions' assets. Thus, liabilities are not recalculated under the three scenarios. Box 2 in Chapter 4 gives a stylised example of the behaviour of insurers' liabilities under the second adverse scenario, while Box 3 describes the loss absorption capacity of liabilities for insurers and IORPs. The loss absorption capacity of liabilities is also included in the cross-sectoral model to estimate second-round losses.

24. The remainder of this chapter provides an overview of the scenarios, which are described in more detail in the accompanying ESRB document.[10] The methodology and results of the sector-specific assessments are presented in the following chapters: banks in Chapter 3, insurers and IORPs in Chapter 4, investment funds in Chapter 5. Chapter 6 presents the cross-sectoral assessment, where the interactions between the three sectors are modelled with the aim to capture system-wide dynamics and the potential for risk amplification. More details on the methodology and underlying modelling frameworks are provided in the Appendices.

Overview of the scenarios

25. The Commission invited the ESRB to develop severe but plausible scenarios that could affect the financial system over the period up to 2030. Three scenarios have been developed in line with the mandate:

- A **baseline scenario** (B) foresees the implementation of the Fit for 55 package in an economic environment that reflects June 2023 forecasts.[11]
- A **first adverse scenario** (A1) focuses on short-term climate-related risks that materialise in the form of asset price corrections triggered by a sudden reassessment of transition risk (the so-called 'run on brown' (RoB)).
- A **second adverse scenario** (A2) combines the same climate-related risks with other macroeconomic stress factors. The selection of non-climate-related stress factors represents a subset of the main financial stability risks considered in the EU-wide EBA stress test 2023, including geopolitical risk.

26. All three scenarios reflect the Commission's call to assume that the Fit for 55 package will be fully implemented and that its objectives will be achieved by 2030. This is guaranteed by two assumptions common to all scenarios:

- the EU achieves emissions reduction of 55% by 2030 with respect to 1990 levels; and
- the amount of energy-related investments in the EU is the same across scenarios.

[10] See ESRB, 'Climate-related scenarios for the one-off scenario analysis exercise on the "Fit-for-55" package', November 2024.
[11] The baseline projections for GDP, interest rates and inflation come from the June 2023 Eurosystem staff Broad Macroeconomic Projection Exercise. These were the most up-to-date figures available in December 2023, when the ESRB developed the scenarios.

Investment estimates are provided by the Commission for 27 countries and 4 economic sectors, and further disaggregated using ECB climate models (Figure 2).

27. In line with the narratives and assumptions outlined above, the scenarios describe the yearly evolution of macroeconomic variables (i.e. GDP, inflation and real estate prices) over the eight-year horizon and the shock profile of the financial variables. The latter (i.e. equity prices, corporate and sovereign bond spreads, swap rates, and residential mortgage-backed securities spreads) are included as one-off, instantaneous shifts relative to their end-2022 levels. These variables are calibrated in line with the structural changes to the economy and the energy systems expected during the green transition process, including EUR 3.7 trillion of investments to transform several polluting businesses and a 14.5 p.p. reduction in the consumption of fossil fuels in favour of renewables and electricity (Figure 3).[12]

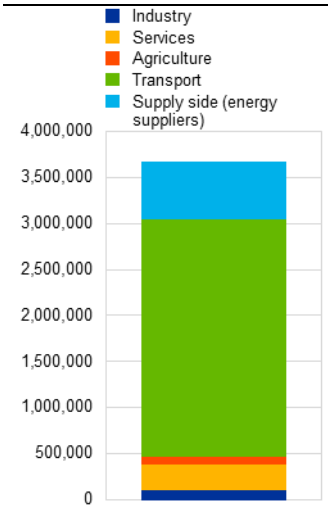
28. In view of the nature of the climate risks, the scenarios are designed in a very granular manner, so that heterogeneous shocks across countries and economic sectors can be applied.[13] The most energy-intensive sectors, such as mining, utilities and transportation, face stronger shocks compared to less energy-intensive ones, as shown by the sectoral gross value added (GVA) developments (Figure 4). In the most adverse scenario, the impact on GVA is driven by both adverse macroeconomic developments and the run on brown.

[12] The scenarios are calibrated by combining the 2023 EU-wide stress test scenarios (2023-2025) with the NGFS 'Nationally Determined Contributions (NDC)' climate scenario (2023-2030) published in Phase IV (November 2023). The NGFS climate scenarios are regularly updated to reflect changes in climate science and the evolution of the transition, and are subject to the limitations and assumptions outlined in 'NGFS scenarios: Purpose, use cases and guidance on where institutional adaptations are required', January 2024.

[13] The scenarios are provided for all EU countries, six non-EU countries and the 'rest of the world'. The breakdown by economic sector depends on the variable considered and goes up to 22 different categories.

Figure 2: EU aggregate green investment needs by sector over the period 2022-2030

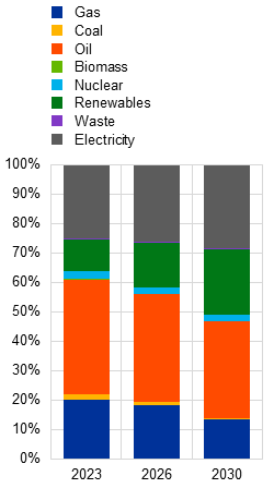
(EUR million)



Source: Commission estimates in line with the EU climate targets.

Figure 3: Evolution of the EU aggregate energy mix over time

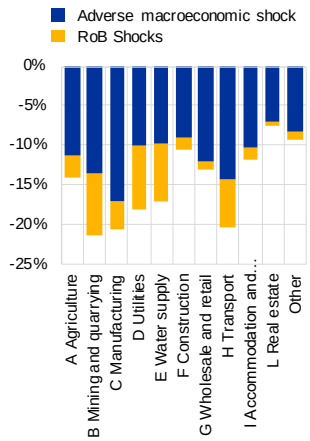
(percentages)



Source: ECB calculations based on Eurostat and NGFS climate scenarios data.

Figure 4: Gross value added shocks by sector and source of impact

(2023-2030, percentages)



Source: ESRB Fit for 55 climate scenarios.

3. Banking sector

Overview of the sector

29. The EU banking system has proven to be robust over the past few years. EU/EEA banks have maintained solid capital and liquidity positions. Furthermore, starting from the second half of 2022, the EU banking sector has benefited from the high interest rate environment generated by the tightening of central banks' monetary policies. As a result, net interest income (NII) has increased and interest margins (NIMs) widened, boosting bank profitability to record levels by the end of 2023. In fact, EU/EEA banks' average return on equity (RoE) and return on assets (RoA) reached historical highs of 11.1% and 0.72% in September 2023.

30. Nevertheless, the higher interest rate environment and the overall macroeconomic uncertainty have led to some visible signs of stress. Loan growth has slowed down since mid-2022, with effects more pronounced for lending to non-financial corporations (Figure 6). In addition, asset quality has deteriorated across all segments and in most countries, with increases in the share of non-performing loans (NPLs) amid slightly positive net NPL inflows. Tensions in CRE markets have led to the emergence of NPLs in several individual cases.[14]

31. In accordance with the Commission's mandate, the starting point of the exercise is the balance sheet data as of the end of 2022. Consequently, the following paragraphs will provide a more in-depth view of the EU banking sector towards the end of 2022.

32. In 2022, EU/EEA banks had strong capital positions and held ample liquidity. The fully loaded CET1 ratio reached 15.3% as of December 2022, following an increasing trend over the last decade. This further improved already existing sizeable capital headroom over regulatory requirements. Liquidity ratios were maintained well above regulatory minimums despite the gradual repayments of the ECB's targeted longer-term refinancing operations (TLTROs). The Liquidity Coverage Ratio (LCR) was reported at 164.7%, slightly lower than the highest levels recorded during the pandemic period, but well above pre-pandemic levels (below 150%). Similarly, the Net Stable Funding Ratio (NSFR) was reported at 125.8%, considerably above the regulatory minimum of 100%.[15]

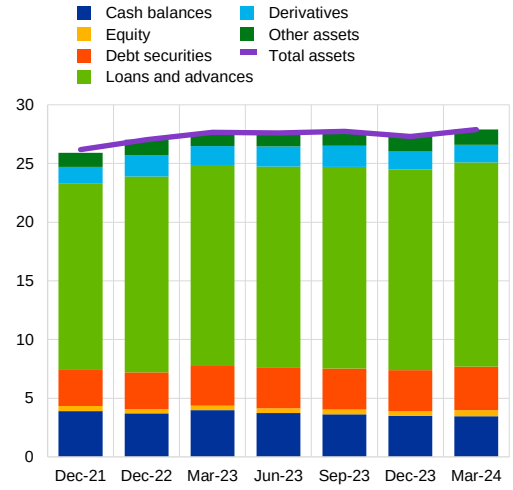
33. In December 2022, the EU banking sector reported total assets of EUR 27 trillion, with loans and advances accounting for around EUR 19.8 trillion, while cash balances and deposits at central banks amounted to about EUR 3.7 trillion. Debt securities held by EU/EEA banks stood at around EUR 3.1 trillion[16], representing around 11.6% of total assets (Figure 5). Sovereign exposures amounted to EUR 3.1 trillion and were mainly towards debt securities and EU/EEA

[14] On the latest developments of the EU banking sector, please refer to the EBA risk assessment report - July 2024 and the EBA Risk Dashboard – Q2 2024.
[15] On the situation of the banking sector towards the end of 2022, here and in the following, please refer to the EBA risk assessment report – December 2023 and the EBA Risk Dashboard - Q4 2022.
[16] Please note that, of these securities, around EUR 1.5 trillion is booked at amortised cost. The remainder is measured at fair value, either through profit and loss or through other comprehensive income.

countries. EU/EEA banks' asset quality was generally sound with no major signs of deterioration, despite the pandemic and the worsening macroeconomic environment. NPLs stood at EUR 357.4 billion as of December 2022, while the NPL ratio remained at historically low levels of 1.8%.

Figure 5: Evolution of EU/EEA banks' asset composition, from December 2021 to March 2024

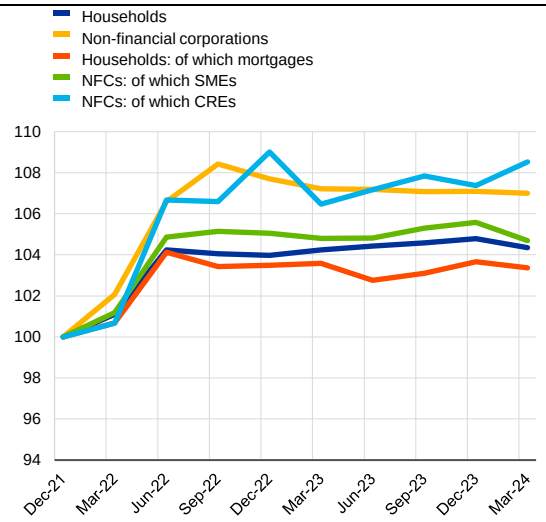
(EUR trillion)



Source: EBA supervisory reporting data.

Figure 6: Growth in loans and advances by segment, December 2021 to March 2024

(December 2021 = 100)



Source: EBA supervisory reporting data.

Data and overview of the methodology

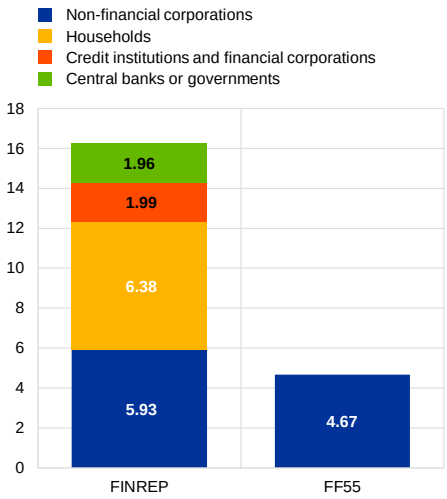
34. To support the banking module of the Fit for 55 exercise, ad hoc data collection was launched by the EBA and the SSM[17]. They collected granular data on banks' exposures to different country sectors and individual counterparties from 110 banks (96 in the EA, 12 in the EU and 2 in NO), whose total assets represent 83% of the total assets of the EU banking system. The data collection covered banks' corporate exposures to credit and market risk, as well as their income (NII and NFCI)[18]. Credit risk exposures of commercial real estate loans are furthermore broken down by geographical area (NUTS3) and EPC buckets in a dedicated template. Banks reported not only climate-related information on their books, but also financial and climate-related information on their counterparties.

[17] For more details on the ad hoc data collection, see https://www.eba.europa.eu/legacy/risk-analysis-and-data/climate-risk-stress-testing-eu-banks/one-fit-55-climate-risk-scenario.
[18] Credit and market risk were prioritised over other types of financial risks (e.g. operational risks) given that they are considered the most material for climate risk.

35. Credit risk exposures in scope concern only loans to non-financial corporations (NFCs), which total EUR 4.67 trillion (Figure 7).[19] Loans to households, other financial corporations, and central banks and governments are not considered in the exercise, hence credit risk exposures in scope account for around 35% of the total loans reported under FINREP by the banks in the sample. Within the NFC sector, the exposures in scope cover around 80% of total loans reported under FINREP. Banks are mainly exposed to corporations in the manufacturing sector, the wholesale and retail trade, and the real estate sector. The economic sectors are affected differently by the transition depending on the composition of their energy mix and their brown energy intensity, which is highest in mining and utilities (Figure 8). Market risk exposures amount to EUR 1.2 trillion and account for 26%[20] of the total fair value portfolio items held by banks, as reported under FINREP (Figure 9). They cover equity, corporate and government bonds, funds and loans at fair value. Government bonds and loans at fair value represent 77% of the market portfolio (Figure 10).

Figure 7: Credit risk coverage: comparison with total loans in FINREP

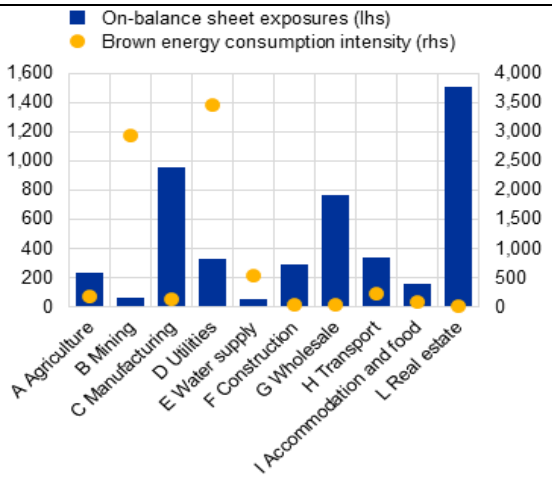
(EUR trillion)



Source: Ad hoc data collection for the one-off Fit for 55 exercise.

Figure 8: Credit exposures to NFCs by counterparty sector and aggregate brown energy intensity

(lhs: EUR billion; rhs: mWh/EUR million)



Source: Ad hoc data collection for the one-off Fit for 55 exercise and ECB calculations based on Eurostat and ECB data.

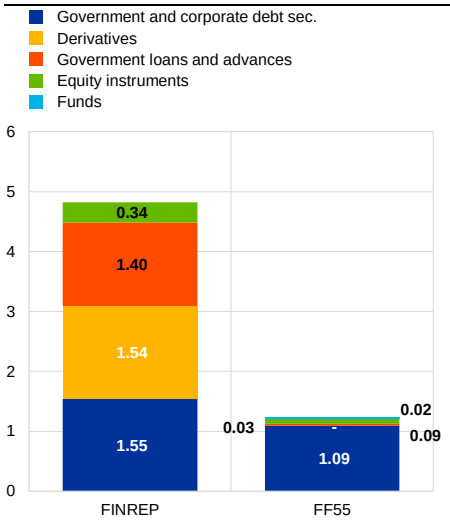
Notes: The brown energy consumption intensity is computed as the average by NACE sector of the brown energy consumption divided by the revenues [mWh/EUR million] of the firms operating in the given sector. Firms in our sample operating in C sector show high revenues, which mitigates the brown energy consumption intensity.

[19] The coverage is determined with respect to the total market and credit risk exposures reported in FINREP template 06 by economic sector of the counterparty.

[20] Hedging effects from derivatives on bonds and equity instruments were considered for the banking sector module to offset losses. This mitigation effect of derivatives was estimated by leveraging internal data on sensitivities and not using their related fair value. Therefore, the fair value of derivatives is excluded from the coverage ratio (26%) as it could not be directly quantified.

Figure 9: Market risk coverage: comparison with total FINREP fair value book

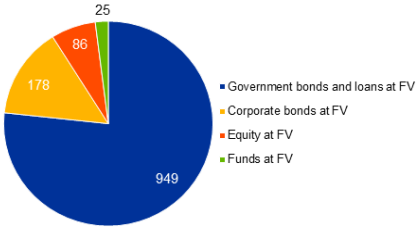
(EUR trillion)



Source: Ad hoc data collection for the one-off Fit for 55 exercise.

Figure 10: Fair value by asset class as of 31 December 2022

(EUR billion)



Source: Ad hoc data collection for the one-off Fit for 55 exercise.

36. Major data quality issues concern the counterparty-level templates of the ad hoc data collection. Banks faced challenges in providing counterparty-level data on emissions for most of the counterparties they reported, relying mostly on inferred data and proxies. In addition, banks were unable to provide identification codes for a significant share of their counterparties (70%). These factors made it difficult to properly utilise all counterparty-level information for the scenario analysis. Internal granular data available at the ECB has been used to fill these data gaps.[21]

37. The estimation of credit risk losses is based on the methodology used in the 2023 EU-wide stress test, as described in the EBA methodological note.[22] Credit losses are estimated separately for real estate and non-real-estate exposures at bank-country-sector[23] level and are driven by changes in counterparties' probabilities of default (PDs) and loss given default (LGDs). Appendix I provides a detailed description of the methodology.

38. The projection of probabilities of default (PDs) for non-financial corporations (NFCs) is based on the ECB top-down, economy-wide climate stress test models.[24] Balance sheet items of

[21] Firm-level information on exposures and greenhouse gas (GHG) emissions is available at the ECB for almost 3 million non-financial corporations in Europe. GHG emissions are directly reported by around 3 000 firms, while they are estimated based on inference methodologies for the remaining firms (mainly SMEs and non-listed companies). The estimates are derived based on the economic sector of the firm and its financials. The estimation of emissions for a large part of the sample introduces an additional layer of uncertainty in the modelling phase.
[22] See 2023 EU-Wide Stress Test: Methodological Note.
[23] Country-sector refers to the geographical and sectoral allocation of the counterparty.
[24] See the two ECB Occasional Papers 'ECB economy-wide climate stress test' (September 2021) and 'The Road to Paris: stress testing the transition towards a net-zero economy' (September 2023).

individual NFCs are projected forward by incorporating climate risk shocks from the scenarios as exogenous shocks. Firm-level PDs are then projected year by year via a logit model based on firms' projected profitability and leverage. Finally, to achieve consistency with the starting point PDs reported by banks in the Fit for 55 ad hoc data collection, projected firm-level PDs are aggregated at country-sector level and rescaled accordingly. Further details can be found in Appendix I.

39. The projection of loss given default (LGD) rates is based on the credit risk methodology of the ECB top-down stress test models.[25] LGDs for loans collateralised by real estate and loans not collateralised by real estate are projected separately. For loans collateralised by real estate, LGD projections are determined by the evolution of real estate prices in the scenarios. The projection of LGDs of exposures not collateralised by real estate is driven by their sensitivity to the GDP growth rates in the scenarios. Further details can be found in Appendix I.

40. Market risk losses are generated by applying the financial shocks provided in the scenario to the fair value[26] of the instruments at the starting point. As in the EU-wide stress test, an instantaneous shock is applied, combined with the assumption of a static balance sheet. Hedges for equities and bonds are considered, based on estimates obtained from EBA internal data[27]. A detailed description of the approaches followed to estimate losses for the four asset classes in the scope of the exercise is provided in Appendix II.

Results for the banking sector coming from first-round effects

3.1 Overall results

41. Under the baseline scenario, in which the Fit for 55 package is implemented in an economic environment that reflects the current economic projections, aggregate losses covering credit risk over the eight-year horizon and market risk amount to 5.8% of total exposures in scope reported for the end of 2022. This equates to EUR 343 billion of losses (Figure 11).[28] The baseline scenario is usually included in stress testing exercises as a reference, so that it is meaningful to assess the adverse scenarios' impacts as deviations from the impacts assessed at the baseline. Indeed, it compounds the Eurosystem staff baseline projections in the first three years with macroeconomic developments consistent with a full and smooth implementation of the measures included in the Fit for 55 package in the remaining years of

[25] See chapter 3.3.3. in 'Advancements in stress-testing methodologies for financial stability applications', ECB Occasional Paper Series No 348.
[26] HtM bonds are not within scope, as for the EU-wide stress test.
[27] Hedging is an important component of the business model of banks, but less relevant for insurance corporations, pension funds and investment funds. Hence, this mechanism is included only for the banking sector. Considering hedges only for banks mitigates the estimated impact for banks compared to funds and insurance companies.
[28] Total exposures include credit risk exposures and market risk exposures in scope. In the remainder of this report 'total exposures' refers to exposures falling within the scope of credit risk and market risk, as just described. The presented credit risk losses are based on 105 banks out of 110 banks in the total sample. The remaining five banks were not considered because they did not hold any NFC loans and advances at amortised cost as of end-2022 in their portfolios and, hence, did not report any credit risk exposures in the Fit for 55 data templates.

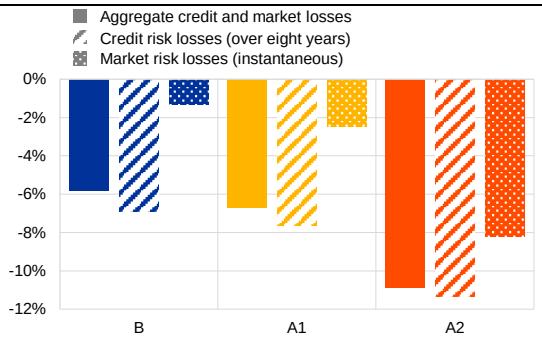
the scenario horizon, therefore allowing for an assessment of accrual of economic costs to the financial system in the absence of major climate and financial shocks occurring.[29]

42. Under the first adverse scenario, in which a run on brown scenario is triggered by a sudden reassessment of transition risk, the share of aggregate losses from market and credit risk over total exposures in scope is higher than under the baseline scenario, namely 6.7% (EUR 393 billion). In line with the narrative, losses equal those under the baseline scenario until early 2026, when the run on brown scenario materialises and produces a sudden increase in annual losses that revert to the baseline values by 2030.

43. Under the second adverse scenario, in which the run on brown scenario is coupled with other macroeconomic stress factors, aggregate losses from credit and market risk are around 86% higher than under the baseline scenario. The share of aggregate losses from market and credit risk over total exposures at the starting point is higher than under the baseline scenario, namely 10.9% (EUR 638 billion). The increase in losses is significant already in the first three years, mainly driven by the adverse macro environment, which however does not seem to later amplify the effects of the run on brown. By the end of the horizon, annual losses are still almost 1.5 times higher than under the baseline scenario.

Figure 11: Aggregate credit and market risk losses

(2023-2030, percentages)



Source: EBA and ECB calculations.

Note: losses are expressed as a share of exposures in scope as of end-2022.

44. It should be noted that the results of this exercise are not fully comparable to those of the EU-wide stress test for several reasons. First, the scenarios of the Fit for 55 exercise include several

[29] See ECB Economic Bulletin, issue 1/2024, 'Assessing the macroeconomic effects of climate change transition policies': 'The fiscal measures included in the Eurosystem staff baseline projections are unlikely to be sufficient to fully achieve the EU targets for emission reduction, energy efficiency and renewable energy production [in the Fit for 55 package].' However, it is unlikely that the measures (and assumptions) included in the current projections will be sufficient to fully meet EU targets, for several reasons: (i) some of the measures geared to these targets will only be implemented after the end of the current projection horizon in 2026; (ii) some of the EU targets for energy efficiency and renewable energy production still need to be transposed into national and European legislation; and (iii) the national emission reduction targets that were strengthened under the Fit for 55 package, from 29% to 40% by 2030 compared with 2005, still need to be followed up by EU Member States. That is why recent emission projections by Member States still point to a large gap with the EU targets, and more measures will be needed to achieve the Fit for 55 targets.

components related to the implementation of the Fit for 55 package that are not included in the EU-wide stress test, such as energy-related investments and changes in the composition of firms' energy mix. Furthermore, for market risk shocks, the magnitude of the shocks differs significantly in the two exercises. Second, the credit risk parameters of the Fit for 55 exercise are calibrated based on a top-down, firm-level model designed for the purpose of climate stress testing, to capture the most relevant channels of climate-related risks at granular level and embedding climate-related features such as changes in energy expenses and debt raised to finance the green transition. Third, the exposures in scope and the starting point data of the two exercises come from different data collections, thus rendering the results of the two exercises difficult to compare. It should be additionally noted that the credit and market risk losses registered by banks in the 2023 EU-wide stress test are mitigated by earnings, which are projected to increase under a baseline high-interest rate environment. While earnings partially offset credit risk losses in the 2023 EU-wide stress test, they are not modelled or assessed as part of this exercise.

45. Finally, the results presented here and produced under a static balance sheet assumption allow assessment of the resilience of the banking sector to climate-related shocks and its loss-absorbing capacity for the exposures in scope of the exercise. However, they do not provide information on the lending capacity of the banking sector and on how it could evolve over time under adverse conditions. Extending the exercise to a dynamic balance sheet framework (see Box 1 for details) shows how banks could adjust their lending in response to the macroeconomic environment and transition risks. While this adjustment could potentially amplify an economic downturn and reduce the availability of funding for the green transition, the results suggest that banks have the capacity to play a significant role in financing the green transition. However, funding from other financial intermediaries and the financial sector, including capital markets, will be required, particularly under adverse macroeconomic conditions.

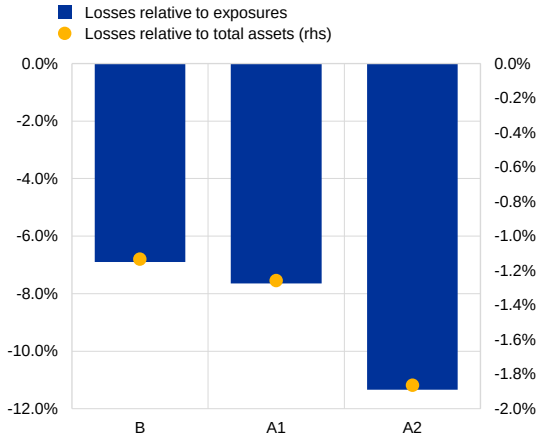
3.2 NFC loan portfolio

46. Credit risk in the corporate portfolio is the main driver of the losses, representing 95% of total losses under the baseline scenario and 84% of total losses under the most adverse scenario. The relative size of the credit and market portfolios (EUR 4.7 trillion and EUR 1.4 trillion, respectively) only partially explains these differences, which are then amplified by a more severe revaluation of assets in the credit portfolio.

47. In all scenarios, losses represent less than 11.3% of banks' exposures in scope (Figure 12) and are mainly driven by an increase in the probability of default (PD) of borrowers (0.6 p.p. in B, 1.3 p.p. in A1 and 2.3 p.p. in A2, on average). The projected increase in the loss given default (LGD) is responsible for only 14% of aggregate credit losses in the baseline scenario, and 15% and 31% in the first and second adverse scenarios, respectively (Figure 13). Being sensitive to energy prices and debt levels, PDs are more directly and granularly affected by climate risk shocks than the LGD.

Figure 12: Aggregate credit losses 2023-2030 as a share of exposures/total assets in 2022

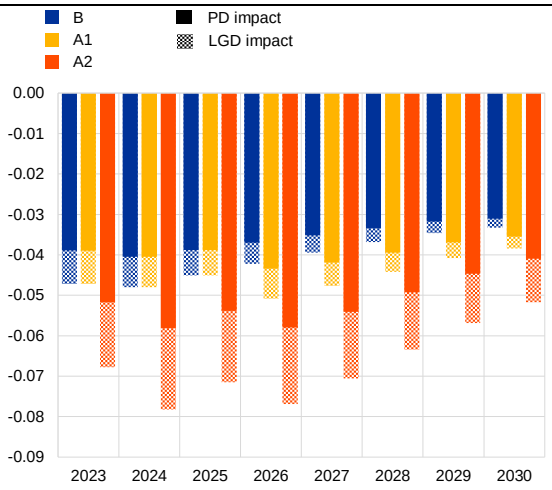
(percentages)



Source: EBA and ECB calculations.

Figure 13: Credit risk losses by year, scenario and source of impact

(EUR trillion)



Source: EBA and ECB calculations.

48. Looking at the different economic sectors, companies operating in energy-intensive industries face higher increases in PDs and thus higher losses relative to total exposures (Figure 14).[30] PDs in mining and transportation are affected the most and are projected to rise by 5.4 p.p. and 3.6 p.p. respectively, generating 14.9% and 13.9% of losses in the relevant portfolios under the most adverse scenario. The reasons are twofold. On the one hand, the leverage of companies in these sectors is expected to increase as banks finance their green investments to reach the Fit for 55 targets. This would also lead to an increase in these companies' financial expenses, driven by both higher lending volume and higher interest rates reflecting the run on brown scenario. On the other hand, the profitability of these companies is more strongly affected by changes in energy prices during the transition, which increase energy expenses, particularly under the most adverse scenario.

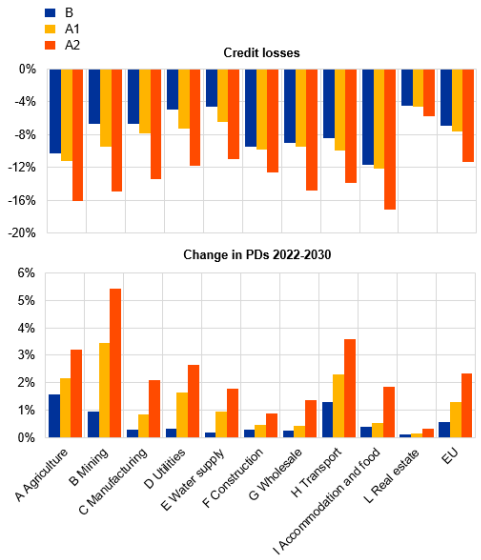
49. The distribution of relative losses across banks is more heavy-tailed under the most adverse scenario, in which credit losses for more than 10 banks amount to more than 25% of total exposures (Figure 15). Moreover, 50% of the losses in all scenarios are concentrated on eight banks, which are among the biggest EU banks and not necessarily the most impacted in relative terms.

[30] The high level of losses registered in the agriculture and the accommodation and food sectors is due to the higher starting point PDs of companies operating in those sectors (3.5% for agriculture, 4.7% for accommodation and food, with respect to 2.4% on average in the full sample).

50. Using firm-level data reported by banks for their top counterparties (instead of country-sector aggregates, whenever available) to compute losses, the results do not change significantly.[31] Losses computed based on firm-level data account for 7.8% to 8.6% of total losses depending on the scenario. Around 6 237 counterparties included in the calculation of (firm-level) credit losses account for 90% of total exposures in the (firm-level) sample and 93% of credit risk losses in the respective sample. More details on the concentration of losses are provided in Appendix I, where the granular counterparty-level loss network is visualised.

Figure 14: Aggregate credit losses and change in PDs, by sector

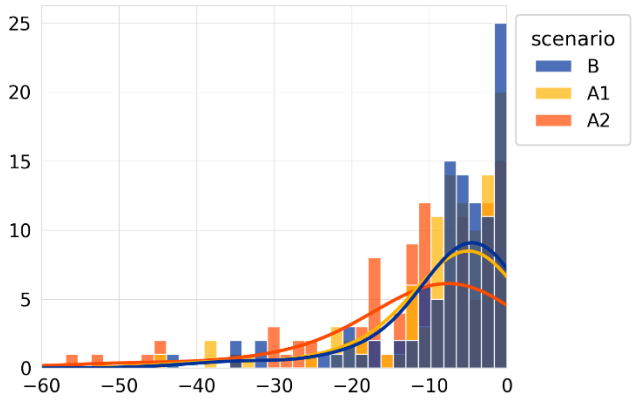
(top: losses 2023-2030 as a share of exposures in 2022 in percentages; bottom: absolute increases in percentage points)



Source: EBA and ECB calculations.

Figure 15: Distribution of bank-level losses

(x-axis: losses 2023-2030 as a share of exposures in 2022 in percentages; y-axis: number of banks)



Source: EBA and ECB calculations.

3.3 Market risk exposures

51. Under the most adverse scenario, financial shocks lead to a drop in the fair value of market exposures of 8.2% (EUR 101 billion) with respect to the starting point, while they have a limited impact under the other two scenarios, with a decline in the fair value of 2.5% (EUR 31 billion) under the first adverse scenario and 1.3% (EUR 16 billion) under the baseline scenario (Figure 16). Please refer to paragraph 33 for details on market exposures in scope. Under all three

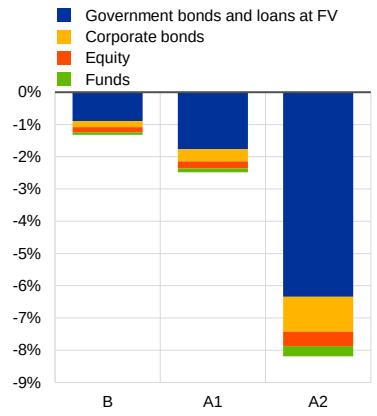
[31] In the ad hoc data collection, on top of exposures aggregated at country-sector level, banks were asked to report individual exposures to their top 15 counterparties in each climate-relevant NACE 2 sector and to the companies listed in the Eurostoxx 50. Overall, banks reported around 17 300 credit relationships with identifiable counterparties (EUR 1.1 trillion in total) in this template.

scenarios, losses on government bonds, corporate bonds and equity are mitigated by hedging positions.[32]

52. Losses on government bonds and loans[33] held at fair value represent the main drivers of market risk losses under all three scenarios, accounting for 67.8% of the total under the baseline scenario, 71.2% under the first adverse scenario and 77.5% under the second adverse scenario. The extent of the losses on government bonds and loans can be explained by the severity of the shocks to the swap rate and the government yield spread. These result from the higher costs of the green transition and the investments that the government and private sector will have to finance. In addition, government bonds at fair value account for a high proportion of banks' market risk portfolios within scope. Losses on corporate bonds represent the second largest component of total market risk losses under all three scenarios, followed by losses on equity and funds (Figure 16).

Figure 16: Market risk losses by asset class

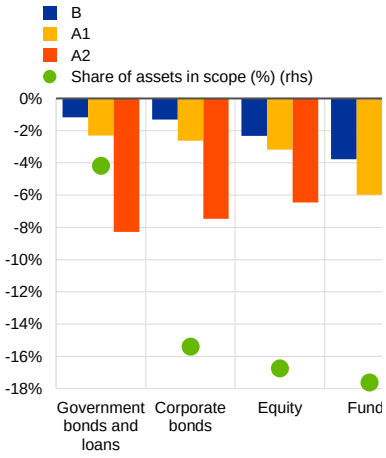
(percentage change with respect to the starting point, total market risk exposures)



Source: EBA and ECB calculations.

Figure 17: Market risk losses by asset class vs. share of assets in scope

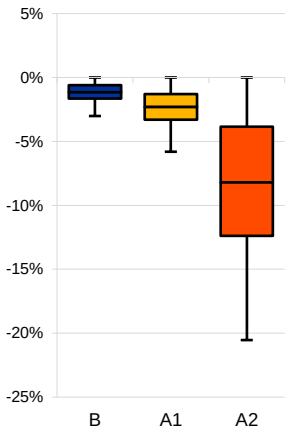
(losses: percentage change with respect to the starting point, market risk exposures of each asset class; share of assets: percentages)



Source: EBA and ECB calculations.

Figure 18: Dispersion of market risk losses across banks

(median, interquartile range, 5th and 95th percentiles; losses relative to starting point, market risk exposures at fair value in percentages)



Source: EBA and ECB calculations.

53. Looking at the decrease in fair value for the different asset classes, funds show the largest decline, with a reduction in fair value relative to the starting point of 3.8% under the baseline scenario, 6.0% under the first adverse scenario and 15.9% under the second adverse scenario.

[32] Hedges on government bonds, corporate bonds and equity are determined based on estimates obtained from the EBA's internal data.
[33] Government loans, which amount to EUR 33 billion and represent a limited share (3%) of the market portfolio in scope, are considered at fair value and treated as bonds, applying instantaneous swap rate and government yield spread shocks.

Given the low significance of banks' exposures to funds, however, this contributes only marginally to total market risk losses (Figure 17).

54. Finally, banks' losses under the baseline scenario and the first adverse scenario show a low dispersion, while they are more heterogeneous under the most adverse scenario, ranging between -12.4% (25th percentile) and -3.8% (75th percentile) relative to market risk exposures at the starting point (Figure 18).

Box 1: Banking sector amplification and real economy effects

This box extends the Fit for 55 exercise to a dynamic balance sheet approach for the euro area banking sector using the Banking Euro Area Stress Test (BEAST) model.[34] Unlike the static balance sheet approach, the BEAST operates with a dynamic balance sheet that accounts for banks' endogenous responses to macroeconomic scenarios and transition risks. It also considers the feedback effects between the banking sector and the real economy. The analysis provides additional insights into the potential impact on the real economy, in particular on bank lending, under the different Fit for 55 climate scenarios.

In terms of credit losses, the results of the simulations are broadly in line with those computed considering only the first-round effects.[35] Considering these losses, the volume of loans to the non-financial corporations (NFC) sector increases under the baseline and the first adverse scenario by 26% and 22% over the eight-year horizon. The increase is less pronounced under the first adverse scenario because of the impact of the run on brown shock (Figure 19). Loan volumes to NFCs under the second adverse scenario decrease by 11% relative to the starting point. Under the most adverse scenario, loan volumes overall are lower than under the baseline scenario as banks attempt to restore their solvency position, which deteriorates due to the increase in credit losses and adverse macroeconomic developments. This reduction in credit reinforces the economic downturn through a feedback loop between the banking sector and the real economy. In the most severe scenario, this feedback loop reduces growth of euro area GDP over the eight-year horizon from -1.7% to -2.5%, with approximately one third of this effect attributable to the run on brown scenario (Figure 20). In line with the first-round results on losses, the impact on both lending and the economy from only the run on brown shock is relatively limited. The largest impact on the real economy occurs under the materialisation of the adverse macroeconomic scenario combined with the run on brown shock in the second adverse scenario (Figure 21).

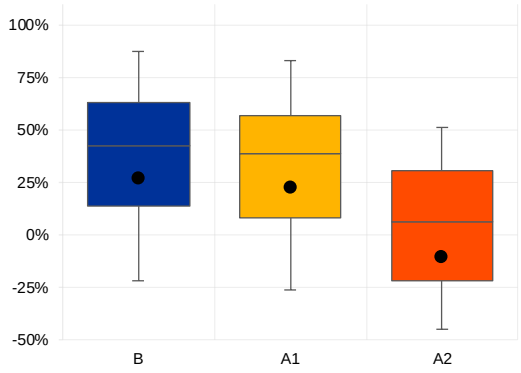
In line with the narrative, a sudden reassessment of climate-related risks triggers a run on brown shock. This shock leads to a deterioration of financing conditions and of funding availability for firms, which in turn increases PDs for energy-intensive firms (see Figure 14 for changes in PD by sector). In response to the sudden negative shock, loan portfolios in the BEAST model are reshuffled toward less risky exposures/borrowers (Figure 22). As a result, in the scenarios featuring a run on brown shock, banks reduce lending to energy-intensive sectors in favour of sectors with lower energy intensity, whereas

[34] See Budnik et al. (2023) for a detailed description of the model and Cappelletti et al. (2024) for a recent application of the model using the EBA 2023 stress test scenarios.
[35] The differences in losses between the BEAST model and first-round credit losses are mainly due to the dynamic balance sheet assumption, which allows for changes in the volume and composition of the banks' loan portfolios during the exercise.

lending to all sectors remains stable under the baseline scenario. The reshuffling might be offset by higher returns on investment for energy-intensive sectors, although related information was not available.[36] As such, in the model, banks moving away from energy-intensive sectors is de-risking behaviour in line with the scenario narrative and not the consequence of a strategic choice to green their investments.

Figure 19: Loan volume to the NFC sector – bank-level distribution

(eight-year change in percentages)

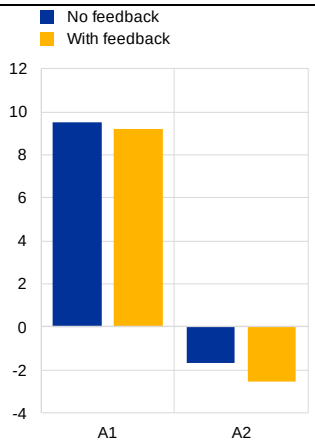


Source: ECB calculations.

Notes: BEAST projections and EBA ST 2023 starting points. The point on the box plot represents the weighted average % change from the starting point in the total loans outstanding to the NFC sector for all banks in the EA banking system. Box plot shows the 10th, 25th, 50th, 75th and 90th percentiles.

Figure 20: GDP growth

(percentage over the eight-year horizon, euro area)

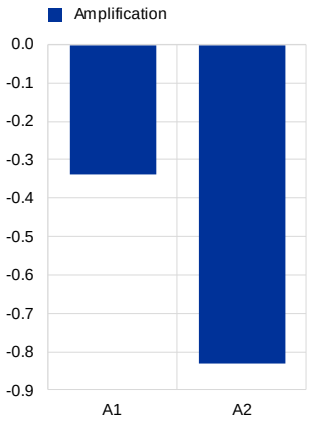


Source: ECB calculations.

Notes: 'No feedback' is equivalent to the change in GDP that is estimated as part of the macro scenario. 'With feedback' includes any amplification of the change in GDP due to the banking sector - real economy feedback loop that occurs in addition to the macro scenario change.

Figure 21: Amplification effect under the adverse scenarios

(percentage over the eight-year horizon, euro area)



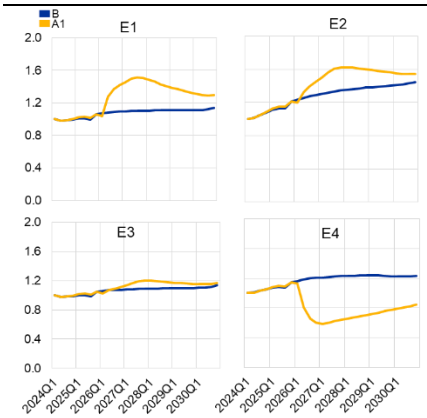
Source: ECB calculations.

Note: 'Amplification' refers to the difference without vs. with feedback.

[36] To model new lending to NFCs in the absence of information on the expected return on investments, we apply a weighting method broadly equivalent to the inverse volatility portfolio (IVP) approach, substituting the PD for volatility. For example, see Millard, Roncalli and Teiletche (2010) 'The properties of equally weighted risk contribution portfolios'.

Figure 22: New loans to NFCs, grouped by energy intensity of sectors under B and A1

(y-axis: volume of new loans, indexed; x-axis: year)

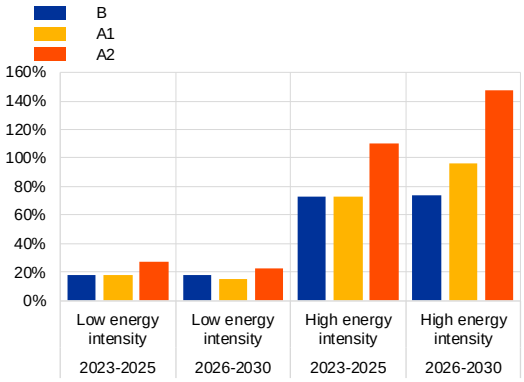


Source: ECB calculations.

Notes: Starting points for new lending to NFCs are extracted from the 2023 EBA ST 'CSV_CR_SECTOR' template for the NACE levels reported. Sectors E1-4 indicate the sectors with lower, medium-low, medium-high and higher brown energy intensity, respectively. Bank share of new lending for each sector is inversely related to the level of riskiness (proxied by PD) compared to the average riskiness across all sectors.

Figure 23: Green transition investment needs as a percentage of NFC lending

(y-axis: green investment needs / NFC new lending)



Source: ECB calculations.

Notes: Green transition investment needs are provided by the Commission and estimated as part of the impact assessment of the 2030 Climate Target Plan, and include all investments expected to come from the private sector (according to the private/public sector split estimate provided in the EIB investment report 2021/2022). Low energy intensity = E1 + E2 and high energy intensity = E3 + E4.

According to the results of the BEAST model, while the banking sector's capacity to fund NFCs during the green transition is generally resilient, it might face challenges under the most adverse scenario, particularly when severely adverse economic conditions arise along with climate-related risks. Figure 23 compares investment needs for the green transition[37] and projected bank lending to NFCs over the eight-year horizon. On average throughout the entire period, the estimated green investment needs amount to 24% of projected new lending per year for sectors with a low energy intensity in the most adverse scenario. For energy-intensive sectors, investment needs exceed projected new lending by an average of 33% per year over the same period.[38] Hypothetically, if banks had to finance all these investments, they would have to increase their lending to sectors with high energy intensity, particularly under the most adverse scenario. Alternatively, NFCs could resort to other financial intermediaries (e.g. mutual funds, insurance companies and pension funds) and financial markets (including capital markets) to cover remaining funding needs for the green transition.

[37] Green transition investment needs are estimated by the Commission as part of the impact assessment of the 2030 Climate Target Plan and include all investments expected to come from the private sector. The proportion of private sector investment covered by the banking system is assumed to be approx. 50% in line with the EIB Investment Report 2021/2022. More recently, the share of private sector investment for the green transition has been estimated to be closer to 70%, see Bouabdullah et al. 2024.

[38] Investment needs are solely those for energy-related expenditures pertinent to the green transition and do not encompass investments unrelated to this transition. In contrast, projected bank lending figures represent total amounts, including loans to NFCs for purposes not associated with the green transition.

4. Insurance and IORP sectors

Overview of the sectors

55. The European insurance sector maintains a solid capitalisation. Median Solvency Capital Requirement (SCR) ratios both for life insurers and non-life insurers stood comfortably above 200% at the end of 2022, which is the reference date for this exercise, and have since been on an upward trend. Gross written premiums have been increasing for the non-life sector, mainly driven by rising claims costs and inflation adjustments, which have challenged underwriting profitability. However, profitability has benefited from higher returns on investment portfolios amid higher interest rates. At the same time, the higher interest rate environment has not yet led to an increase in lapses in life business, with the median lapse ratio remaining stable at approximately 3%.

56. The European reinsurance sector performs well on most indicators and has benefited from hardening market conditions. Reinsurers grew their written premiums, improved underwriting performance, and maintained robust solvency positions.

57. Insurers' portfolios are heavily skewed towards fixed income assets, followed by equities, exposing insurers to interest rate and credit risks, alongside market risks. The insurance sector maintains a significant connection with the banking sector, mostly through its investments in bonds, which account for 13% of total investments on aggregate. Also, insurers are heavily investing through investment funds, which represent approximately a quarter of their investments.

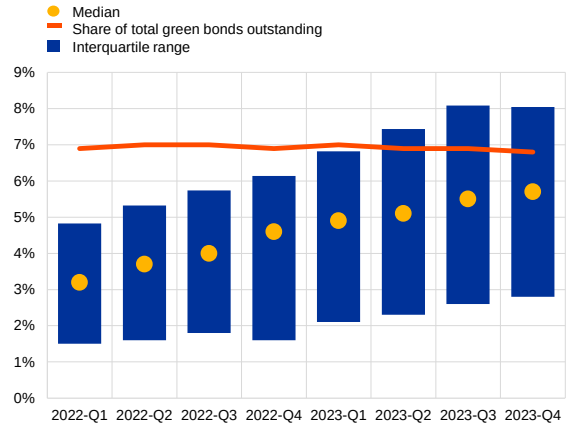
58. The European Institutions for Occupational Retirement Provision (IORPs) sector remains resilient, though sensitive to monetary policy shifts. Defined Benefit (DB) IORPs have further improved their already strong financial position after the recovery from the COVID crisis, maintaining a median funding ratio of approximately 118%. In response to inflation movements and banking sector turmoil in the beginning of 2023, pension funds have prioritised liquidity to hedge interest rate derivative mismatches. Positive market developments have led to growth in fixed income assets and equities on IORPs' balance sheets.

59. The asset allocations of IORPs differ from those of insurers, but also between defined benefit (DB) and defined contribution (DC) schemes. On aggregate, IORPs have lower exposures to fixed income assets and higher exposures to equity and property when compared to insurers.

60. As major long-term investors, insurers and pension funds can play a significant role in putting the EU economies on a more sustainable track and in supporting the transition towards a low-carbon economy. Figure 24 shows that the median investments in green bonds as a share of the total corporate bond portfolio had steadily increased over the past year and amounted to about 5.7% at the end of 2023 for the insurance sector. An analysis for IORPs finds that currently 4.5% of direct non-financial EEA-issued corporate bond and equity holdings could be

considered Taxonomy-aligned, while another 26.1% are Taxonomy-eligible (Figure 25)[39]. For insurers, a previous study pointed to 5.7% of Taxonomy-aligned assets, with another 34.1% Taxonomy-eligible.[40]

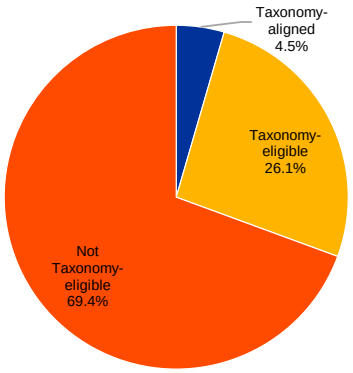
Figure 24: Share of investments by insurers in green bonds relative to corporate bonds



Source: EIOPA Risk Dashboard. Refinitiv and EIOPA own calculations based on SII QRT S.06.02.

Notes: The lhs axis shows the distribution across insurers' investments in green bonds over their total corporate bond investments. The rhs axis shows the share of insurers' aggregate investment in green bonds over total green bonds outstanding.

Figure 25: EU Taxonomy alignment and eligibility of equity and corporate bond holdings for IORPs



Source: EIOPA own calculations based on IORP PF.06.02 and Alessi and Battiston (2022).

Notes: As of Q3 2023. Data only concerns EEA-issued non-financial securities.

Data and overview of the methodology

61. Insurers and IORPs report detailed asset holdings as part of their regulatory Solvency II and IORP II reporting. [41] As per the mandate, data as of the end of 2022 is used as the starting point. The post-stress valuations are calculated top-down, based on reported Solvency II and IORP II data and the set of market shocks provided by the ESRB scenarios. The market shocks are applied as one-off, instantaneous shocks to the fixed balance sheet at the reference date. No reactive management actions are considered. The focus of this exercise is only on the assets side of insurers and pension funds as no specific shocks are prescribed to the liabilities side of the two sectors, nor to reinsurance assets. The absence of the recalculation of the liabilities' impact and of any potential reactive management actions of the institutions suggests that the losses resulting from the application of the shocks are overestimating the impact on the two

39 Occupational pension funds' green investments – EIOPA (europa.eu)
40 Insurers' green investments – EIOPA (europa.eu)
41 For the purpose of this exercise, the data is extracted from the reporting template 'List of assets' – S.06.02/S.06.03 and PF.06.02.

sectors. Therefore, the results should be carefully interpreted in the light of the caveats and assumptions taken throughout this exercise.

62. At the end of 2022, insurers' total investment assets amounted to EUR 8.5 trillion, out of which 81% (EUR 6.8 trillion) are in the scope of the exercise, whereby the largest single exposure is towards collective investment undertakings (CIUs) (Figure 26). The assets out of scope largely concern property, mortgages and loans, as well as cash and deposits. Considering the look-through into investments via CIUs (Figure 27), the largest asset exposure is towards corporate bonds, closely followed by equity (each EUR 2.4 trillion and 28% of total investments) and government bonds (EUR 2.1 trillion, 24% of total investments).

63. IORPs' total investments amounted to EUR 2.3 trillion at the end of 2022, out of which 76% (EUR 1.8 trillion) are in scope of the exercise. Considering the look-through into investments via CIUs (Figure 27), the largest asset exposure by type is towards equity (EUR 0.7 trillion, 30% of total investments), followed by government bonds (EUR 0.6 trillion, 25% of total investments) and corporate bonds (EUR 0.4 trillion, 18% of total investments).

Figure 26: Insurers' and IORPs' investment portfolio

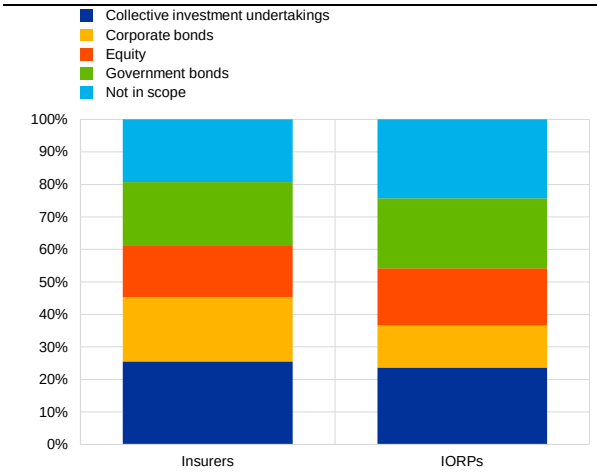
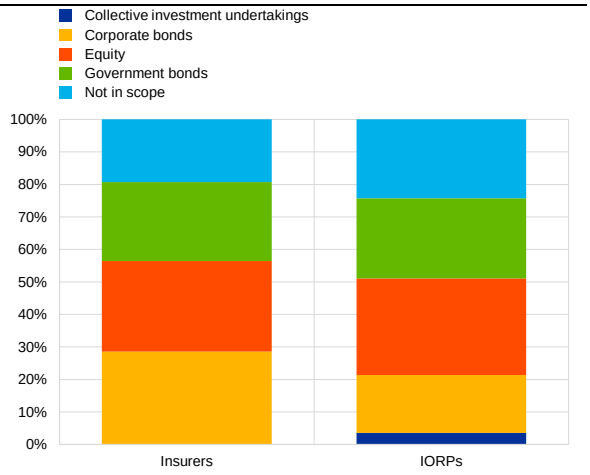


Figure 27: Insurers' and IORPs' investment portfolio with look-through into CIUs



Source: Solo Annual QRTs S.06.02/S.06.03 and PF Annual Individual PF.06.02/PF.06.03.

64. Across all undertaking types, approximately 80-85% of investments are in scope of this exercise (Figure 28). Life undertakings and composite undertakings each account for EUR 2.7 trillion of investments and thus the largest part of the insurance sectors' investments. Both have a significant part of their investments pertaining to unit-linked or index-linked business (UL/IL), which on aggregate accounts for EUR 1.5 trillion. The remaining investments in scope are split between non-life undertakings (EUR 0.9 trillion) and reinsurance undertakings (EUR 0.6 trillion).

65. Composite and life undertakings tend to hold more fixed income assets, as they provide predictable cash flows that can be timed to coincide with the payout obligations. Furthermore,

fixed income assets with durations that match these insurers' typically long-term liabilities help to manage interest rate risk. When interest rates change, the value of their liabilities and assets move more synchronously, reducing overall balance sheet volatility. On the other hand, reinsurers hold more equities and participations to leverage higher returns, achieve diversification, enhance capital efficiency and capitalise on strategic opportunities. For unit-linked and index-linked business, about 70% of the investments are via CIUs.

66. DB IORPs dominate the EEA market, with EUR 1.8 trillion, while mixed pension funds account for EUR 364 billion. DC pension funds account for another EUR 152 billion. The portfolio composition at asset class level for IORPs differs from those of insurers, but also between DB and DC schemes. On aggregate, IORPs have lower exposures to fixed income assets and higher exposures to equity and property when compared to insurers.

Figure 28: Insurers' investment portfolio by type of undertaking

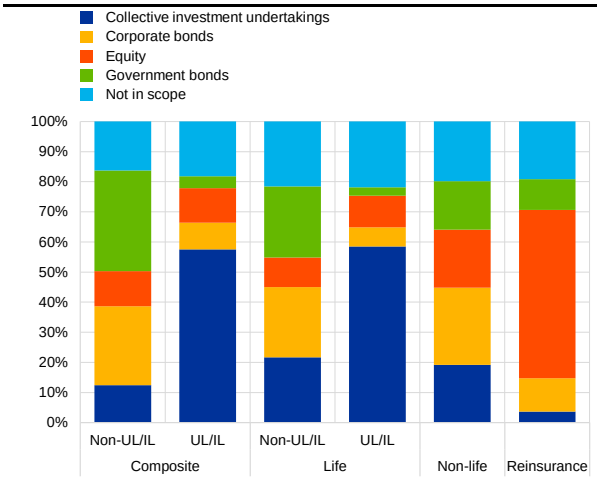
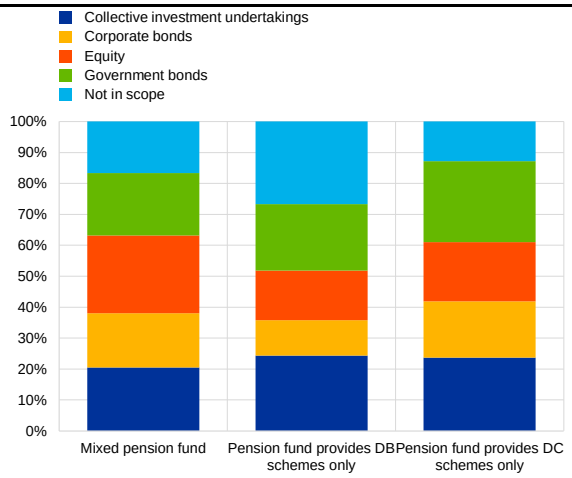


Figure 29: IORPs' investment portfolio by type of IORP



Source: Solo Annual QRT S.06.02 and PF Annual Individual PF.06.02.

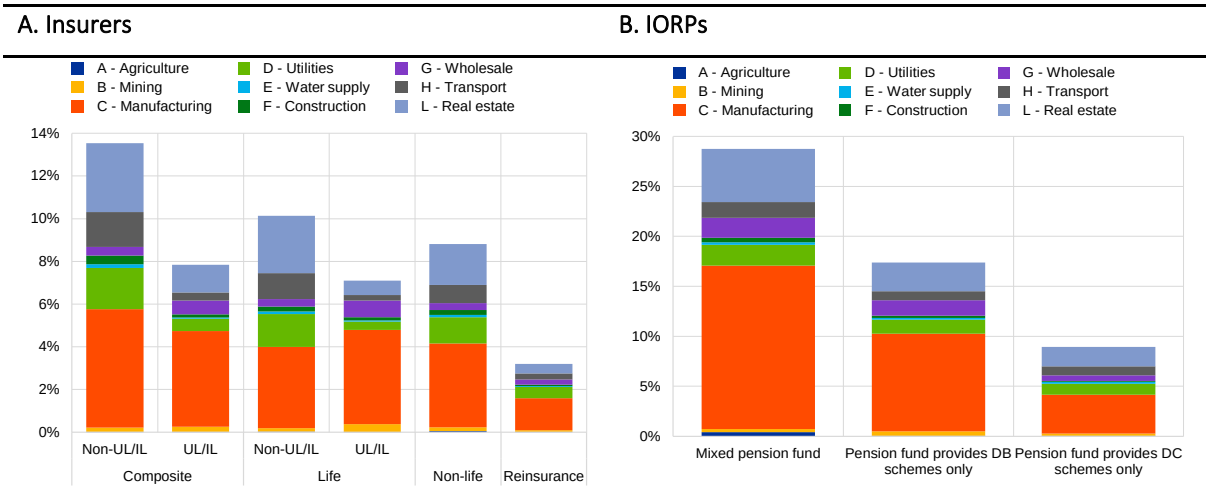
Notes: Data as of Q4 2022. Non-UL/IL refers to investments pertaining to neither unit-linked nor index-linked business. UL/IL refers to investments pertaining to unit-linked or index-linked business.

67. Insurers held EUR 667 billion in direct investments towards corporate bonds and equity at the end of 2022 issued by non-financial firms active in potentially climate-relevant economic sectors. These exposures amount to approximately 10% of total investments in scope. The largest exposure is towards manufacturing firms, followed by real estate activities, which together account for two thirds of the relevant exposures. IORPs held EUR 329 billion in direct investments in corporate bonds and equity at the end of 2022 issued by non-financial firms active in potentially climate-relevant economic sectors. These exposures thus amount to approximately 18% of total investments in scope. IORPs' investments are not as tilted towards financial firms as for insurers, thus the significantly higher share of relevant exposures. In a similar way to what was observed for insurers, the largest exposure is towards manufacturing firms, followed by real estate activities, which together account for more than two thirds of

the relevant exposures. As the look-through into CIUs is only partial, relevant exposures via CIUs could not be identified.

Figure 30: Direct investments towards equity and corporate bonds issued by non-financial firms

(percentage of investments in scope)



Source: Solo Annual QRT S.06.02 and PF Annual Individual PF.06.02.

Notes: Data as of Q4 2022. Non-UL/IL refers to investments pertaining to neither unit-linked nor index-linked business. UL/IL refers to investments pertaining to unit-linked or index-linked business.

68. The data as described above serves as the starting point for this exercise. The reported data contains information on the geographical area of issuance as well as, where relevant, the NACE sector, credit quality and modified duration of a given asset. Based on this information, the post-stress valuations under all three scenarios are calculated via a top-down approach.

69. While the data reported provides very detailed information about individual assets, a few key caveats should be mentioned.

- For investments via CIUs, insurers and IORPs report a 'look-through' template which allows the underlying investments to be distinguished by asset category and country of issuance. For some bond funds, the average credit quality step (CQS) and modified duration are reported. However, the template does not contain information on the NACE sector of underlying investments. The missing data requires further assumptions and enriching, while the calculation of post-stress values remains consistent with that applied to direct investments.
- Where data is missing or reporting errors are identified, the dataset has been enriched either with external data from the ECB's Centralised Securities Database (CSDB) or using a set of pre-defined rules drawing e.g. on sample averages or other data available within the full reported dataset. In a few cases, individual observations were excluded for data quality or implementation reasons (accounting for <0.1% of total investments).

- As the CQS does not form part of the regular IORP reporting, reported CQS for the same assets from Solvency II reporting have been matched where possible. This covers around 53% of IORPs' corporate bond holdings, while an additional 15% of assets were assigned a CQS based on the external rating reported. In line with the regular stress test methodology, remaining assets without a CQS were assigned a CQS of 3 (BBB).

70. The purpose of these rules is to ensure consistency and as large a coverage in terms of asset classes as possible. Robustness checks and comparison with results for other sectors (e.g. investment funds) were carried out to ensure that key conclusions in this report are robust with respect to these choices.

Results for the insurance and IORP sectors coming from first-round effects

71. Under the baseline scenario, insurers and IORPs experience minor impacts on the value of investments of -2.2% (EUR -153 billion) and -3% (EUR -54 billion), respectively (Figure 31)[42]. The sudden shift in the perception of climate risk under the first adverse scenario and the subsequent run on brown scenario more than doubles the impact compared to the starting point. Yet, the impact relative to exposures in scope at end-2022 remains manageable at -5.2% (EUR -356 billion) for insurers and -6.4% (EUR -113 billion) for IORPs. Finally, both sectors are severely impacted by the second adverse scenario; insurers experience a decrease in the value of their investments of -18.8% (EUR -1 285 billion), while for IORPs' investment values drop by -21.5% (EUR -379 billion) compared to the starting point (end-2022). Relative to total investments and not just investments in scope, the impact for insurers is -15.2%, while for IORPs it amounts to -16.3% (Figure 31).

72. Both sectors prove to be resilient under the baseline and first adverse scenarios, thus also against the run on brown, while a more significant impact only arises under the second adverse scenario due to the adverse macro-financial environment. The impact relative to the first adverse scenario is more than tripled under the second adverse scenario, amid the impact of the severe market and economic conditions depicted in the narrative. This is explained by the strong increase in swap rates and credit spreads in the second adverse scenario that leads to significant decreases in market value, especially on corporate and sovereign bonds, which account for about half of both insurers' and IORPs' investments in scope (when considering look-through exposures to CIUs, corporate and sovereign bonds account for 65% and 56%, respectively). Directly held sovereign bonds alone account for approximately 40% of the impact for both insurers and IORPs (Figure 32).

73. The impact is amplified by typically longer durations held in the portfolio, which is why life insurers and IORPs are more severely affected, especially under the second adverse scenario (Figure 33 and Figure 34). Unit-linked business experiences milder impacts, due to the higher

[42] The results are presented relative to the investments in scope of the exercise, which for insurers amount to EUR 6.8 trillion and for IORPs to EUR 1.8 trillion.

share of equity funds in its portfolio and the lower share of long-duration bonds. Reinsurance undertakings are the least affected across all three scenarios, due to the high share of equity investments, especially towards financial companies.

Figure 31: Losses for insurers and IORPs

(percentage change with respect to starting point exposures)

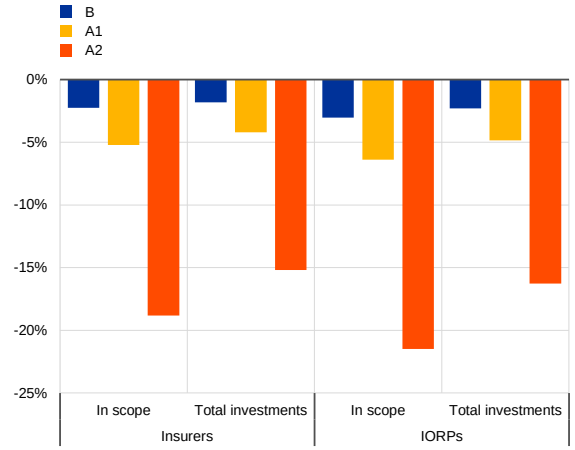


Figure 32: Losses by asset class for insurers and IORPs

(percentage change with respect to starting point exposures)

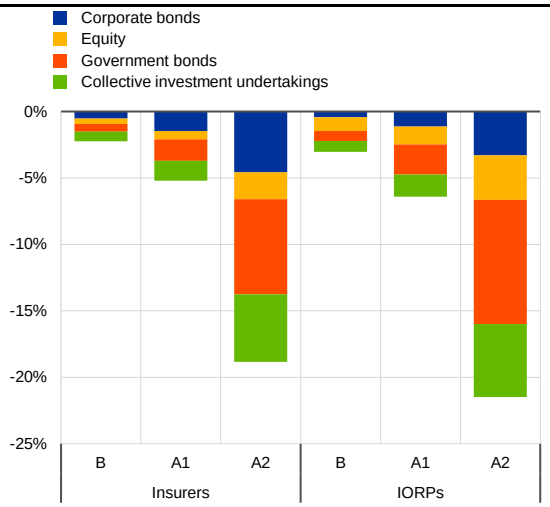


Figure 33: Losses by type of business for insurers

(percentage change with respect to starting point exposures)

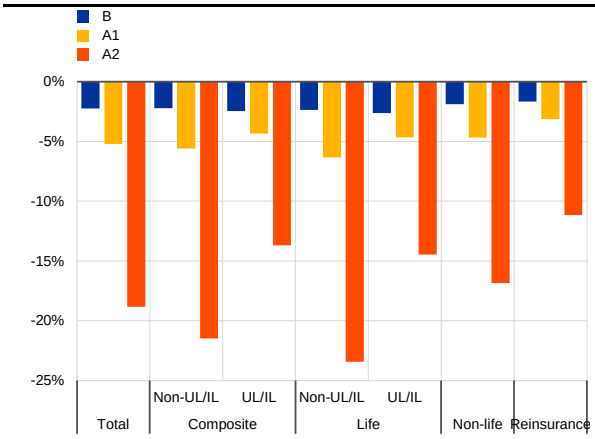
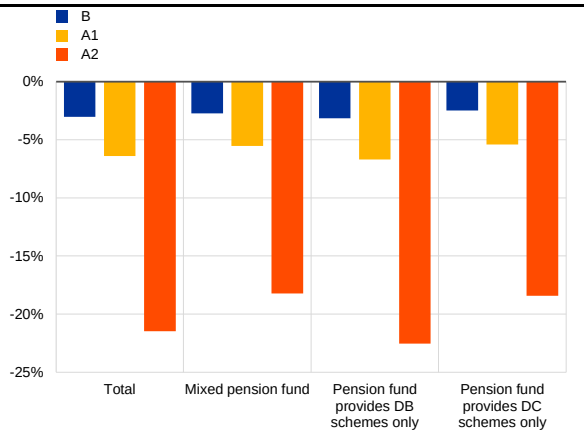


Figure 34: Losses by type of business for IORPs

(percentage change with respect to starting point exposures)



Source: EIOPA calculations. Non-UL/IL refers to investments pertaining to neither unit-linked nor index-linked business. UL/IL refers to investments pertaining to unit-linked or index-linked business.

74. Except for equity investments, insurers and IORPs are similarly affected across asset types. The relatively mild impact on equity investments for insurers stands out, with only a decrease of approximately 10% in market value under the second adverse scenario (Figure 35 and Figure 36). This is due to the portfolio composition of insurers, as most of their direct equity investments are towards financial firms, e.g. participations in related undertakings. For IORPs, equity investments are more impacted, reflecting the larger proportion of assets in climate-

relevant economic sectors held. Another notable impact is on sovereign bonds, which stand out as by far the most impacted asset type under the second adverse scenario. Market values of sovereign bonds decrease by almost 30% for insurers and by even 33% for IORPs. As described above, this is due to the sharp increase in swap rates and credit spreads paired with the long duration of insurers' and IORPs' sovereign bond portfolios.

75. Given that the most severe impact comes from the shocks to fixed income assets, it is important to mention that both sectors, which are liability-driven businesses, match the duration of their technical provisions (liabilities) to their assets. The significant increase in interest rates prescribed in the adverse scenarios would lead to a notable reduction in liabilities of insurers and IORPs when discounting them with the new risk-free rate curves, partially offsetting the losses in the market value of the investment assets. This suggests that only assessing the impact of the scenarios on the asset side of the two sectors provides a more conservative picture leading to an overestimation of the potential losses. Box 2 provides more details on the liabilities of insurers and IORPs and describes how a swap rate increase such as in the second adverse scenario would simultaneously decrease the market value of the liabilities due to the discounting of the technical provisions with higher risk-free rate curves.

76. Furthermore, for unit-linked business or DC IORPs, it should be noted that the impact of climate risks is not going to be borne fully by the insurance or IORP sectors. This is a limitation of the analysed scenarios that consider only an impact on the asset side. For all the losses in the insurance sector, around 20-30% are absorbed by unit-linked products. For the IORP sector, the vast majority of assets are held in DB or mixed IORPs, meaning that only around 10% of the losses are absorbed by beneficiaries in DC products. Box 3 explains the loss absorption by policyholders and beneficiaries in UL/IL and DC schemes.

Figure 35: Losses by asset class for insurers vs. share of assets in scope

(losses: percentage change with respect to the starting point exposures; share of assets: percentages)

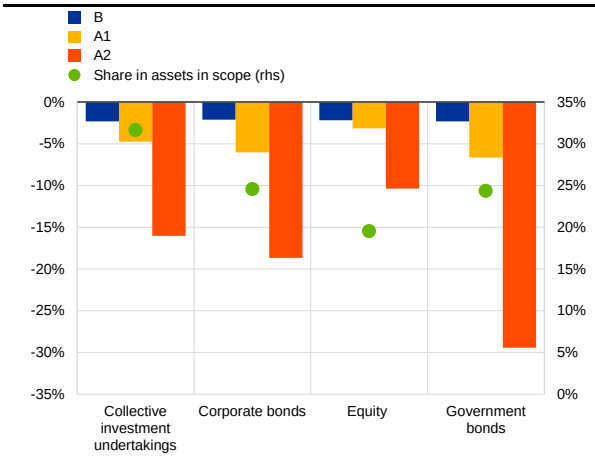
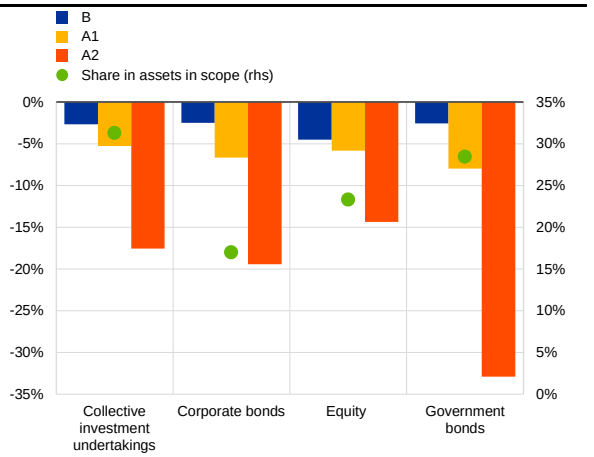


Figure 36: Losses by asset class for IORPs vs. share of assets in scope

(losses: percentage change with respect to the starting point exposures; share of assets: percentages)



Source: EIOPA calculations, and Solo Annual QRT S.06.02 and PF Annual Individual PF.06.02.

77. For the baseline scenario, the distribution of impacts across insurers is sharply peaked around -2%, pointing to a mild and homogeneous impact of the scenario. For the first adverse scenario, impacts across companies vary more strongly, pointing to some heterogeneity in the vulnerability towards the run on brown. Finally, for the second adverse scenario, the distribution is dispersed, indicating heterogeneity in the impact of the shocks, with part of the sample insignificantly impacted by the scenarios while other parts suffer more severe losses depending on the portfolio composition. As described before, the larger impacts concern mostly life insurers with long-duration bond portfolios, while smaller impacts arise for some non-life and reinsurance undertakings. For all three scenarios, the distributions of the losses for insurers and IORPs follow a similar pattern. The distributions for IORPs are, however, slightly shifted to the left, indicating higher impacts and confirming the aggregate results.

Figure 37: Distribution of individual insurers' losses

(x-axis: share of insurers; y-axis: losses as a percentage change with respect to the starting point exposures)

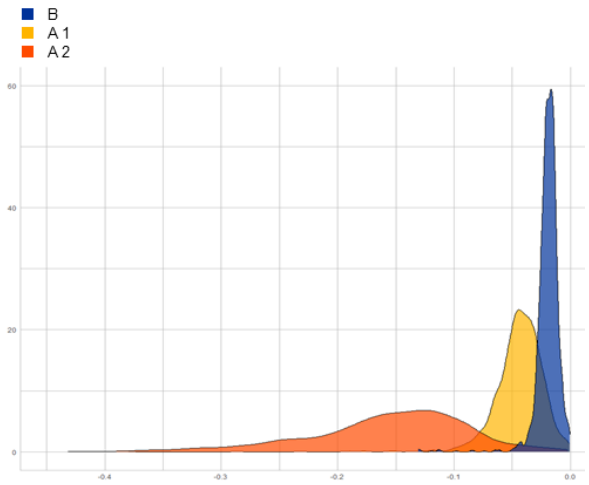
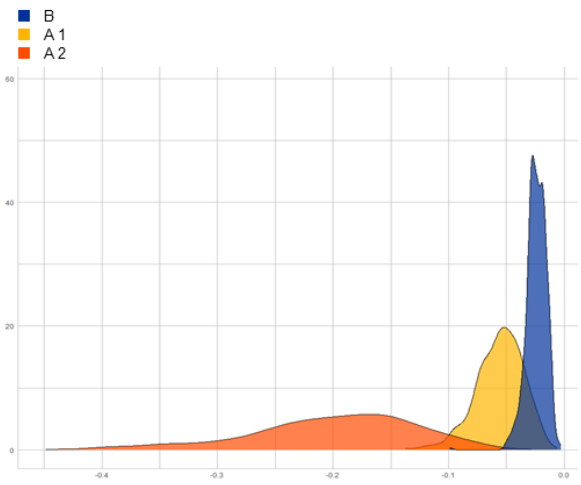


Figure 38: Distribution of individual IORPs' losses

(x-axis: share of IORPs; y-axis: losses as a percentage change with respect to the starting point exposures)



Source: EIOPA calculations.

78. For both insurers and IORPs, the utilities sector stands out as the most affected sector in both adverse scenarios. However, relevant investments only account for a minor portion of insurers' (1%) and IORPs' (2%) portfolios. Investments towards firms in the mining, transport and water supply sectors are also severely affected, but individually do not surpass 1% of investments for insurers or IORPs. Combining impact and weight in the portfolio, investments in manufacturing stand out with losses slightly above 20% in the second adverse scenario and accounting for 5% of insurers' investments and even 10% for IORPs.

Figure 39: Sector contribution of losses in all scenarios for insurers

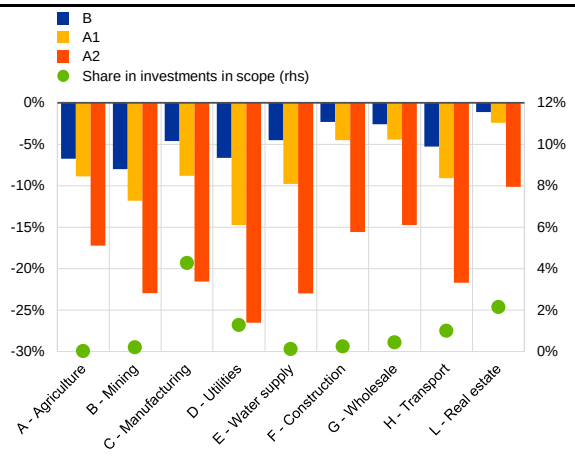
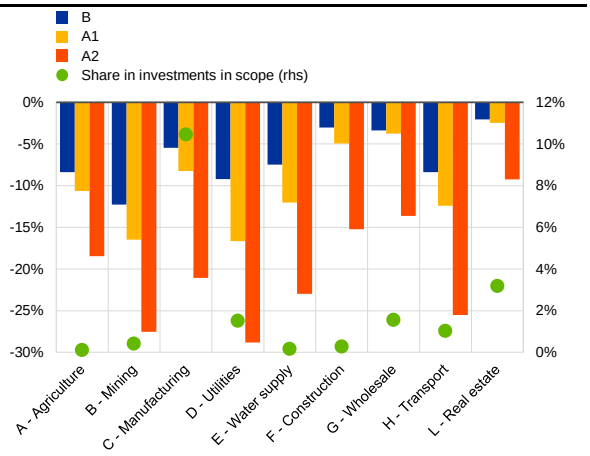


Figure 40: Sector contribution of losses in all scenarios for IORPs



Source: EIOPA calculations, and Solo Annual QRT S.06.02 and PF Annual Individual PF.06.02.

Notes: Figure 39: only assets that had an economic sector considered. Figure 40: only assets that had an economic sector shock considered.

Box 2: Liabilities of insurers and IORPs

The exercise explores risks and vulnerabilities in the EU financial sector linked to disruptive repricing of assets affected by the transition or other adverse real economy and market conditions which could affect the financial sector's ability to finance a smooth transition to the Fit for 55 goals. As insurers and IORPs follow a liability-driven investment approach, the results of this exercise should be interpreted carefully in the absence of recalculation of the market value of liabilities and the hedging provided hereby, especially with respect to the capital and solvency position of the sectors.

Liabilities for both insurers and IORPs represent their future obligations, such as insurance claims and pension payouts, which are directly influenced by factors like interest rates, inflation and longevity trends, etc. The liabilities are thus the expected discounted cash flows representing these obligations. Based on the duration of the estimated future cash flow trajectories, undertakings can determine the asset strategy suitable to minimising their risks, trying to match their cash outflows with the cash inflows from their investments. Typically, the insurance undertakings and IORPs seek to minimise the duration gap between their investment portfolio (assets) and liabilities. This is particularly relevant in a full mark-to-market regime as under Solvency II, where the valuation of both assets and liabilities reflects the level of interest rates observed in the market. It is worth noting that the Solvency II framework encompasses instruments to minimise the unintended consequences of full mark-to-market regimes:

- Tools included in the Long-Term Guarantees package (e.g. volatility adjustment, matching adjustment, equity dampener) aim at smoothing the effect of short-term market movements and avoiding potential procyclicality of insurers as a reaction to short-term volatility.

- Moreover, the different types of business determine the risks, which are borne by the insurers, or which may be passed on in full or to some extent to policyholders. For instance, traditional with-

profits products or non-guaranteed unit-linked contracts transfer market risks to the policyholders to a different extent. This feature is captured in the Solvency II framework under the 'loss-absorbing capacity of technical provisions'[43] (see Box 3).

Against this background, the results given by the isolated scenarios that only capture the change in the value of assets and ignore the risks of the liability side but also, and more importantly, the hedging provided thereby, should be carefully interpreted.

To put the described impact on the asset side into perspective, an illustrative example on the movements of the liabilities can be calculated based on the increase in the euro interest rate swap rates under the second adverse scenario for insurers. The shift in swap rates translates into a positive shift in the risk-free rate curves used to discount insurers' liabilities. For a mixed sample of more than 1 500 insurers, the result is that the severe and sudden increase in interest rates assumed under the second adverse scenario would lead to a decrease of approximately 21% in liabilities held by insurers at the end of 2022.[44] Thus, a significant part of the losses incurred on the assets would be offset by the reduction in liabilities. In other words, losses incurred on the assets cannot be transferred to the capital position of insurers (i.e. own funds) or IORPs, as movements in the interest rates also impact the liabilities. The combined effect depends on the duration mismatch between assets and liabilities.

In conclusion, the results of this exercise for insurers and IORPs should be carefully interpreted in the absence of any liabilities considerations. Focusing solely on assets overlooks the fact that balancing the management of both assets and liabilities ensures that these institutions can meet their long-term commitments to policyholders and beneficiaries, maintaining solvency and protecting against potential mismatches that could threaten their viability.

Box 3: Loss absorption by policyholders and beneficiaries in unit-linked and defined contribution schemes

In the context of assessing the financial impact of the losses discussed in this report on the insurance and IORP sectors, it is essential not only to focus on the losses on the asset side but also to take into account factors that distinguish how these losses are absorbed and by whom.

Within the insurance sector, it is necessary to differentiate between two main types of investment portfolio: unit-linked and non-unit-linked. The key distinction lies in the allocation of investment risk. In unit-linked insurance, policyholders own investment units within their insurance policies, and as such they bear the investment risk. This means any losses on the assets in these portfolios do not affect the insurer's balance sheet but are instead passed on to the policyholders, affecting the value of their policies.

On the other hand, with non-unit-linked insurance, the insurer bears the investment risks. Losses on these assets can directly impact the insurer's financial health and, consequently, may affect the stability of the company and its ability to meet policyholder obligations. Furthermore, it should be noted that there may be special features for non-unit-linked products that can lead to changes on the

[43] The ISA model, used in the chapter on cross-sectoral amplification, takes the loss-absorbing capacity of technical provisions into account when calculating results.
[44] This is only an approximation of how much insurers' liabilities would decrease as no other shocks are considered (i.e. impact of inflation on claims and expenses), nor is the impact of interest rate swaps.

liabilities side if losses occur on the assets side. For example, losses in the value of investments are likely to reduce bonus participation for policyholders, which in turn may lead to a reduction in technical provisions, and thus a decline in liabilities. Such interlinkages between assets and liabilities (e.g. loss-absorbing effects) are not taken into account in the analysis as explained in Box 2. Therefore, the determined losses on the asset side cannot simply be used to calculate the potential amount of own funds or excess assets over liabilities or even the solvency coverage.

Turning to the IORP sector, the situation is analogous. Defined Contribution (DC) IORPs operate on the principle that beneficiaries pay a fixed or defined contribution into their pension scheme. Unlike Defined Benefit (DB) plans, DC plans do not promise specific pay-out levels upon retirement. Therefore, any losses on the assets of DC IORPs directly affect the eventual pension rights and pay-outs of the beneficiaries. The financial position of the IORPs themselves, however, remains unaffected by these asset losses, as the investment risk is borne by the individual plan members.

The charts below provide a distinction between the overall losses for life insurers and IORPs split by the portfolio. For all the losses in the insurance sector, around 20-30% are taken by unit-linked products. For the IORP sector, the vast majority of assets are held in DB or mixed IORPs, meaning that only around 10% of the losses are absorbed by beneficiaries in DC products. This share is relatively stable across the scenarios, as the DC and DB portfolios are reacting in a proportionate way to the prescribed shocks, while the unit-linked portfolio is less sensitive to the two adverse scenarios.

Figure 41: Insurance sector losses split by portfolio type as a percentage share in total losses

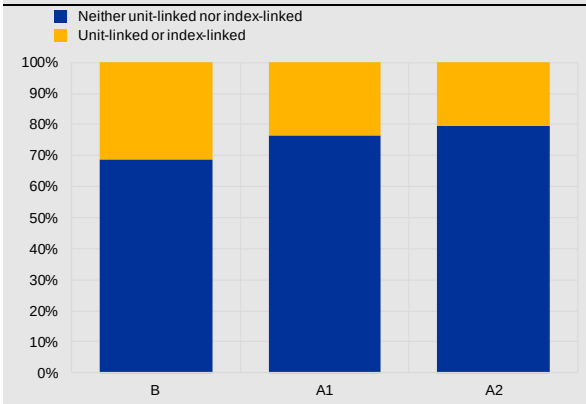
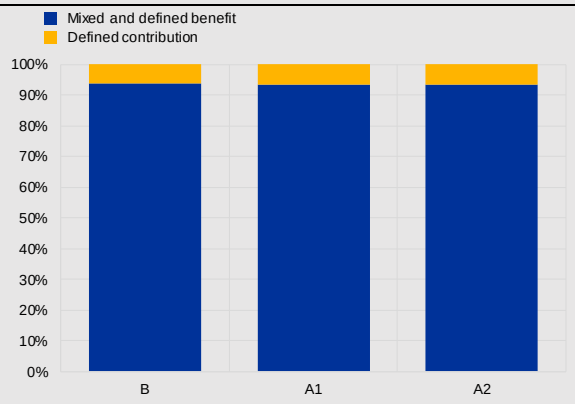


Figure 42: IORP sector losses split by scheme type as a percentage change in total losses



Source: EIOPA calculations.

5. Investment funds

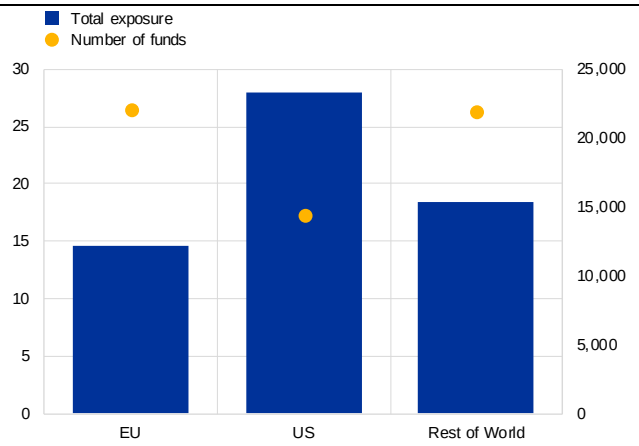
Overview of the sector

79. The investment fund sector, with assets under management (AuM) of over EUR 60 trillion globally and EUR 17 trillion in the EU, is a key component of the financial system. Funds are a means for investors to pool capital and diversify risk, while allocating capital and financing companies' activity by purchasing the securities they issue.[45] The sector's crucial role in financing economic activity and the green transition makes it an important area of focus when modelling the financial sector's resilience to climate shocks.

80. In keeping with the overall focus of this report on the EU financial sector, this section focuses on EU-domiciled investment funds, with some statistics on other regions provided for comparison. The EU fund sector represents over a quarter of funds globally and around 15% of total assets by value (Figure 43).

Figure 43: Distribution of funds and holdings by region as of end-2022

(lhs: EUR trillion; rhs: numbers of funds)



Sources: Morningstar, ESMA calculations.

81. Within the EU, most funds are regulated either as undertakings for collective investment in transferable securities (UCITS) or alternative investment funds (AIFs). UCITS are subject to more stringent liquidity and leverage requirements than are AIFs. At the end of 2022, EU UCITS had almost EUR 10 trillion of assets, while AIFs had EUR 6.8 trillion.[46] Among AIF types, funds of funds accounted for 17% of net assets, followed by real estate funds (16%), private equity

[45] Sources: Global figure from the Investment Company Institute 2023 Fact Book covers regulated open-ended funds as of Q2 2023. Assumed exchange rate: EUR/USD = 1.05. EEA figure from European Fund and Asset Management Association (2023) covers total assets under management (AuM) in UCITS and AIFs, excluding those domiciled in the UK, as of end-2022.
[46] Sources: ESMA Report on Costs and Performance of Retail Investment Products 2023, ESMA Market Report on Alternative Investment Funds 2023

funds (11%) and hedge funds (2%). At the aggregate level, adjusted leverage in 2022 was around 120% of net asset value.

82. The dataset used for the present analysis covers around 22 000 EU-domiciled funds, over 19 000 of which are UCITS. In the EU, funds are generally required to disclose under the Sustainable Finance Disclosure Regulation (SFDR) how they integrate sustainability risks and principal adverse impacts in their investment decision-making processes.[47] Around 850 of the funds disclosed that they have sustainable investments as their objective (Article 9 SFDR), while a further 9 000 disclosed that they promote environmental or social characteristics (Article 8 SFDR).

83. The fund sector enables cross-border capital flows, both by investing in assets issued outside the fund's domicile and by facilitating investments from foreign clients. In 2022 UCITS sold cross-border represented 58% of the total value of all UCITS.

84. EU investment funds tend to be much smaller than their US counterparts. In 2022, the average value of assets held by US funds was over EUR 2.6 billion, whereas the figure for EU funds was just under EUR 300 million. Retail investors held 60% of total EU UCITS assets outstanding, a lower figure than in the US, where households held 88% of US mutual fund assets.

85. Ongoing market monitoring – separate from the scenario analysis carried out in this report – has identified several risks currently facing investment funds. These include liquidity risk, and the potential for losses related to interest rates, credit risk and valuation issues. Vulnerabilities around leverage remain high for some funds and have triggered recent policy interventions in the case of GBP-denominated liability-driven investment (LDI) funds.[48] Real estate funds have faced downward pressure on valuations in housing markets.

86. In recent months, the EU fund sector has enjoyed positive returns across fund categories. Bond funds and money market funds have seen inflows. There has been a trend towards investing in higher-yielding fixed income assets, particularly among some money market funds with a longer maturity. From a risk perspective, there is a broad-based market perception of declining credit risk, reflected in low credit spreads, despite higher interest rates. However, bond fund portfolio credit quality — measured by credit rating — has not improved, raising the prospect of a disorderly repricing of risky assets in the future. Risks continue around liquidity and potential losses related to interest rates, credit risk and valuation issues.

Data and methodology

87. This section of the report outlines how the total value of assets held by investment funds responds to the price changes specified in each of the scenarios. It includes (i) the direct and immediate impact of changes in bond and equity prices on the value of fund portfolios; (ii) the follow-on impact of these price changes via cross-holdings, i.e. where one fund owns shares in

[47] See Article 6 SFDR. The regulation sets out how financial market participants must disclose sustainability information. SFDR Article 8 funds promote environmental or social characteristics, while SFDR Article 9 funds have sustainable investment as their objective.
[48] Source: ESMA Report on Trends, Risks and Vulnerabilities no 2, 2024

another.[49] These are known as 'first-round' effects. It excludes dynamic, second-round effects whereby managers, investors or market participants respond to the change in conditions, e.g. by redeeming fund shares, changing the dividend payments a fund makes or rebalancing portfolios.[50]

88. The analysis of the first-round (i.e. static) impact on fund values uses an extensive dataset of fund portfolio holdings obtained from Morningstar and enriched with further information from Refinitiv Eikon, though, as noted above, coverage is lower for AIFs than UCITS. To ensure recent data was used for the exercise, the raw portfolio data was cleaned by removing duplicates and funds whose latest reported position values were older than 2022.[51] The dataset represents a portfolio snapshot as of December 2022.

89. The dataset covers around 22 000 funds domiciled in the EU, with total assets of around EUR 14.7 trillion as of the end of 2022.[52] For comparison, the European Fund and Asset Management Association (EFAMA) recorded a total of around 57 000 EU-domiciled funds with assets of EUR 17.1 trillion for Q4 2022.[53] In terms of assets, therefore, the estimated coverage of the sample of EU-domiciled funds used in this section of the report was over 85%, even though many funds (especially AIFs) were not covered.[54]

90. Within the EUR 14.7 trillion of EU-domiciled funds in the dataset, the analysis focuses on equities, corporate bonds and government bonds, whether held directly or held indirectly via fund cross-holdings. Other holdings, such as cash and derivatives, are excluded. Holdings in scope had a total value of just under EUR 10 trillion, around half of which was direct equity holdings (Table 2).

[49] ESMA's approach to modelling the impacts of climate shocks on the fund sector is set out in Amzallag, Harris and Reiche (2023). In the terminology of that article, this section of the report covers (i) 'direct static' impacts and (ii) 'indirect static' impacts and uses the same methodology for those components. Dynamic modelling is covered separately in this report in Chapter 6 on cross-sectoral amplifications.
[50] The modelling of second-round effects in Chapter 6 includes important assumptions in respect of fund liquidity management, as set out in that chapter. In particular, it excludes redemption gates or suspensions that in practice would be expected to reduce redemptions and hence reduce pressure for 'fire sales' of portfolio assets. This feature of the modelling therefore tends to overstate the second-round losses.
[51] Negative position values were also removed. These made up around 6% of total position values in magnitude. Among those asset classes included in the first-round effects analysis (namely equities, corporate bonds and governments bonds), negative position values are much less than 1% of the total. Finally, three very large position values (> EUR 50 billion) were removed following manual inspection, as they appeared to be erroneous.
[52] Statistics in this chapter that compare EU-domiciled funds with the rest of the world or other regions are based on a wider dataset of around 59 000 open-ended investment funds globally, with total assets of EUR 61 trillion as of end-2022.
[53] Source: EFAMA Quarterly Statistical Release no 92, February 2023. EFAMA recorded 29 520 EU-domiciled UCITS with total assets of EUR 10.7 trillion and 27 521 AIFs with total assets of EUR 6.4 trillion, making a total of 57 041 EU-domiciled funds with total net assets of EUR 17.1 trillion.
[54] Among AIFs, the estimated coverage by value was much lower, at 17%.

Table 2: Assets in the scope of the simulation held by EU-domiciled funds

Fund assets by class	Market value, EUR trillion	% of total
Equities	5.0	50.3%
Corporate bonds	2.6	25.9%
Government bonds	1.6	15.8%
Cross-holdings	0.8	7.9%
Total	*9.9*	*100%*

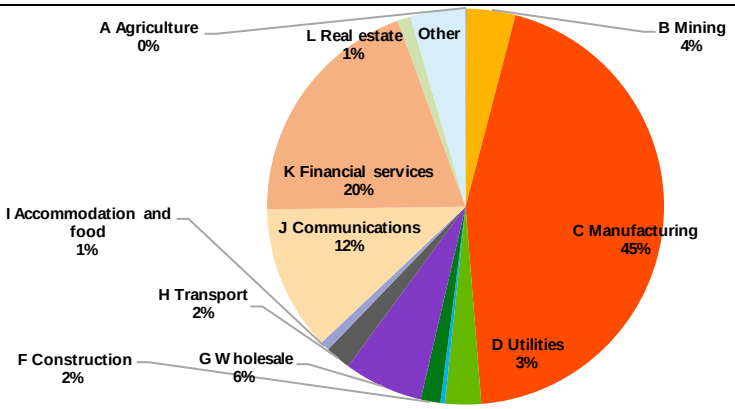
Notes: Table summarises the portion of the global dataset of 58 747 open-ended funds that covers 22 215 open-ended funds domiciled in the EU. Totals may not sum exactly due to rounding. Cross-holdings in other funds (i.e. redeemable shares in one fund held by another) are included in the analysis to the extent that they reflect indirect exposure to equities, government debt or corporate bonds held by other funds.

91. Despite this high coverage in terms of asset values, however, the analysis had to address some significant data gaps. Only around 40% (by value) of these assets have information on the economic sector of the issuer. For assets missing this information, average price shock values contingent on asset class and issuer country (or region) were imputed.[55]

92. Among the subsample of assets for which data on the economic sector was available, the largest sector was manufacturing (46%), followed by finance and insurance (22%), as shown in Figure 44.

Figure 44: Asset holdings by sector, EU-domiciled funds

(percentages)



Note: percentage values of portfolio holdings by economic sector (NACE 2) for combined direct and indirect holdings of equities, corporate bonds and government bonds.

Sources: Morningstar, ESMA calculations.

[55] For example, an equity issued in the US for which no information was available on economic sector would be assigned the average price shock across all US equities.

93. To calculate first-round impacts, the prices of equities and bonds in the fund portfolios were updated in line with each scenario. Following this, through an iterative process, the value of indirect holdings was calculated, starting with funds whose cross-holdings are in other funds that hold only equities or bonds.[56]

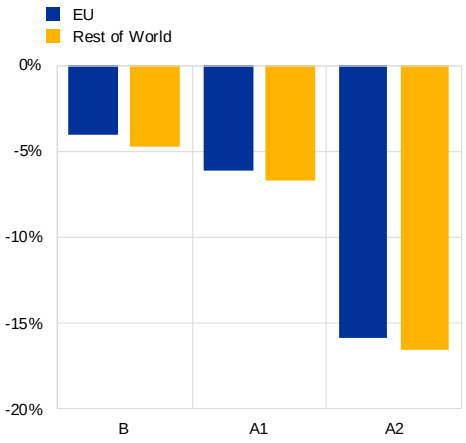
First-round effects

94. Under the three scenarios, the investment fund sector undergoes a significant reduction in total asset value due to negative shocks to the prices of those assets modelled (equities, government bonds and corporate bonds). The bulk of the effect is realised through direct holdings, with a relatively small part attributable to indirect exposure to these assets through cross-holdings. This is as expected, given that cross-holdings represent a relatively small share (7.9%) of the value of assets in scope (see Table 2).

95. Comparing estimated impacts on EU-domiciled funds to those located in the rest of the world can inform an assessment of relative levels of vulnerability. According to the data simulations, EU funds fare marginally better than those domiciled outside the EU across scenarios (Figure 45).

Figure 45: Estimated average first-round impact by region of fund domicile and scenario

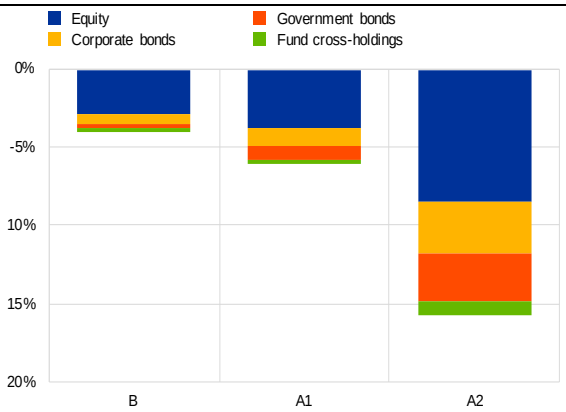
(losses: percentage change with respect to the starting point exposures)



Source: Morningstar, Refinitiv, ESMA calculations.

Figure 46: Estimated average first-round impact by asset class of fund holdings, EU domiciled-funds only

(losses: percentage change with respect to the starting point exposures)



Source: Morningstar, Refinitiv, ESMA calculations.

96. Breaking down the impacts for each scenario by the class of assets held by EU funds, equities are responsible for more than half of the total impact in each case, exceeding their share of

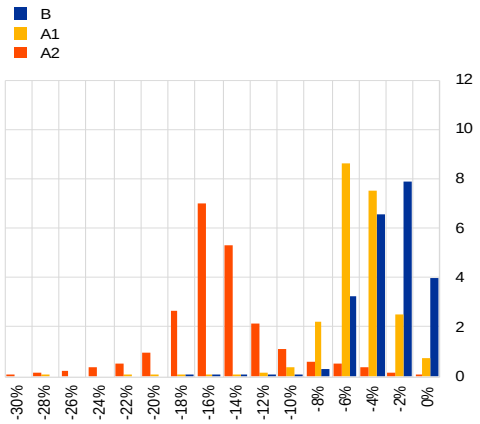
[56] Indirect first-round effects are calculated via iteration, as follows. First, define S1 to be the set of funds that hold direct equities only, for which direct static effects are first calculated. Then define S2 to be the set of funds that hold shares in funds in S1 and otherwise only directly hold equities. Given the updated valuation of funds in S1, price effects in S2 are calculated, and so on at higher levels.

initial exposure. This follows from the specification of the scenarios, in which equity prices suffer more on average than do bond prices (Figure 46). Finally, the share of the first-round impact attributable to equities decreases in the severity of the scenario, another effect attributable to the specification of the asset price shock in the scenarios. In particular, bond prices are typically more sensitive to default risk, which tends to rise steeply in more stressed scenarios, than are equity prices.

97. Estimated first-round impacts vary across the fund population for each asset class (Figures 47-50). This reflects the fact that funds tend to focus their investments on different economic sectors, which experience a range of price impacts under each scenario (Figure 51). The greatest dispersion is in the second adverse scenario, resulting in a relatively wide range of impacts at asset level, for any given asset class in scope. Primary industries that intensively use physical resources, such as mining and utilities, are subject to the greatest impact across scenarios. Funds that concentrate their investments in a particularly hard-hit economic sector will fare much worse than funds that focus on more insulated sectors. There is also some dispersion in impacts across global regions (Figure 52), but it is less pronounced than the dispersion across sectors.[57]

Figure 47: Distribution of estimated first-round impacts among EU funds

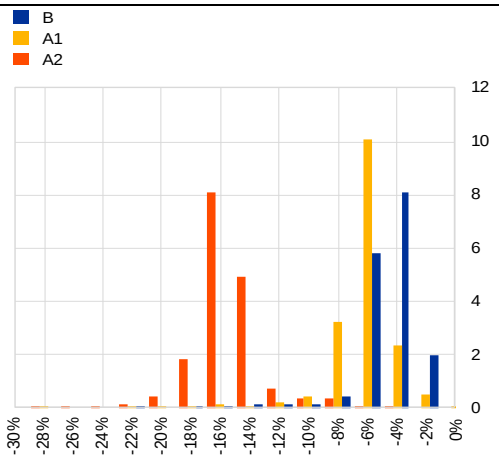
(number of EU funds with percentage impact in given interval, thousands)



Source: Morningstar, Refinitiv, ESMA calculations.

Figure 48: Distribution of first-round impacts on equity holdings of EU funds

(number of EU funds with percentage impact in given interval, thousands)

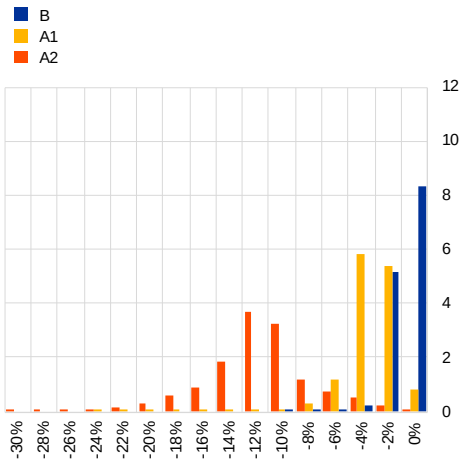


Source: Morningstar, Refinitiv, ESMA calculations.

[57] Fund holdings of securities issued in Europe undergo relatively large impacts compared with other regions under scenarios B and A1 in Figure 49. This effect is driven by the design of the scenarios. The baseline assumes the implementation of the Fit for 55 package in the EU and reflects upfront costs associated with the transition.

Figure 49: Distribution of estimated first-round impacts on corporate bond holdings of EU funds

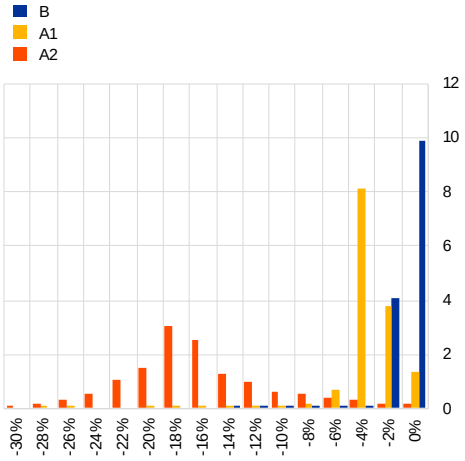
(number of EU funds with percentage impact in given interval, thousands)



Source: Morningstar, Refinitiv, ESMA calculations.

Figure 50: Distribution of first-round impacts on government bond holdings of EU funds

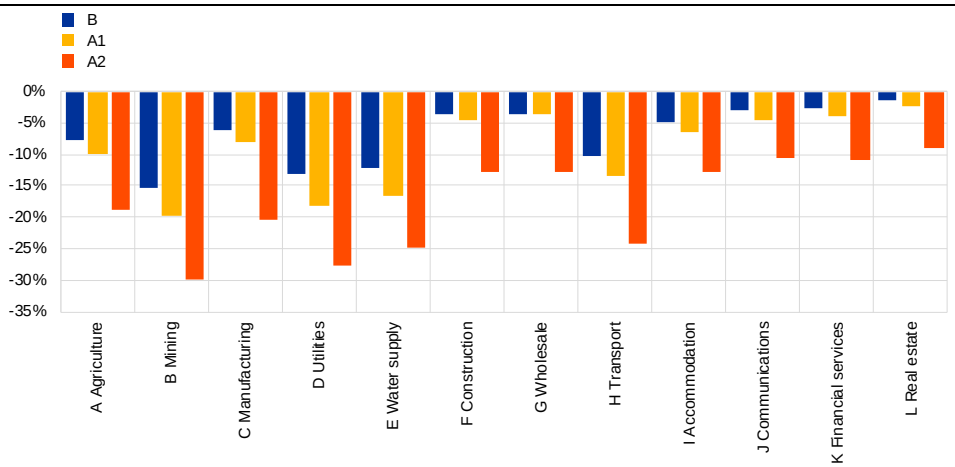
(number of EU funds with percentage impact in given interval, thousands)



Source: Morningstar, Refinitiv, ESMA calculations.

Figure 51: Estimated first-round impacts by issuer sector

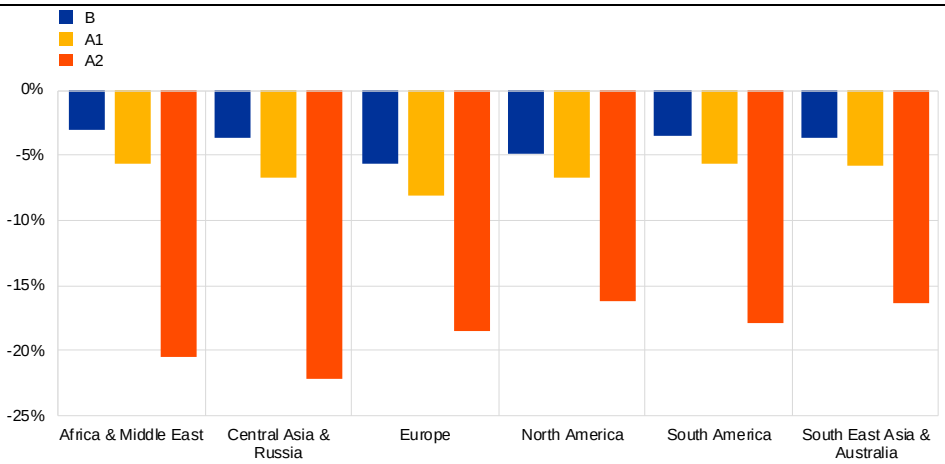
(percentage change relative to initial exposure, combined across all asset classes in scope for EU funds)



Sources: Morningstar, ESMA calculations.

Figure 52: Estimated first-round impacts by issuer region

(percentage change relative to initial exposure, combined across all asset classes in scope for EU funds)



Sources: Morningstar, ESMA calculations.

6. Cross-sectoral amplification effects

98. This chapter explores the role of second-round effects in amplifying the shocks analysed in the previous chapters. More specifically, it studies the effect of spillovers between financial institutions, meaning within each sector as well as across the different sectors. The analysis presented in this chapter relies on the Interconnected System-wide stress test Analytics (ISA) model, which builds on work conducted at the ECB.[58]

Data and overview of the methodology

99. The dataset on which this chapter is based is a network that integrates three types of entities: banks, insurance corporations and investment funds.[59] For the banking sector, the relevant information has been retrieved from AnaCredit, FINREP, COREP, SHS-G (Securities Holding Statistics – Group level) and the Fit for 55 data collection mentioned in Chapter 3. The insurance data stems from data provided by EIOPA on Solvency II reporting templates combined with SHS-S (Securities Holding Statistics – Sector level) data on securities holdings at ISIN level. Commercial data from Lipper IM is used for investment funds. Specifically, the banking sector comprises 96 large, consolidated banking groups within the EA, while the insurance sector consists of 19 country-level company aggregates. The investment fund sector includes 21 378 open-end investment funds, after aggregating at the group level, with the results primarily covering the 4 189 fund groups domiciled in the EU. It is important to note that the rest of the funds contribute to the propagation of the shock, thereby having an influence on the results reported for European funds. Moreover, some funds are present in the data on their liability side only, i.e. other financial institutions report exposures to funds whose assets are not available in Lipper IM data. The data collection employed for this exercise refers to end-2022.

100. The comparison of the asset side balance sheet composition across the different sectors resembles the asset coverage outlined in the previous chapters. Figure 53 shows that market risk exposures cover the largest share of total assets of the financial system (EUR 15.8 trillion, corresponding to 36.8% of the total assets of the system). However, there are sizeable differences across sectors: market portfolio accounts for only 12.9% of banks' total assets (EUR 3.19 trillion), while it comprises 61.4% of insurers' assets (EUR 5 trillion) and 76% of investment funds' assets (EUR 7.58 trillion). On the other hand, credit risk exposures, covering 67.2% of banks' total assets, represent the most relevant balance sheet item for the banking sector.

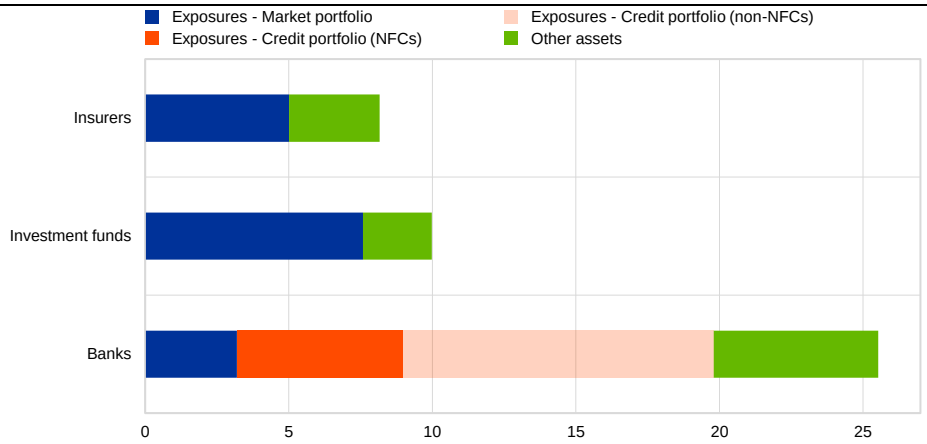
[58] See Sydow et al. (2024) 'Shock amplification in an interconnected financial system of banks and investment funds', Sydow et al. (2024) 'Banks and non-banks stressed: liquidity shocks and the mitigating role of insurance companies', Fukker et al. (2022) 'Contagion from market price impact: a price-at-risk perspective' and Gourdel and Sydow (2023) 'Non-banks contagion and the uneven mitigation of climate risk'.

[59] IORPs are not included due to data and modelling limitations.

Loans to NFCs constitute around one third of the banks' loan portfolios, whereas insurers and investments funds are not exposed to a credit portfolio.

Figure 53: Composition of asset side balance sheet by sector

(EUR trillion)

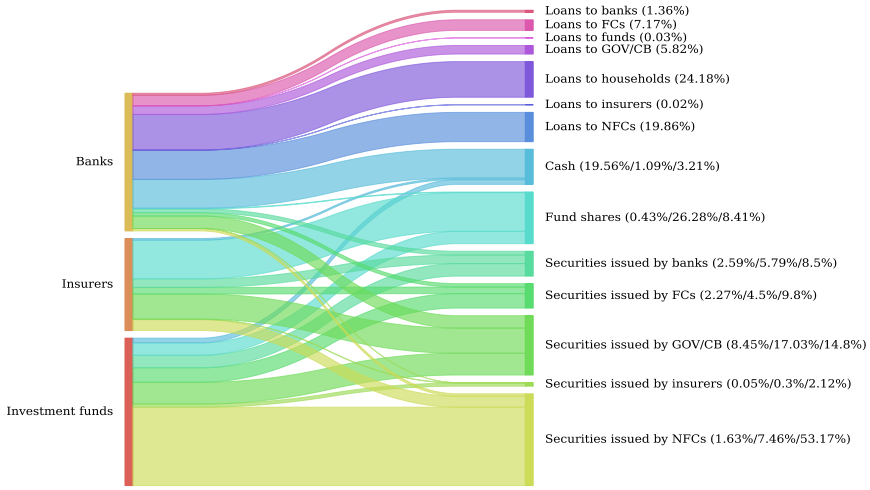


Source: ECB calculations.

Notes: Market portfolios (blue bars) are composed of holdings of bonds, stocks and fund shares. Credit portfolios (red and pink bars) consist of loans towards NFCs, households, FCs and sovereigns. Other assets (green bars) are composed of all the remaining assets not included in the previous categories (e.g. cash).

101. Beyond direct exposures, overlapping portfolios play a crucial role for the analysis of the financial system interconnectedness. Figure 54 illustrates the financial system cross-holdings covered by the ISA model. The banking sector is mostly exposed to sovereign securities in the financial market, which are also a major component of tradable assets held by the other two sectors. Insurers are the primary holders of investment fund shares and securities issued by governments. Investment funds are the primary holders of securities issued by NFCs, while they also have sizeable interconnections within their sector.

Figure 54: Cross-holdings covered by the ISA model



Source: ECB calculations.

Notes: Holders of assets are shown on the left and issuers and types of assets on the right. The percentages in brackets express the share of exposures in the balance sheets of banks, insurers and investment funds, respectively. Assets for which counterparty information is not available are not included in the figure.

102. Heterogeneous data sources and geographical coverage led to a different starting point for the ISA model compared to the models used in the other sector-specific chapters.[60] To ensure comparability across the different chapters of this report, results of the ISA model have been rescaled to align with the results reported in the previous chapters. The rescaling is based on the ratios of initial market losses observed in the sector-specific applications and in the ISA model. This addresses issues of data discrepancies and allows for the results estimated for second-round losses to be interpreted as an add-on to the ones identified in previous chapters.

103. The simulation results of the ISA model embed both direct shock propagation from the cross-exposures of financial entities, and indirect loss amplification. The latter manifests through additional liquidity stress that is triggered by the scenario shock, and it is mostly propagated via indirect exposures, i.e. overlapping portfolios. First-round losses are the combination of credit risk shocks (see Appendix I) and market risk shocks (see Appendix II), where the latter is composed of the direct portfolio depletion due to revaluation of securities driven by the

[60] The banks chapter also covers non-EA banks while the ISA model focuses on the EA only. EIOPA covers IORPs while the cross-sectoral analysis excludes pension funds. Moreover, the latter analysis is based on country-level data. Regarding funds, discrepancies stem from the data sources adopted: ESMA employs Morningstar while the ECB retrieves data from Refinitiv Lipper IM.

scenario shocks and fund shares losses in line with the corresponding funds' NAV reduction in the network. Second-round losses are driven by the intertwined reactions of all the financial institutions in the system to liquidity and solvency constraints, which lead to interbank liquidity withdrawals, redemptions and fire sales (see Appendix III). First-round losses are based on the scenario realisation at the end of the first year of the projection horizon. Second-round losses develop suddenly in the subsequent period, as a reaction to first-round losses until an equilibrium is reached in terms of liquidity and solvency. Compared to the sector-specific chapters, this also includes liability side dynamics, such as the adjustment of insurers' liabilities to shocks on swaps, or redemptions by funds' investors.

Results on system-wide amplification

104. The scenarios of this exercise imply first-round credit and market shocks to financial institutions. In the ISA model, this results in contagion effects across sectors through market, liquidity and credit risk channels. The ISA model takes as an input the credit losses in 2023, and the market shocks. The model captures the short-term propagation of relatively sudden financial developments, and it makes use of granular information on the asset holdings of financial institutions. Therefore, this exercise focuses on simulating the most proximate shock.

105. Spillovers between sectors are generally weaker than the amplification within a sector, and similarly at the institution level. Moreover, funds are prominently stressed in the first round from their market risk exposure, which is most reactive to short-term dynamics. Thus, the amplification is also stronger by design for them.

106. From a credit risk perspective, only banks are affected due to their balance sheet composition. Figure 54 illustrates how banks are exposed mostly to households', NFCs' and FCs' loans. Compared to Chapter 3, which solely tests the impact of NFCs' loans, the present chapter accounts for the overall credit portfolio. Moreover, for a realistic modelling of the banks' profit and loss account, scenario-conditional projections of net operating income (NOI) are included in the ISA model in the latter case.[61]

107. From a market risk perspective, the scenario is translated into changes in the valuation of securities holdings within the financial system, with funds and insurers holding most securities issued by NFCs, FCs and other sectors (see also Figure 1). In turn, the depletion of funds' NAV is reflected in all fund shares held in the market, affecting primarily insurance corporations. Following the scenario shock, funds are exposed to two sources of liquidity stress. First, they face redemptions from external investors (not covered by the ISA model) as a reaction to initial market losses, with the simplifying assumption that no liquidity gates or suspensions are modelled. Second, in subsequent dynamics, when some financial institutions in the model experience liquidity needs they partially alleviate them by redeeming fund shares that they may hold. The indirect contagion from this liquidity stress stems from funds selling some of

[61] The NOI projections have been generated using the ECB model (see Budnik et al. (2024) 'Advancements in stress-testing methodologies for financial stability applications') in alignment with the EBA stress test methodology. It is important to highlight that the NOI projections are used only in the cross-sectoral part of the exercise.

the equity and bond securities in their portfolio to meet liquidity needs. In turn, these fire sales have a downward effect on prices, leading to further losses across the financial system. We assume in this exercise that investment funds aim at maintaining their initial ratios of cash to capital. In turn, this implies that they use cash to meet redemptions only to a limited extent. This assumption is supported by empirical results,[62] but it is possible that in a stress scenario funds would use cash buffers to help absorb a shock, which would mitigate second-round losses. Additionally, no liquidity management mechanisms (e.g. redemption gates) or redemption fees are considered, which could in practice limit the initial liquidity stress. Subsequently, the direct exposure channel of fund shares assumes that counterparties holding fund shares are affected by the mark-to-market revaluation of the corresponding funds' net asset value.

108. At the system level, scenario-conditional market risk losses drive overall second-round results implied by the ISA model. Figure 55 displays aggregate losses across the three scenarios with respect to the initial exposures, reaching a total of 3.7%, 6% and 14.6% for scenarios B, A1 and A2, respectively. While first-round market portfolio losses increase significantly with the severity of the scenarios (growing from 3.2% of market exposure under B to 16.5% under A2), credit risk losses see a sharp increase only under the most severe scenario, due to the economy-wide recession narrative. Contingently on tighter market conditions, results point toward material second-round market portfolio losses (moving from 1.7% of market exposure under B to 6.8% under A2), which are triggered by the liquidity stress induced by the initial scenario shocks and the subsequent fire sales of securities. On the other hand, second-round credit risk losses, triggered by entities defaulting in the system in the aftermath of the scenario shocks, are always negligible.

109. For banks, credit losses are particularly important, following the results of Chapter 3: they account for 94% of their first-round losses under the baseline scenario, 89% under the first adverse scenario and 79% under the second adverse scenario.[63] However, second-round losses from the credit risk channel are insignificant. Figure 56 indicates that total second-round market losses remain contained under the baseline scenario, which is the scenario closest to expectations. Even under stressed market conditions, as prescribed under the adverse scenarios, market risk losses for banks remain at a low level, due to their hedging mechanism. Moreover, in line with banking regulation, unrealised losses of the held-to-maturity portfolio do not impact P&L.

110. Insurance corporations are mainly affected by the channel of fund share revaluations. Insurers have a high exposure to investment funds, so that a loss of value of fund shares is their primary driver of second-round losses, accounting for up to 67% of second-round losses (Figure 56). The rest of the shock for insurers is driven by the price impact channel following fire sales.

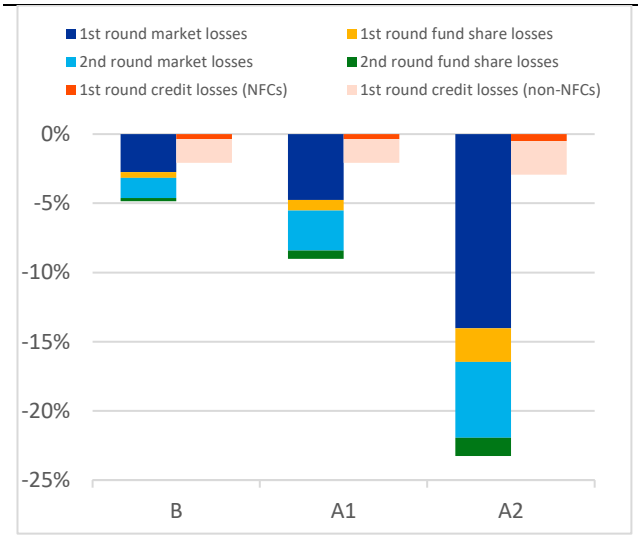
[62] See Baranova et al. (2017) 'Simulating stress across the financial system: the resilience of corporate bond markets and the role of investment funds', Financial Stability Paper No. 42, Bank of England.

[63] These credit losses refer both to the NFCs and non-NFCs loans portfolio.

111. Most of investment funds' second-round losses are due to the price impact following fire sales of securities.[64] This accounts for 94% to 95% of their second-round losses across all scenarios, with the remainder being due to cross-holdings between funds. The vulnerability to fire sales stems from funds being the main sellers of securities in the simulations and the price impact materialising at the security level. Therefore, those who sell are affected most by the price impact. Meanwhile, institutions in the other two sectors whose portfolios have a lower overlap and correlation with that of investment funds are relatively shielded from the price impact channel. In addition, banks benefit from the same mitigating mechanisms (hedging and held-to-maturity assets) as in the first round, while for insurers the loss-absorbing capacity of technical provisions is included in the second round. This reduces the final effect of fire sales on their balance sheets.

Figure 55: First and second-round losses at the system level (as share of exposures in 2022)

(percentages)

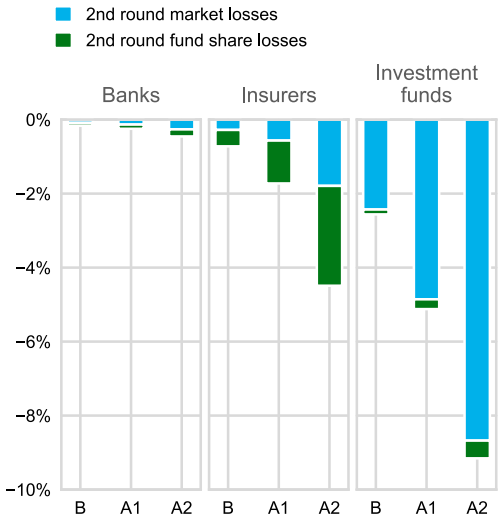


Source: ESAs and ECB calculations.

Note: second-round credit losses are excluded from the picture as they are too small to be visible.

Figure 56: Second-round losses by sector (as share of exposures in 2022)

(percentages)



Source: ESAs and ECB calculations.

Note: second-round credit losses are excluded from the picture as they are too small to be visible.

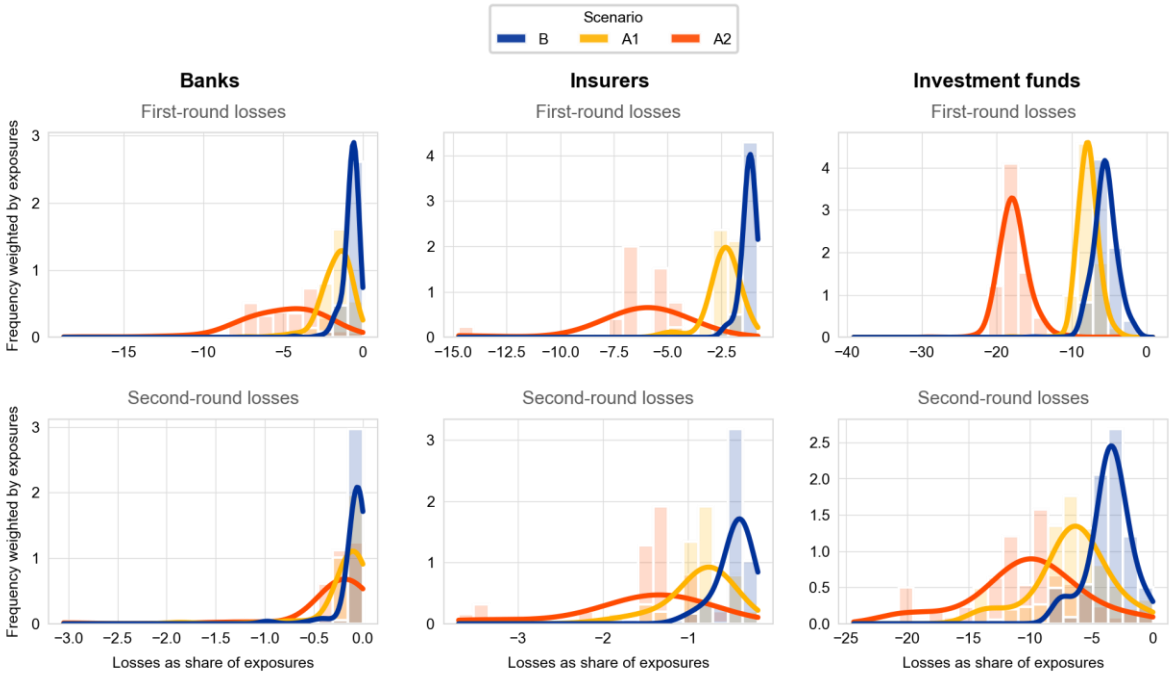
112. For all sectors, second-round losses are less widely spread than first-round losses and are more concentrated in the biggest entities. Figure 57 shows the distributions of first and second-round market losses for the three financial sectors. In both rounds, the variance in entity-level losses increases for more severe scenarios, while the distribution of impacts under the baseline

[64] The calibration of the price impact is important in that regard. Its details are explained in Appendix III.

scenario is rather narrow.[65] Figure 61 in Appendix III provides a complementary view of these losses.

Figure 57: Distribution of first and second-round market losses on the market portfolios

(x-axis: percentage points; y-axis: EUR trillion for each bucket of the histogram)



Source: ECB calculations.

Notes: The first and second rows of panels provide the distribution, by scenario, of the ratios of first-round losses and second-round losses, respectively, with respect to initial exposures. Panels are also divided into columns, the first referring to the banking sector, the second to the insurance sector, the third to the investment fund sector. The distributional graphs exclude lending and collective investment undertakings.

[65] In the case of insurers, the distribution is less informative as the model works with country aggregates, which are thus limited in number.

7. Conclusions

113. The Fit for 55 climate scenario analysis exercise marks an important milestone in climate stress testing, being the first EU-wide and cross-sectoral exercise for the financial sector carried out jointly by European institutions and supervisory authorities.

114. As with all forward-looking projections the outcomes are subject to inherent uncertainty, and to the associated modelling/estimation error linked to the novelty of the climate stress testing approaches as well as data quality concerns. Therefore, the results should be understood as relating only to scenarios considered in this exercise, and as based only on part of financial institutions' total exposures. Despite these natural limitations, the exercise maintains consistency across sectors and models interconnections within the financial system.

115. In responding to the Commission's request, the ESAs and the ECB have enhanced their modelling tools, shared their expertise and gained valuable insights by identifying key risks associated with the transition to a green economy. Although its results will not envisage recapitalisation actions, the exercise will still inform the future work of ESAs and the ECB on this crucial topic. Furthermore, the exercise contributed to the supervisory engagement with the industry and to the enhancement of industry internal tools for assessing climate-related risks.

116. Under the scenarios considered, the banking sector faces aggregate losses over total credit and market exposures in scope between 5.8% and 10.9%. Losses are mainly driven by increased PDs of the borrowers. The effect of a potential run on brown is quite limited, indicating that perceived changes in climate risks are not the main source of concern for the banking system. Adverse macro developments, however, could negatively interfere with the evolving transition and increase credit losses significantly. The Fit for 55 exercise shows the importance of considering specific climate risk shocks and transmission channels when assessing risks for the banking sector originating from the dynamics of a transitioning economy. Importantly, the analysis excludes income components which, especially during high interest rate periods, could mitigate losses by boosting profitability. Finally, the dynamic balance sheet framework explored in Box 1 illustrates how banks might adjust their lending practices in response to the macroeconomic environment and transition risks. The findings indicate that banks could potentially contribute to financing this transition. However, under challenging macroeconomic conditions additional funding from other financial intermediaries and sectors, including capital markets and the public sector, will be necessary to finance the green transition.

117. Moving to the insurance sector, the scenarios lead to overall impacts ranging from -2.2% to - 18.8% of investments in scope for insurers when assessing first-round losses. For IORPs, the impact is slightly more pronounced, ranging from -3% to -21.5% of investments in scope. Both

sectors prove to be resilient to the run on brown triggered in the first adverse scenario. The relatively small impact is largely due to the portfolio structure of insurers and IORPs, with only limited exposures towards assets heavily impacted by the run on brown. The adverse macroeconomic environment in the second adverse scenario then leads to more pronounced impacts through the strong increase in swap rates. This can also be explained by the portfolio structure, as for both insurers and IORPs it is tilted towards fixed income assets. Life insurers and IORPs especially, which tend to match the long duration of their liabilities with corresponding longer-duration bonds, suffer strong decreases in market value under the second adverse scenario. For the interpretation of the results of these two sectors it is important to note that the results might overestimate the actual impact for several reasons. First, the exercise focuses on the impact on investments of insurers and IORPs and does not include the effect on liabilities. Across all scenarios and most notably under the second adverse scenario with its significant positive shock to swap rates, discounting of liabilities, especially for long durations such as in life insurance business or for IORPs, would lead to a significant decrease in liabilities, partially offsetting the drop in market value of investments (see Box 2 in Chapter 4). Furthermore, part of the impact is borne by policyholders, as is the case for unit-linked business or for DC IORPs (see Box 3 in Chapter 4), which further softens the impact for parts of both sectors. Finally, no reactive management actions have been considered, thus their mitigating effect is not included in the assessments.

118. For the EU investment funds sector, first-round losses in the baseline scenario are estimated at around 4.0% of total exposures in scope, driven largely by declines in the values of equities held by the funds. The magnitude of the decline increases to 6.1% in the first adverse scenario, as the run on brown shock leads to a further decline in market values. This decline in value increases with scenario severity, driven by the increasing effect of default risk premia for bonds issued by companies. In the second adverse scenario, the additional effect of a sharp, exogenous deterioration in the macroeconomic environment drives an overall immediate decline of 15.8%. A key driver of the impact on funds is likely to be the economic sectors they invest in, more than the asset class or the geographical focus of the fund. Intuitively, sensitivity to the carbon price varies greatly by the type of economic activity being conducted. Finally, almost all the first-round impact is attributable to funds directly holding assets, rather than indirect exposure via holding shares in other funds.

119. As with the other sectors, the simulation of first-round losses for funds faced data and methodological limitations. Only a minority of the assets by value are classified in detail by economic sector, so to model first-round impacts it was necessary to interpolate asset price shocks in each scenario. Additionally, the analysis is based on impacts expressed as a percentage in fund value while excluding holdings of cash, cash equivalents, derivatives, real estate and other assets. Cash holdings would 'dilute' somewhat the magnitude of effects.[66]

[66] An additional limitation is that the analysis neglects cases where funds hedge their exposure by using short positions, which will offset the estimated falls in fund value to some extent. However, the data suggests that short positions are unlikely to make a large difference to the estimated first-round effects in the fund sector. According to the data, for instance, negative position values make up only 6% of the absolute value of fund positions.

120. Following first-round effects, investors and fund managers will respond in some way. In so doing, they will interact with other market participants, including financial institutions elsewhere in the financial sector. Second-round amplification effects can cause further losses of a significant magnitude if market conditions amplify liquidity stress. However, the shocks induced by the Fit for 55 scenarios, even under adverse conditions, do not lead to a degree of solvency or liquidity stress that would endanger the safety of the financial system. Overall, second-round losses are found to be material, so that considering only a simple sum of sector-level losses would underestimate the total losses for the system.

121. At a more granular level, we see that most of the major institutions included do not incur massive losses either in the first or in the second round. This can be linked to several factors. First, most large financial institutions are currently well capitalised, and many still enjoy high levels of liquid assets from the past period of expansionary central bank balance sheets. Second, the diversification of the bigger institutions – coupled with some sector-specific mechanisms such as hedging and loss-absorbing capacity – mitigates the shock. While diversification has been shown to increase correlation between financial institutions, which can become harmful beyond a certain stress threshold, the current exercise does not reach such a threshold. This is different in the case of smaller investment funds, where the adverse scenario impact is larger, which may ultimately add up to sizeable losses when aggregated over the whole EU investment fund sector.

122. Importantly, second-round loss estimates rely on several assumptions on top of the main scenario, with an aim to capture the risk in the tail. For example, funds are assumed to keep the same liquidity profile, while a reduction in liquidity could attenuate the immediate shock amplification. Yet, some other channels have not been included in this exercise, such as broader liquidity shocks that affect banks and insurers. Such shocks may still materialise if the Fit for 55 package implementation is contemporaneous with a period of financial turmoil. Policy implementation and communication are thus important to ensure that the kind of behavioural responses that have not been included here do not threaten financial stability.

Appendix I: Credit risk methodology and further results

123. In what follows, the methodology for calculating credit risk losses for banks is explained in detail. First, the calculation of credit risk losses is presented. The subsequent sections present the methodologies for the projection of the components of the credit loss calculation, namely the projection of probabilities of default (PDs), loss given default (LGDs) and lifetime loss rates (LTLRs).

Credit risk losses

124. The calculation of credit risk losses is based on the methodology for the calculation of provisions employed in the 2023 EU-wide stress test, as described in the EBA methodological note[67]. However, this exercise does not distinguish between stage 1, 2 and 3 loans, but rather between performing (stage 1 and 2) and non-performing (stage 3) loans[68]. Hence, the EU-wide stress test methodology has been simplified for the purpose of the credit loss calculation for the Fit for 55 exercise. In line with the original methodology, credit losses are calculated separately for real estate and non-real-estate exposures at a bank-country-sector level. Exposures are distinguished between performing (stage 1 and 2) and non-performing (stage 3) loans, in line with the data reported in the Fit for 55 data collection templates. In what follows, the superscript j denotes the bank, t the year ∈ [2023,2030], c the country of the counterparty, d the sector of the counterparty and s the scenario.

125. Credit risk losses are defined as the increase in provisions that a bank registers from one year to another. Additional provisions consist of provisions for newly recognised non-performing exposures as well as the difference in the stock of provisions for previously existing performing and non-performing exposures:

$$CR\ losses_{c,s}^{t,j} = Provisions\ newly\ non\_performing_{c,s}^{t,j} + \Delta\left(Stock\ of\ provisions\ performing_{c,s}^{t,j} + Stock\ of\ provisions\ non\_performing_{c,s}^{t,j}\right)$$

126. Provisions depend on the stock of performing and non-performing exposures, which change over the scenario horizon. The 'no cure' constraint is assumed, meaning that exposures that become non-performing cannot revert to performing at a later stage. This implies that the

[67] Please check here.
[68] Unlike the EU-wide stress test, the template of the Fit for 55 ad hoc data collection does not have an exposure breakdown by loan stage.

stock of non-performing (performing) exposures increases (decreases) over time proportionally to the probabilities of default as follows:

$$Stock\ of\ performing\ loans_{c,s}^{t,j} = \left(1 - PD_{c,s}^{t-1,j}\right) * Stock\ of\ performing\ loans_{c,s}^{t-1,j}$$

$$New\ non\_performing\ loans_{c,s}^{t,j} = PD_{c,s}^{t-1,j} * Stock\ of\ performing\ loans_{c,s}^{t-1,j}$$

$$Stock\ of\ non\_performing\ loans_{c,s}^{t,j} = New\ non\_performing\ loans_{c,s}^{t,j} + Stock\ of\ non\_performing\ loans_{c,s}^{t-1,j}$$

127. The stock of provisions **for existing performing exposures** is determined by the stock of existing performing exposures, the 12-months-ahead projected probability of default and the loss given default for performing loans.

$$Stock\ of\ provisions\ performing_{c,s}^{t,j} = PD_{c,s}^{t,j} * LGD_{c,s}^{t,j,performing} * Stock\ of\ performing\ loans_{c,s}^{t,j}$$

128. The stock of provisions **for newly non-performing exposures** is determined by the stock of existing performing exposures, the 12-months-ahead projected probability of default and the loss given default for non-performing loans.

$$Provisions\ newly\ non-performing_{c,s}^{t,j} = LGD_{c,s}^{t,j,non-performing} * New\ non\_performing\ loans_{c,s}^{t,j}$$

129. The stock of provisions **for existing non-performing exposures** is the maximum between the stock of provisions for non-performing loans in the previous year (t-1) and the lifetime loss estimate of the existing stock of non-performing exposures from the previous year (t-1).

$$Stock\ of\ provisions\ non_{performing}{}_{c,s}^{t,j} = MAX(Stock\ of\ provisions\ non\_performing_{c,s}^{t-1,j}, Stock\ of\ non\_performing\ loans_{c,s}^{t-1,j} * LTLR_{c,s}^{t,j})$$

Probabilities of default

130. The projection of probabilities of default (PDs) for non-financial corporations (NFCs) is based on the ECB top-down, economy-wide climate stress test models. The model is calibrated based on firm-level data for around 3 million firms in the euro area. The dataset is further complemented by counterparty-level information from the Fit for 55 ad hoc data collection to calibrate PDs for firms in other EU, non-euro-area countries. Balance sheet items of individual NFCs are projected forward by incorporating climate risk shocks from the scenarios as exogenous shocks. This section focuses explicitly on the PD model. Further details on the projections of the shocks of PDs and other balance sheet variables can be found in Appendix 2 of Emambakhsh et al. (2023). In what follows, the superscript I denotes the firm, j denotes the bank, t the year ∈ [2023,2030], s the scenario, c the country of the firm and d the (NACE) sector of the firm.

131. PDs for individual firms are derived year by year based on firms' projected profitability and leverage. PD was projected using a logit model which is run for each NFC sector separately, which is specified as:

$$\widehat{PD}_t^{i,s} = \alpha + \beta_1 \widehat{leverage}_t^{i,s} + \beta_2 \widehat{profitability}_t^{i,s} + \epsilon_t^i$$

132. The projections of profitability and leverage incorporate exogenous climate shocks of each scenario, using the equations of the credit risk models of the second ECB top-down, economy-wide climate stress test[69]. Profitability of firms deteriorates in all scenarios due to higher energy prices, driven by the transition and macroeconomic factors, as well as due to higher interest rate expenses on green investments. At the same time, firms raise funds to invest in renewable energies and to reduce their carbon footprint, which increases their leverage. Green investments furthermore raise the amortisation cost of firms' (green) assets, therefore leading to lower profitability.

$$\widehat{Profitability}_{t,s}^{i} = \frac{\widehat{Net\ earnings\ before\ tax}_{t,s}^{l}}{\widehat{Total\ assets}_t^{i,s}}$$

$$= \frac{Revenues_{t,s}^{l} - Operating\ expenses(\widehat{energy\ costs}, financial\ expenses, amortisation\ rates)^{l}_{t,s}}{\widehat{Total\ assets}_{t,s}^{i}}$$

$$\widehat{Leverage}_{t,s}^{l} = \frac{\widehat{Total\ liabilities}_{t,s}^{l}}{\widehat{Total\ assets}_{t,s}^{i}} = \frac{Total\ liabilities(\widehat{green\ investments})_{t,s}^{l}}{\widehat{Total\ assets}_{t,s}^{i}}$$

133. Projected firm-level PDs are aggregated at country-sector level and rescaled to the starting point PDs of banks for the respective country-sectors as reported in the Fit for 55 ad hoc data collection. Based on the distance-to-default methodology of Budnik et al. (2024), Appendix 8.1, the country-sector-level PDs are translated to a distance-to-default measure (DD):

$$DD_{c,d,s}^{t} = \Phi^{-1}(\widehat{PD}_{c,d,s}^{t})$$

$$DD_{c,d,s}^{t_0} = \Phi^{-1}(\widehat{PD}_{c,d,s}^{t_0})$$

Where $\Phi^{-1}(.)$ is the inverse standard normal cumulative distribution function and t0 corresponds to the year 2022.

134. The distance-to-default measures are applied to the reported starting points to tailor the projections to bank-specific PDs. Specifically, the absolute changes in the distance to default $\Delta DD_{c,d,s}^{t} = DD_{c,d,s}^{t} - - DD_{c,d,s}^{t_0}$ are applied to the bank-country-sector-specific starting points to obtain the desired projection path for each bank-country-sector exposure (j, c, s):

$$PD_{c,d,s}^{t,\,j} = \Phi(\Phi^{-1}(PD_{c,d,s}^{t_0,j}) + \Delta DD_{c,d,s}^{t})$$

[69] See Annex A2 in https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op328~2c44ee718e.en.pdf.

Where $PD_{c,d,s}^{t_0,j}$ is the starting point reported by the bank in the Fit for 55 ad hoc data collection.

Loss given default

135. The projection of loss given default (LGD) rates is based on the credit risk methodology of the ECB top-down stress test[70]. We project LGDs for loans collateralised by real estate and loans not collateralised by real estate separately.

i. LGD of loans collateralised by real estate

136. For loan collateralised by real estate, LGDs are reported at the bank-country level and their projections are determined by the evolution of real estate prices in the scenarios. Specifically, the value of real estate collateral of real estate loans towards the NFC sector is aligned with commercial property prices. The loss given default of each bank-country exposure is modelled as a function of the loan-to-value ratio, the probability of cure and the expected sales ratio, as follows:

$$LGD_{c,s}^{t,j} = \left((1 - \text{Probability of cure}) \cdot LGL_{c,s}^{t,j} \right) + AdmCosts$$

Where LGL represents the loss given loss, i.e. the loss given default in case of no cure, and *AdmCosts* is a constant reflecting typical administrative costs of real estate transactions. LGL can be derived from the loan-to-value and the expected sales ratio (E(SR)) upon liquidation, which is defined as the ratio between recovery and collateral value:

$$\text{LGL}_{\text{c,s}}^{\text{t,j}} = MAX\left(\frac{Loan - Recovery\ value}{Loan}, 0 \right) \leftrightarrow$$

$$MAX\left(\left(\frac{Loan - Recovery\ value}{Loan} \Big/ Collateral\ value \right), 0 \right) \leftrightarrow MAX\left(\frac{\text{LTV}_{\text{c,s}}^{\text{t,j}} - \text{E(SR)}}{\text{LTV}_{\text{c,s}}^{\text{t,j}}}, 0 \right).$$[71]

137. In addition, uncertainty around the reported collateral value is accounted for. The collateral may be overvalued, deviating from realised market values, due to outdated valuations or adverse market conditions leading to declines in real estate prices. Under the assumption that the expected sales ratio (E(SR)) is normally distributed, and considering the relation above between the recovery value, the loan-to-value and the expected sales ratio (E(SR)), the E(SR) can be expressed as follows:

$$E(SR)^{t,j}{}_{c,s} = \mu \left[\Phi\left(\frac{LTV_{c,s}^{t,j} - \mu}{\sigma} \right) - \Phi\left(\frac{-\mu}{\sigma} \right) \right] + \frac{\sigma}{\sqrt{2\pi}} \left[e^{-\frac{\mu^2}{2\sigma^2}} - e^{-\frac{\left(LTV_{c,s}^{t,j} - \mu \right)^2}{2\sigma^2}} \right]$$
$$+ LTV_{c,s}^{t,j} \left[1 - \Phi\left(\frac{LTV_{c,s}^{t,j} - \mu}{\sigma} \right) \right]$$

[70] See chapter 3.3.3. in https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op348~6b72fbe3cf.en.pdf?f2edfa4bf1a5fd1e443b386a109f7f24.

[71] The inclusion of the MAX operator is based on the legal framework in most EU countries, where any surplus from selling collateral beyond the defaulted borrower's debt obligation to the bank should be returned to the borrower.

Where LTV denotes the indexed loan-to-value at the point of sale, μ represents the mean of the sales ratio distribution, σ indicates the standard deviation of sales ratio distribution and $\Phi(.)$ denotes the cumulative probability distribution function of the standard normal distribution. The expected sales ratio is bounded between 0 and the loan-to-value.

138. In this approach, parameter mean (μ) has to be found, to thereby let the loss given default fit the observed bank starting point loss given default, conditional on the loan-to-value ratio and sales ratio. For this purpose, a grid combination of probability of cure (or cure rates), loss given default and loan-to-value parameters, derived from previous EU-wide stress test exercises, is used to find the μ and align it with the reported bank starting points.

The projection of loan-to-value ratios is related to the evolution of real estate prices (HP_t) relative to the starting point t0, as follows:

$$LTV_{c,s}^{t,j} = LTV_{t0}^{j}\frac{HP_{t0}}{HP_t} = \frac{LTV_{t0}}{\frac{HP_t}{HP_{t0}}} = \frac{LTV_{t0}}{\frac{HP_{t0}+HP_t-HP_{t0}}{HP_{t0}}} = \frac{LTV_{t0}}{1+\frac{HP_t-HP_{t0}}{HP_{t0}}} = \frac{LTV_{t0}}{1+\Delta HP}$$

ii. LGD of loans not collateralised by real estate

139. The methodology for the projection of LGDs of exposures not collateralised by real estate considers both country-level and bank-level heterogeneity. The credit risk methodology of the ECB top-down stress test[72] used bank-level data from previous EU-wide stress tests to obtain an estimate of the scenario sensitivity of the loss given defaults for NFC loans not collateralised by real estate and financials[73]. The model has the following form:

$$LGD_{c,t} = \beta_0 + \beta_1 GDP\ growth_{c,t} + \beta_2 \Delta UR_{c,t}$$

Where $LGD_{c,t}$ is the loss given default multiple calculated as the ratio of the bank projected LGD over the bank starting point LGD ($\frac{LGD_{scen}}{LGD_{to}}$). The $GDP\ growth_{c,t}$ is the cumulative gross domestic product growth and $\Delta UR_{c,t}$ is the unemployment rate change while the constant is denoted by β_0.[74] For the purpose of the Fit for 55 credit loss calculation, only the LGD sensitivity to GDP is considered because the Fit for 55 scenarios do not include projections for the unemployment rate.

140. The projection of the LGD multiple is then applied in a distance-to-default space to ensure the bank starting point dependency, based on the credit risk methodology of the ECB top-down stress test[75]. The country-level LGDs are translated into a distance-to-default measure (DD):

[72] See chapter 3.3.3. in https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op348~6b72fbe3cf.en.pdf?f2edfa4bf1a5fd1e443b386a109f7f24.
[73] In the original paper, they obtain estimates for the following three portfolios: consumer credits, loans to non-financial corporate not collateralized by real estate and loans to financial institutions.
[74] Other macroeconomic variables were excluded from the regression analyses since they were not significant.
[75] See Appendix 8.1. in https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op348~6b72fbe3cf.en.pdf?f2edfa4bf1a5fd1e443b386a109f7f24.

$$DD^{t}_{c,d,s} = \Phi^{-1}(\widehat{LGD}^{t}_{c,s})$$

$$DD^{t_0}_{c,d,s} = \Phi^{-1}(\widehat{LGD}^{t_0}_{c,s})$$

Where $\Phi^{-1}(.)$ is the inverse standard normal cumulative distribution function and t0 corresponds to the year 2022.

141. The distance-to-default measures are applied to the bank-specific starting points. Specifically, the absolute changes in the distance to default $\Delta DD^{t}_{c,s} = DD^{t}_{c,s} - - DD^{t_0}_{c,s}$ are applied to the bank-country-sector-specific starting points to obtain the desired projection path for each bank-country-sector exposure (j, c, s):

$$LGD^{t,\ j}_{c,d,s} = \Phi(\Phi^{-1}(LGD^{t_0,j}_{c,d,s}) + \Delta DD^{t}_{c,s})$$

Where $LGD^{t_0,j}_{c,d,s}$ is the starting point reported by the bank in the Fit for 55 ad hoc data collection.

Lifetime loss rates

142. The projection of lifetime loss rates (LTLR) is based on the methodology of Budnik et al. (2024), chapter 3.3.4. LTLRs are used for existing non-performing exposures (i.e. exposures that start and end as non-performing in a given year). Due to the 'no cure' constraint, non-performing exposures cannot migrate to another stage.

143. The LTLR parameters rely on the estimates of the expected cumulative credit loss (ECCL). The latter is calculated according to the following formula:

$$ECCL_{(t,M)} = \sum_{s=t+1}^{M} EAD_s \times (LGD_s \times (EAD_s/100)) \times TP_s$$

Where EAD_s is the exposure at default at time s, LGD_s is the point-in-time loss given default at time s, M is the maturity of the portfolio and $t \in [2023, 2030]$ is the time as the calculations are repeated for different years in the scenario. The term $({}^{EAD_s}/_{100})$ refers to the decay factor for LGD_s. LGD_s is assumed to decay at the same pace as the exposure at default, to reflect the fact that the loan-to-value decreases in line with the amortisation of the exposure. The last term in the formula (TP_s) is the marginal, or conditional, probability of migrating to stage 3.

144. The decay factor assumes that the exposure at default (EAD) falls linearly after the initial eight-year scenario. Starting from year nine, the portfolio goes down over its residual lifetime along with the normalised formula:

$$EAD_s = \begin{cases} 100\ if\ s \in [1,9] \\ EAD_{s-1} - \dfrac{100}{M + (t-9)}\ if\ 10 \le s \le M \end{cases}$$

Where $EAD_0 = 100$ and M refer to the maturity of the exposure.

145. The marginal probability of migrating to stage 3 TP_s is conditional on survival up to the reference period. It is approximated via the PDs as:

$$TP_s = PD_s \underbrace{\prod_{k=t}^{s-1}(1 - PD_k)}_{\substack{cumulative\ PiT\ survival \\ probability\ at\ time\ (year)k}}$$

Where PD_k is the incremental (unconditional) probability of migrating to stage 3 from the performing exposures (stage 1 and 2). This implies that annual point-in-time expected credit losses are summed up until the residual maturity (M) of the portfolio in question. At each point in time, only the share of the portfolio that has not defaulted in the previous periods is considered for the calculation of the expected losses.

146. Finally, LTLRs are calculated according to the following formula:

$$LRLT_t = \frac{ECL_{(t,M)}}{EAD_0}, \text{ where } EAD_0 = 100.$$

147. In the adverse scenarios, the reversion of $LTLRs$ to the baseline scenario is assumed from year nine (after 2030) onwards.

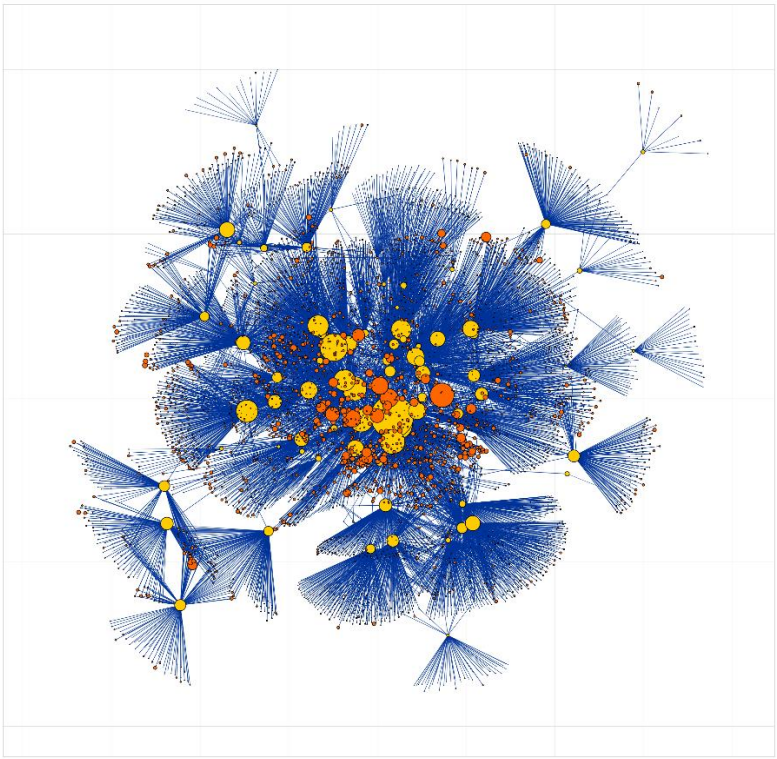
Further results: concentration of credit risk

148. Within all individual counterparties considered in the (granular) credit loss calculation, around 6 237 firms comprise 90% of total exposures in the sample (see Figure 58). Out of total firm-level losses, these firms comprise 94% of total credit risk losses. These counterparties are linked to 85 banks in the network below.[76] Most of the counterparties are linked to at most one single bank, revealing little overlap between loan portfolios of banks. Those counterparties linked to several banks (i.e. those nodes positioned in the centre of the network) are at the same time those that register higher relative losses, therefore indicating a certain degree of concentration in banks' portfolios.

Figure 58: Network of counterparty-level credit losses between 2023 and 2030 in the second adverse scenario

(yellow nodes: banks; orange nodes: counterparties; width of edges: log-exposures between respective bank and counterparty; size of nodes: losses relative to total counterparty losses)

[76] Only counterparties with a reported ID were considered in the calculations in order to be able to capture the interconnection of banks and counterparties within the network.



Notes: Top counterparties of banks, comprising 90% of total counterparty exposures and with a reported ID, plotted. Average number of edges for banks: 104. Average number of edges for counterparties: 1.4.

Appendix II: Market risk methodology

149. Market risk losses are generated by applying the financial shocks provided in the scenario to the fair value of the instruments at the starting point. Data on holdings of financial instruments by banks was gathered by the EBA through an ad hoc collection exercise, while holdings by investment funds were retrieved from a commercial database. For insurers and IORPs, internal supervisory reporting data was used for the application of the shocks. Finally, the cross-sectoral analysis benefits both from regulatory reporting and commercial data.

150. For all three sectors an instantaneous shock approach is applied, together with a static balance sheet assumption. In the case of banks, hedges for equities and bonds are also considered, based on estimates obtained from the EBA's internal data. In the next sections, the methodological approaches for calculating market risk losses are explained in detail, distinguishing between the different asset classes in the market risk scope.

Market risk losses for banks

151. Market risk losses for equity, corporate bonds and funds are computed based on the counterparty-level data submitted by banks as part of the Fit for 55 ad hoc data collection and the shocks provided for the different scenarios. For these asset classes, the top counterparty-level information is used to proxy the country-sector distribution of aggregate exposures.[77]

152. In the specific case of equities, fair value shocks are provided by country and by sector in the scenarios and thus assigned to each counterparty based on its geographical and sectoral allocation. For each bank, average fair value haircuts by sector, weighted by fair value, are computed for the three scenarios. These average sector-specific fair value drops are then applied to the fair values of equities at sectoral level, collected for each bank in the template for aggregated exposures.[78] This allows losses to be obtained for equities, under the three scenarios, for each bank. Losses for equities are mitigated by hedges, estimated by the EBA using internal data.

153. A similar approach is followed in the case of corporate bonds, relying on the swap rate and corporate credit spread shocks provided for the different scenarios. For each counterparty, the swap shocks for the different scenarios are assigned based on the country and the residual

[77] In the Fit for 55 ad hoc data collection, banks were asked to report exposures to market risk in two ways: (1) aggregated exposures at sector level, and (2) individual exposures to their top 15 counterparties in each NACE 2 sector. To calculate market risk losses for equity, corporate bonds and funds, sector-specific average fair value drops are computed starting from the counterparty-level template and then combined with the sector-level data collected for each bank in the template for aggregate exposures.

[78] In the template for aggregated exposures, data is collected at sectoral level, with no information regarding the countries included in each sectoral cluster. Computing sector-specific average fair value drops starting from the counterparty-level template allows consideration of the geographical location of the counterparty too.

maturity, while country average corporate credit spread shocks for the different scenarios are assigned based on the sector and the country. For each bank, average swap and corporate credit spread shocks by sector, weighted by fair value, are computed for the three scenarios. These sector-specific average swap and corporate credit spread shocks are then combined with the sector-level data collected for each bank in the template for aggregated exposures. More precisely, for each bank the swap and corporate credit spread shocks are summed and then multiplied by the average duration. Losses for corporate bonds are mitigated by hedges, estimated by the EBA using internal data.

154. In the case of funds, losses are computed starting from the fair values at fund level submitted by banks and applying fund-specific fair value shocks for the different scenarios. These estimates are determined by ESMA leveraging a look-through approach, which covers about 13% of the aggregate fund exposures. Average fair value shocks, for the three different scenarios, are then calculated for each bank and for the entire sample from the fund-specific fair value shocks identified with the look-through approach. The sample average is used to fill data gaps and provide a fair value shock also for banks' fund holdings that are not covered by the look-through approach. The average fund fair value shocks are thus applied to the aggregate data.

155. Losses for government bonds and loans are calculated by applying haircuts, by country and maturity buckets, to EBA supervisory data (COREP C.33). More precisely, fair value haircuts, by country and maturity buckets, are estimated by repricing all outstanding government bonds[79] with the shocks provided in the Fit for 55 scenarios. This allows computation of bond-specific losses considering their actual duration and convexity. The aggregation of these losses, by country and maturity, provides the fair value haircuts ultimately applied to starting point exposures from COREP. Losses on government bonds are mitigated by hedging positions, estimated by the EBA using internal data.

Market risk losses for insurers and IORPs

156. Shocks to fixed income assets are prescribed in terms of change in yields (in basis points, bps) with respect to the baseline. The shock is applied to the $Reported\ value$ under Solvency II / market value under IORP II of fixed income assets, taking into account the combined effect of the change in yields and of the change in the risk-free rate (RFR) derived from the shocks to swap rates for different currencies. When the shocks to fixed income assets are provided as shocks to spreads, the aggregate shock (to yields in basis points) is derived as follows:

$(i)\ YieldShock_{government} = SwapShock_{currency,maturity} + SpreadShock_{country,maturity}.$

$(ii)\ YieldShock_{corporate} = SwapShock_{currency,maturity} + SpreadShock_{country,CQS,NACE}.$

157. The application of the shocks is in line with the technical documentation of the EIOPA methodology for insurance and IORP stress testing. The $New\ value$ market value for each bond

[79] Source: Bloomberg.

after the application of the aggregate shock to yield is calculated according to the following formula where i denotes $government$ or $corporate$:

$$New\ value = Reported\ value \times (1 - \frac{Duration \times \frac{YieldShock_i\ (in\ bps)}{100}}{100})$$

158. This is an estimation of the impact on the market value of a given bond. As detailed data on cash flows per bond is not available, new market values are approximated via the formula above using the bonds' modified $Duration$ as reported for (re)insurers/IORPs. An underlying assumption is thereby linearity of the price impacts, which is a simplification of the actual, convex relation. The estimated price impacts might therefore overestimate the impact of a yield shock on the market value of a bond. Furthermore, the data does not detail whether a bond has a floating rate or a fixed coupon. All bonds are treated as having a fixed coupon, which might overestimate the impact of the yield shocks on a floating-rate bond's market value.

159. The data on (re)insurers'/IORPs' direct holdings in government bonds stems from the Solvency II/[IORP II Quantitative Reporting Templates (QRTs), in particular template S.06.02/PF.06.02 which lists (re)insurers'/[IORPs' asset-level holdings. The data comprises all bonds reported under Complementary Identification Code (CIC) 1. Government bond spread shocks are provided per issuer country and maturity bucket. For government bonds issued by supranational entities or central banks no additional government bond spread shock will be applied on top of the swap shock.

160. The data on (re)insurers'/IORPs' direct holdings in corporate bonds stems from the Solvency II / IORP II Quantitative Reporting Templates (QRTs), in particular template S.06.02/PF.06.02 which lists (re)insurers'/IORPs' asset-level holdings. The data comprises all corporate bonds reported under CIC 2[80]. The reported CQS for (re)insurers is used wherever available. Where the CQS is not available, the reported external rating is considered. The remaining unrated holdings are assigned to the corporate credit spread shock for CQS 3 holdings. For IORPs, CQS are not part of the reporting template. To enhance the IORP data with CQS, holdings were mapped to the (re)insurers' data by ISIN (covering approximately 53% of IORPs' corporate bond holdings). Holdings that remained after the CQS enrichment were assigned to the corporate credit spread shock for CQS 3-rated holdings. As there is no separate corporate credit spread shock for CQS 0, the shock for CQS 1 to 2 was applied to relevant holdings. The reported information on NACE sectors has been enriched with CSDB data to improve data coverage and consistency. As there was no separate corporate credit spread shock for financial issuers (NACE sector K), the shock for NACE code 'Other' has been applied. Shocks to structured notes and collateralised securities have been applied in line with the shocks to corporate bonds.

161. The shocks for equities have been applied to the Solvency II / IORP II market value of the equity at the reference date (also from the S.06 templates). Equities listed in geographical areas

[80] There is no separate shock for covered bonds (CIC 26, 27), thus the same treatment as for corporate bonds applies.

whose shocks were not prescribed have been shocked using the 'Other' category. Stock indices have been treated according to geographical criteria and NACE sector. The Solvency II / IORP II value of an unlisted equity at the reference date has been recalculated by applying the percentage change in the listed equity prices per geographical area and NACE sector according to the geographical area where the parent company of the issuing entity is located. The same treatment prescribed for the listed company applies. Own shares (held directly) and holdings in related undertakings, including participations, have been treated in principle as listed equities with shocks based on their NACE sector and geographical area. However, as most of the participations fit in the K sector (financial) for which shocks were not provided in the scenario, the shocks to the 'Other' category have been considered.

162. For the application of the shocks to CIUs, the Solvency II and IORP reporting was the main source of information on assets underlying investment funds given in S.06.03 and PF.06.03, respectively, the so-called look-through template. Considering that this template is much less granular than the asset-by-asset template, it is necessary to recognise that, for the assets in the look-through, no sector information is given, and no duration information is available on bonds. Therefore, the assets have been shocked with aggregate less granular shocks as described in the table below.

Table 3: Categories per shocks from the ESRB

	CIC (sub-)categories included	
Sovereign bonds	-	LT underlying asset category 1 – Government bonds
	-	For CIUs where LT not available: CIC 42 – Debt funds
Corporate bonds	-	LT underlying asset category 2 – Corporate bonds
	-	LT underlying asset category 5 – Structured notes
	-	LT underlying asset category 6 – Collateralised securities
Equity	-	LT underlying asset category 3L – Listed equity
	-	LT underlying asset category 3X – Unlisted equity
	-	For CIUs where LT not available: CIC 41 – Equity funds
	-	For CIUs where LT not available: CIC 44 – Asset allocation funds

Note: LT stands for look-through.

Market risk losses for investment funds

163. As in the case of entities in the banking and insurance sectors, first-round impacts on investment funds are calculated on the basis of the price shocks provided in the scenarios by country and economic sector. Where gaps exist in the data, e.g. if the country of issuance of a given financial instrument is not available, a value is assigned by taking the average value of a given shock at a broader level of categorisation where available, e.g. at the level of international regions. Similarly, if the NACE 2 sector of a financial instrument is unavailable, a

shock value is assigned based on the relevant average shock at NACE 1 level for the given scenario.

164. These shock values are then applied to market prices of equity, corporate bond and government bond holdings to calculate direct static effects (i.e. the effects on the values of direct holdings of assets in scope, assuming a static balance sheet). In particular, the impact on bond values due to a given shock to yields is calculated using the same methodology as described in the previous subsection. Bond prices are thus assumed to vary linearly with changes in spread, with a constant duration multiplier, and convexity is not taken into account.

165. The raw portfolio data is a snapshot at end-2022, though some reported position values date from before this point. The data was cleaned by removing duplicates and funds with reported position values older than 2022. To account for outliers, fund portfolio positions with a value of EUR 50 billion were removed, following manual inspection that indicated the values in question were attributable to currency conversion errors. An additional simplification is that negative positive values – representing physical short positions – were also removed. Short positions in equities represent less than 1% of the total net value of equity holdings in the dataset.

166. Following calculation of direct static effects, indirect static effects are calculated via iteration, as follows. First, define S1 to be the set of funds that hold direct equities only, for which direct static effects are first calculated. Then define S2 to be the set of funds that hold shares in funds in S1 and otherwise only directly hold equities. Given the updated valuation of funds in S1, static effects in S2 can be calculated, and so on at higher levels.

Market risk losses for the cross-sectoral analysis

167. The analysis performed in the cross-sectoral chapter considers first and second-round losses in the market portfolio of banks, insurers and investment funds. Calculations are based on a highly granular data structure, which builds on ECB internal data (stemming from, for instance, regulatory reporting) and commercial data. Specifically, for each sector included in the analysis a different database is used to collect portfolio information at ISIN-level for bonds, stocks and fund shares. Bank data is extracted from the Securities Holding Statistics (SHS) data at group level (SHS-G), while insurance corporations' portfolio data is derived from SHS data at security level, clustered into country-sector buckets (SHS-S) that are matched with Solvency II balance sheet information at country level. Finally, Lipper IM is the commercial provider for collecting open-ended funds' portfolio data at security level. The complex data structure behind the ISA model allows these diverse sources of information to be matched into one network of direct exposures.

168. First-round market losses are computed in a similar fashion to the one in the sector-specific chapters, but always building on security-level information. The approach used to determine the stressed price of each security depends on the specific instrument to be stressed. In the case of stocks, a full revaluation of the price is computed: given e_t the price of stock *e* at time *t*, its stressed price in time $t+1$ is defined as:

$$e_{t+1} = e_t * (1 + \frac{s_{country,sector,scen}}{100}),$$

where the shock $s_{country,sector,scen}$ is based on each scenario (*scen*). The data model performs an appropriate matching between individual securities and the corresponding country-specific/sector-specific shocks under the scenarios. As regards bonds, data on modified durations (*D*) and convexity (*C*) of each security is collected from the Centralised Securities Database (CSDB) and Iboxx, allowing for a partial revaluation of fixed income products that also accounts for second-order sensitivities. As regards government bonds, the security-specific shock to the yield (*y*) is derived from the scenario. Such a value is defined as the sum of the shock to the risk-free rate (*r* – the swap rate in the context of the scenario) and the shock to the spread with respect to the risk-free rate (*p*) via the following formula:

$$\Delta y_{m,country,scen} = \frac{\Delta r_{m,curr,scen} + \Delta p_{m,country,scen}}{10{,}000},$$

where *m* stands for the specific tenor of the bond, and *curr* and *country* refer to the currency and the geography of the security, respectively. Given the shock to the yield above, the shock to the bond price (*b*) is approximated as:

$$\Delta b_{m,country,scen} = b_t \left[-\Delta y_{m,country,scen} * D_b + \frac{1}{2} \left(\Delta y_{m,country,scen} \right)^2 * C_b \right].$$

Finally, the revalued bond price under scenario *scen* is:

$$b_{t+1,scen} = b_t + \Delta b_{m,country,scen}.$$

Similarly, the calculation of corporate bonds' revalued fair value requires the extraction from the scenario of the appropriate shock to the yield. Given the shock to the risk-free rate (*r*) and the shock to the spread with respect to the risk-free rate (*p*), the shock to *y* is defined as:

$$\Delta y_{country,sector,ECAI,scen} = \frac{\Delta r_{5,curr,scen} + \Delta p_{5,country,sector,ECAI,scen}}{10{,}000},$$

where *ECAI* and *sector* are the rating step and the NACE sector associated with the bond, respectively. Only the five-year tenor for the risk-free rate shock is considered, which represents the average maturity across corporate bonds. The shock to the corporate bond price (*c*) is computed as:

$$\Delta c_{country,sector,ECAI,scen} = c_t \left[-\Delta y_{country,sector,ECAI,scen} * D_c + \frac{1}{2} \left(\Delta y_{country,sector,ECAI,scen} \right)^2 * C_b \right].$$

The revalued fair value under scenario *scen* is:

$$c_{t+1,scen} = c_t + \Delta c_{country,sector,ECAI,scen}.$$

In order to reprice fund shares, a look-through approach is considered for all the participations referring to funds in the scope of the model.[81]

169. The formulae above apply to all the sectors, although bank losses are considerably buffered by two main mechanisms. First, bonds held to maturity (HtM) imply that banks do not realise losses associated with those securities, hence mitigating the impact of the shocks from the scenario. Second, as also stressed in the banking chapter, derivative hedging plays a crucial role in reducing market portfolio losses for banks.

170. Second-round market risk losses are driven by two main endogenous developments: entity defaults and fire sales. The former case is the least impactful in this analysis and it implies that, following an entity default, all its shares lose all their value, and the holders of their bonds (if any) will suffer the associated loss given default (LGD). The latter situation is what shapes the results of the analysis and relates to the sell-off of securities to face sudden liquidity needs. Such fire sales are performed pro rata across the whole of the portfolio holdings. In this context, the high volumes sold of a security have a strong negative impact on its price, and this is reflected in the portfolios of all the entities holding such a security (see Appendix III.[82] As a consequence of price impacts from fire sales, funds' NAV is also affected and, in turn, insurance corporations suffer to a high degree from such revaluations, given their large exposures to investment funds. In the special case of a bank selling off its assets, the portfolio hedging component is muted, while any held-to-maturity bond sold will suddenly realise all the unrealised losses recognised up to that point in time.

[81] See Section 4.3.3 in Sydow et al. (2024) 'Shock amplification in an interconnected financial system of banks and investment funds'.
[82] As a reference to the mechanism adopted by the ISA model to assess the price impact deriving from fire sales, see Fukker et al. (2022) 'Contagion from market price impact: a price-at-risk perspective'.

Appendix III: Cross-sectoral methodology and further results

Price impact parameter calibration

171. A key variable in determining the scale of the amplification is the 'boundary' parameter of the price impact mechanism,[83] expressing the extent to which a fire sale of a certain security (i.e. a sudden oversupply of volumes) is negatively affecting the price of that security. Since these coefficients are obtained from quantile regressions, each scenario considers a specific quantile of the 'boundary' values associated with it. The quantiles are chosen to match the severity of scenario variable shocks with respect to their historical distribution. More specifically, the 35th, 25th and 15th percentiles are used for scenarios B, A1 and A2, respectively. Note that these percentiles are estimated and applied at the security level, thus the same percentile has been selected across all marginal distributions of the joint price impact distribution whose dimensions are the number of securities. This approach places the model as a corner case of the joint distribution, and, when translated into aggregate effects, the effect is likely to be further in the tail, even after accounting for correlation across securities. Therefore, the selected quantiles lead to more extreme effects compared to the selection of a simple one-dimensional variable.

172. Table 4 illustrates the quantiles derived for the 'boundary' parameters of the price impact mechanism. For each scenario, projections of a diverse set of variables are examined to locate them as a quantile in the historic distribution of quarterly shocks. The variables include the STOXX Europe 600indicator, 1 and 10-year euro swap rates, corporate bond spreads for euro area-based NFCs and for financial corporations, and 10-year government bond spreads. A simple averaging over these variables' historical percentiles is performed to derive a consistent quantile for the price impact boundary. The outcome of this exercise is provided below. Given that the price impact quantile regressions are performed in steps of 5% for the quantiles, each average quantile is associated with the nearest available one.

Table 4: Price impact parameter boundaries across scenarios

Scenario	B	A1	A2
Price impact boundary percentile	32.54	23.96	14.72

Source: ECB calculations.

[83] See Fukker et al. (2022) 'Contagion from market price impact: a price-at-risk perspective'.

Mitigation mechanisms

173. Mitigating mechanisms exist for both banks and insurers, which are embedded in the model. For insurers, the loss-absorbing capacity (LAC) mechanism that has been explained in Box 2of Chapter 2 covering insurers and IORPs is incorporated.[84] Hence, since life insurance contracts may embed profit participation, policyholders bear part of the market risk. The effect of interest rates on the discounting of future cash flows is also considered, given its further impact on the levels of technical provisions of insurers. Hedging is an important component of the business model of banks, but less relevant for insurance corporations, pension funds and investment funds. Hence, this mechanism is included only for the banking sector, in line with the description provided in previous chapters. Banks' hedges for equity and bonds have been provided by the EBA and are considered in the first and second-round loss calculations performed by the ISA model. Additionally, and in line with their corresponding regulation, banks benefit from a specific mechanism for securities held to maturity (HtM). For first-round losses, consistently with the methodology of the standard EBA stress test,[85] the reduction in value of these securities is not realised. Further dynamics depend on liquidity needs, i.e. when banks must engage in fire sales, including of HtM assets, then unrealised losses can partially materialise to the extent that these securities are sold. This approach is consistent with the ad hoc analysis on bank bond holdings run by the EBA in parallel with the 2023 EU-wide stress test.[86]

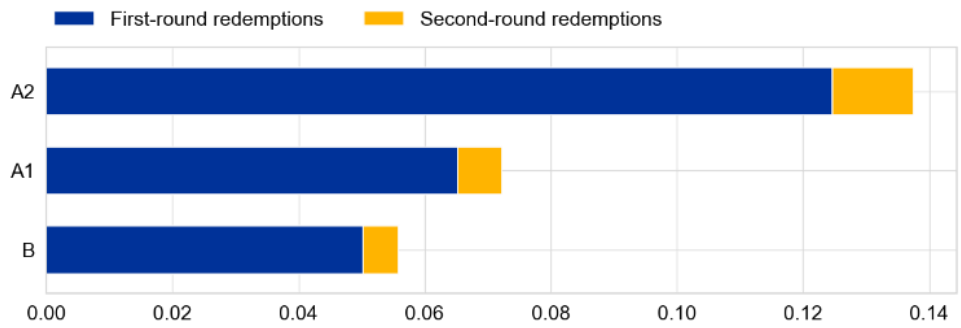
Further results

174. Figure 59 presents the total amount of redemptions in the system, determining the liquidity shock to investment funds stemming from scenario losses and endogenous dynamics. Most of the liquidity stress comes from external investors (not part of the financial institutions in the model) redeeming their fund shares based on the funds' performance.[87] These numbers do not account for potential liquidity management reactions, such as redemption gates, which would have a mitigating effect. The second-round redemptions come from financial institutions within the system, which redeem their shares to meet their own liquidity needs.

[84] See also Sydow et al. (2024) 'Banks and non-banks stressed: liquidity shocks and the mitigating role of insurance companies'.
[85] EBA 2023 EU-Wide Stress Test: Methodological Note.
[86] EBA (2023) 'Ad-hoc analysis of unrealised losses on EU banks' bond holdings'.
[87] The parameters describing this mechanism are obtained from Mirza et al. (2020) 'Fire sales by euro area banks and funds: What is their asset price impact?'.

Figure 59: Decomposition of investment fund redemption volumes across scenarios

(EUR trillion)

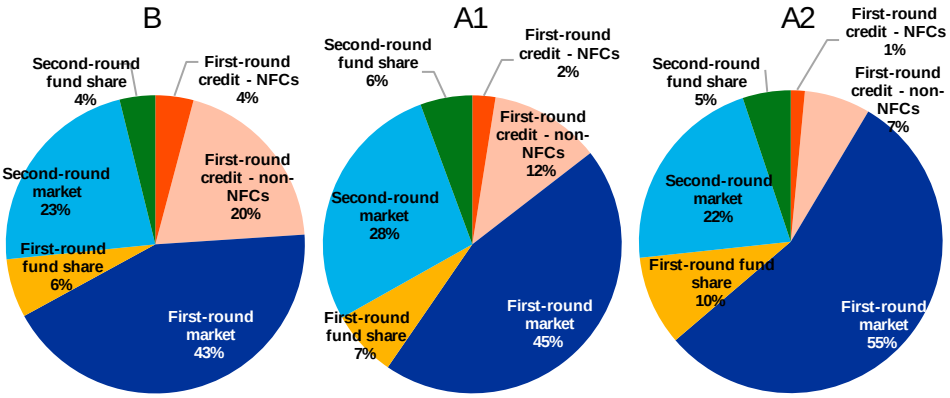


Source: ECB calculations.

175. First and second-round market losses, together with losses on fund shares, account for most of the system losses, ranging between 76% and 91% under scenarios B and A2, respectively. Figure 60 breaks down each scenario by risk type and distinguishes first and second-round losses, to conduct a more comprehensive analysis of the total depletion within the system. In the first round, more than two thirds of the losses are due to market risk and losses on fund shares, with credit risk losses covering the remaining part. Second-round losses stemming from contagion effects are more relevant than first-round credit risk losses under all scenarios, and in particular under the most adverse scenario, where credit risk losses account for 9% of total losses, and second-round losses cover 27%. These differences are less pronounced under the baseline scenario, where 24% of the total losses are generated in the first round by the credit portfolios and the remaining 27% in the second round. The weight of fund share losses generated in the first and second round relative to total losses of the system increases with the severity of the scenarios: starting from 10% of the total under the baseline scenario and peaking at 15% under the most adverse one.

Figure 60: Decomposition of aggregate financial system losses

(percentages)



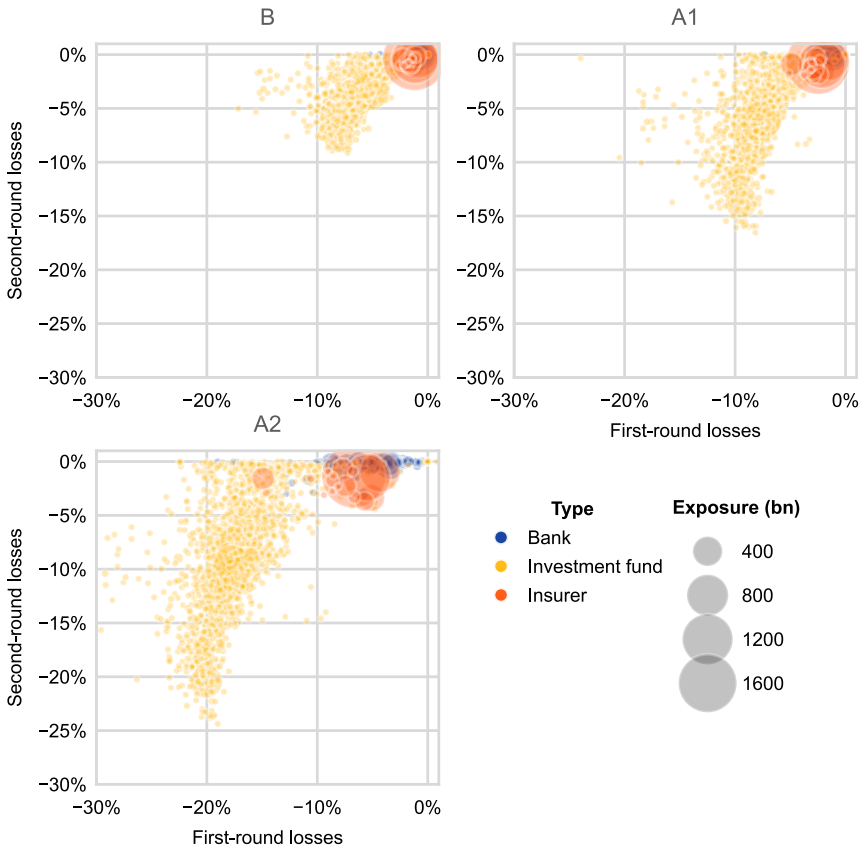
Source: ESAs and ECB calculations.

Note: second-round credit risk losses have been excluded from the figure because they are negligible.

176. The diverse nature of investment funds' portfolios is reflected in a broad distribution of first vs. second-round losses. Figure 61 complements the distribution of losses presented in Figure 57 of Chapter 6, showing the first and second-round losses relative to exposures for all financial institutions under the three Fit for 55 scenarios. A higher degree of heterogeneity for investment funds can be observed already under the baseline scenario, with an even larger dispersion under the second adverse scenario. Three broad categories of impact on financial institutions can be identified: those affected only by first-round losses (along the *x* axis), those shielded in the first round but suffering second-round losses (along the *y* axis), and those that are impacted by both. Such an observation is applicable only to a lesser extent to banks and insurance corporations, which show small first and second-round losses under scenarios B and A1. However, under scenario A2 a greater dispersion can be observed for first-round losses for banks and along both dimensions for insurers.

Figure 61: Scatter plot of first and second-round market losses in the market portfolios by entity

(percentages)



Source: ECB calculations.

Notes: Figures exclude lending and collective investment undertakings. A small number of outlier funds with higher losses are not represented.