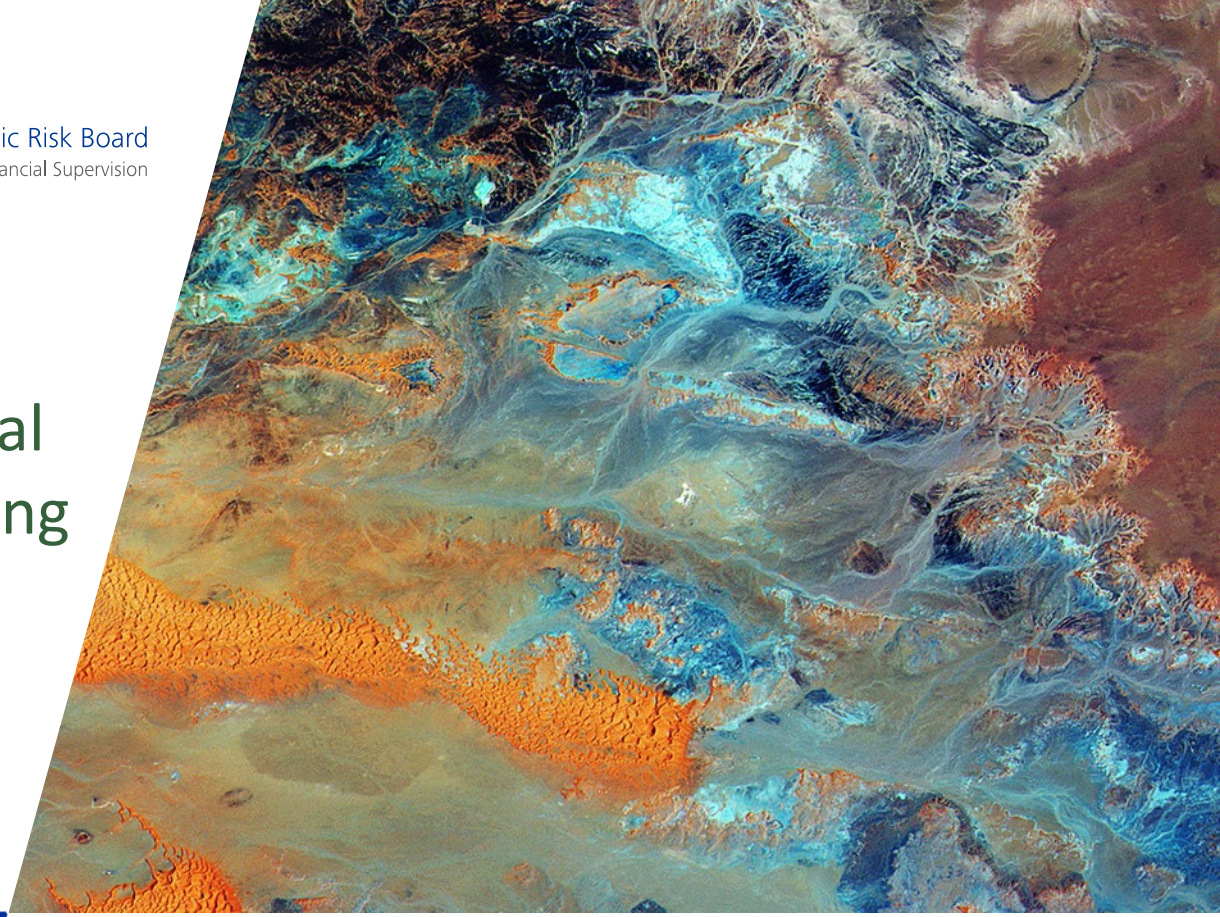
EUROPEAN CENTRAL BANK
EUROSYSTEM

ESRB
European Systemic Risk Board
European System of Financial Supervision

Toward macroprudential frameworks for managing climate risk



SUERF BAFFI Bocconi e-lecture
6 March 2024

Paul Hiebert
European Central Bank
Co-chair, ECB-ESRB Climate Risk Project Team

The ECB/ESRB Project Team on climate risk

2020: How existing data and models could be deployed for climate risk analysis

2021: Filling analytical gaps: physical risk, + longer term scenario analysis

2022: Initial macroprudential policy reflections + broadened analytical foundations

2023: *Frameworks*
(i) climate risk surveillance
(ii) macroprudential policy
(iii) broader nature risk

2024+: Integrate frameworks into standing assessments

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ECB/ESRB Project team on climate risk
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Workstream 2: Policy mapping
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Workstream 3: Environmental considerations
Laura Parisi (ECB)
Julja Prodani (DNB)

EIOPA European Insurance and Occupational Pensions Authority
EBA European Banking Authority
esma European Securities and Markets Authority

Outline

1 | Financial stability surveillance

- Climate shocks, exposures, risk
- Systemic amplifiers

2 | Macroprudential policy options

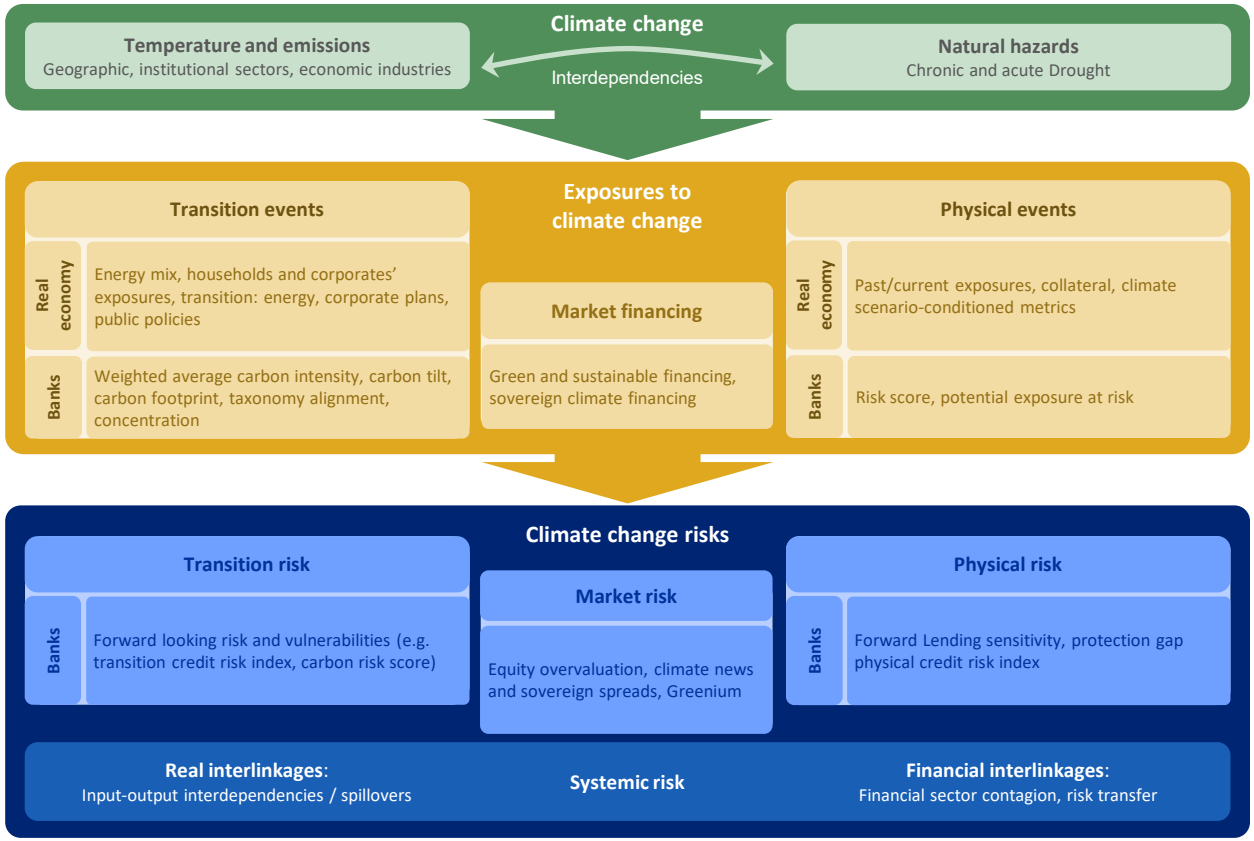
- Strategy
- Implementation

3 | Broader look at nature

- Concepts
- Exposures

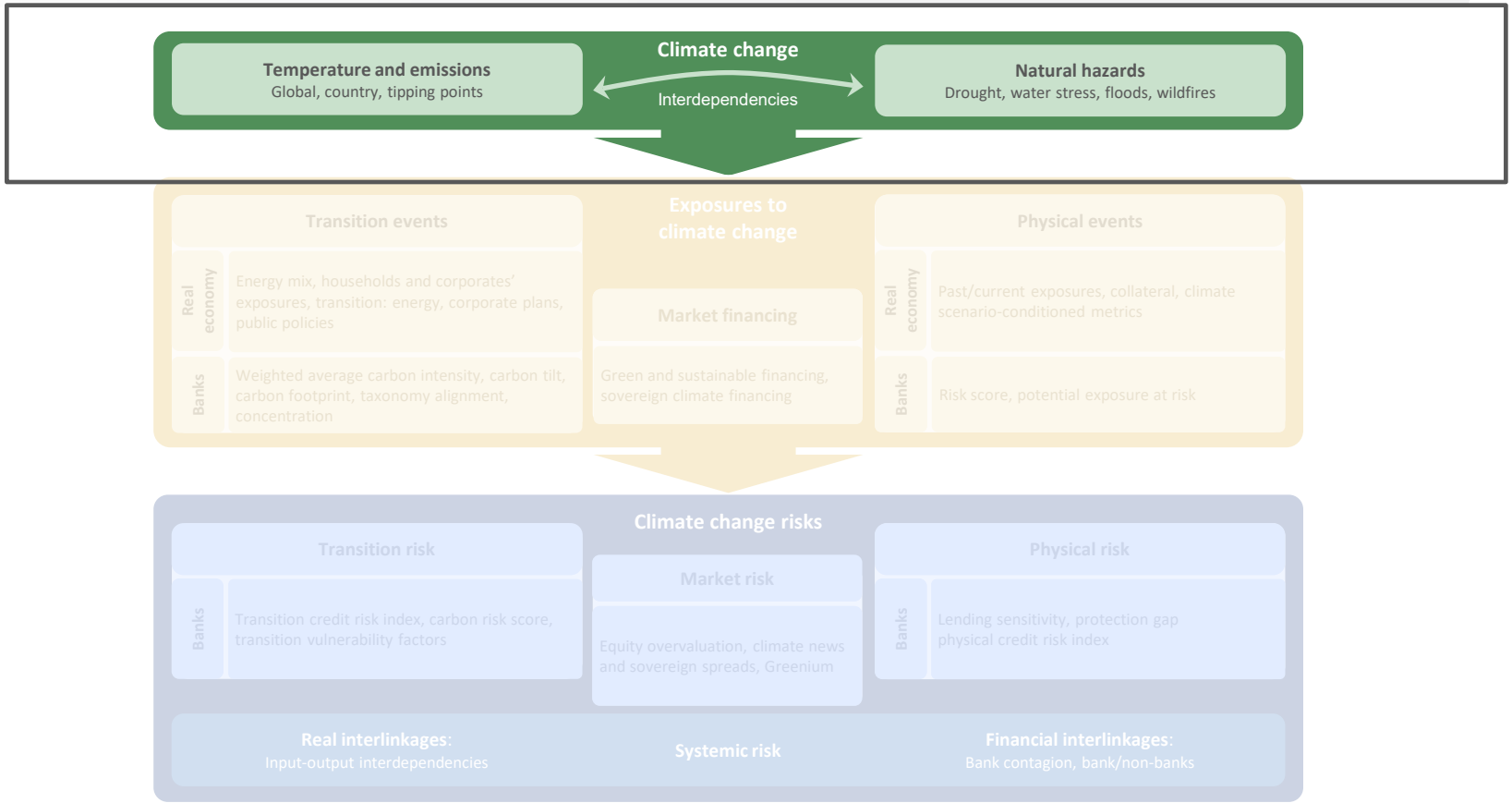
4 | Summary

Surveillance framework for climate-related financial stability risks



ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.

Surveillance framework for climate-related financial stability risks

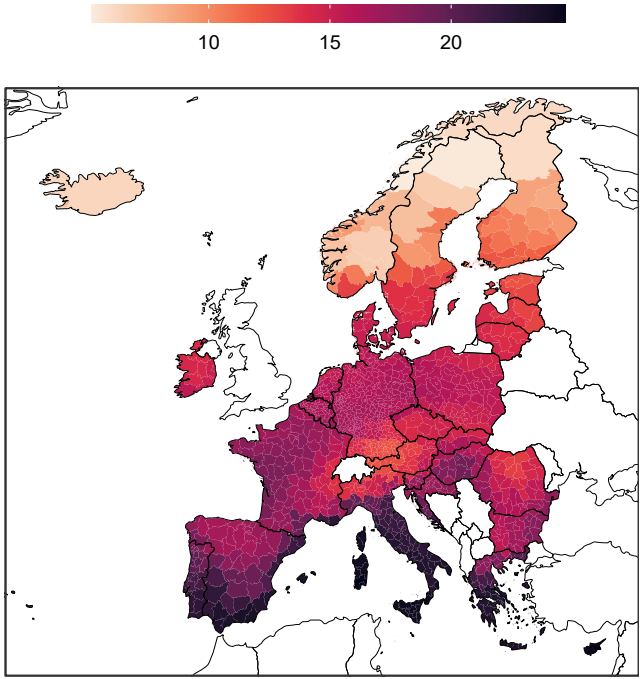


ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.

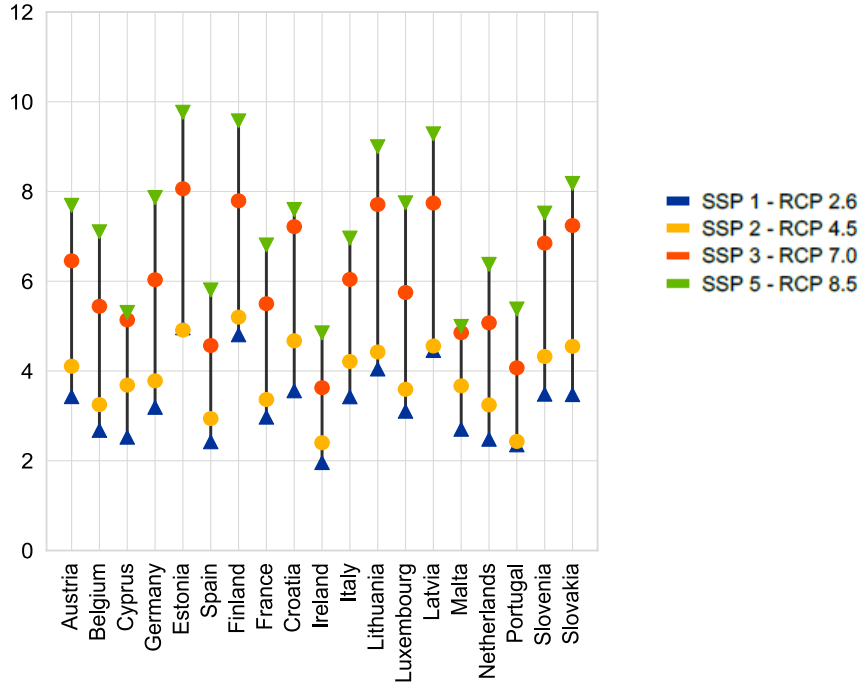
It will get hot in euro area countries, in some cases markedly so

Projected 2100 near-surface air temperature deviations from 1995-2014 average, by EA country and by scenario

(Projected average 2100 near-surface air temperature in °C; SSP 5 -RCP 8.5 scenario)



(Temperature anomaly by country, in °C)

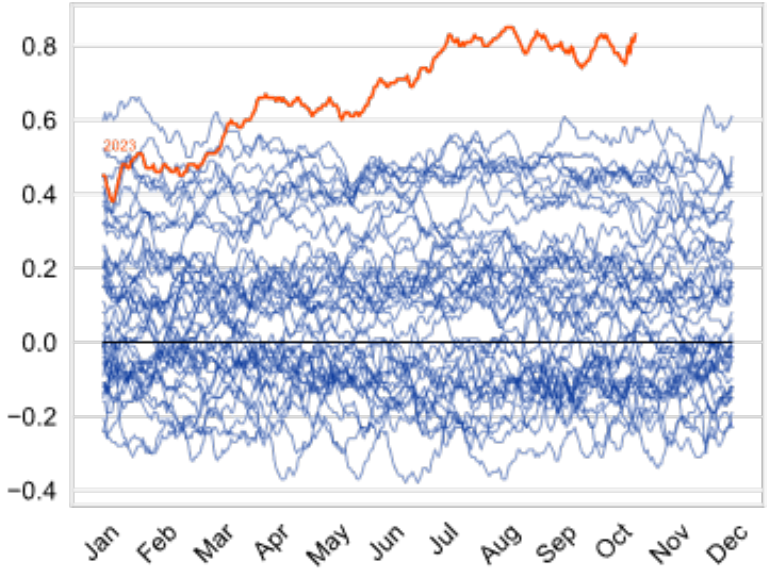


Sources: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk. based on Copernicus Climate Change Service (C3S) Climate Data Store (CDS).
Notes: Panel(a): Projected values from Access-CM2 model. Panel (b): Projected values from Access-CM2 model. Temperature anomaly is calculated as deviation from the average observed during the period 1995-2014.

Chronic, not just acute physical risk, seems to also be accelerating

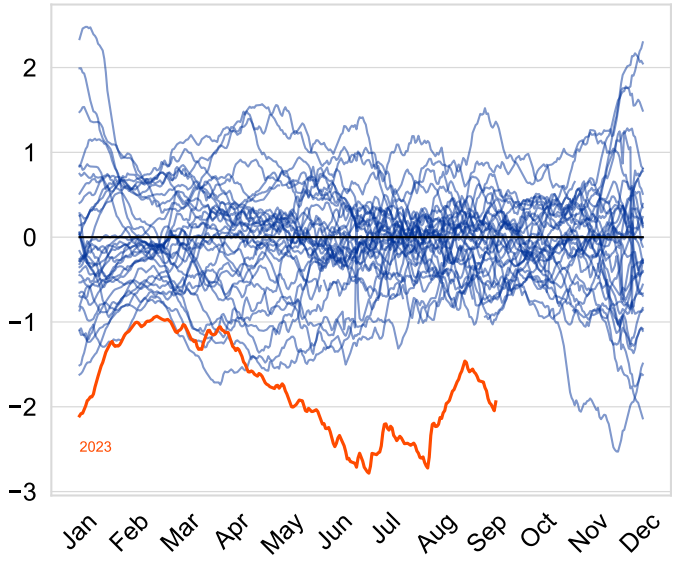
Global sea temperature is rising

Global sea-surface temperature anomaly in °C



Ice extent anomaly

Antarctic Region, (y-axis: Millions of square kilometres)

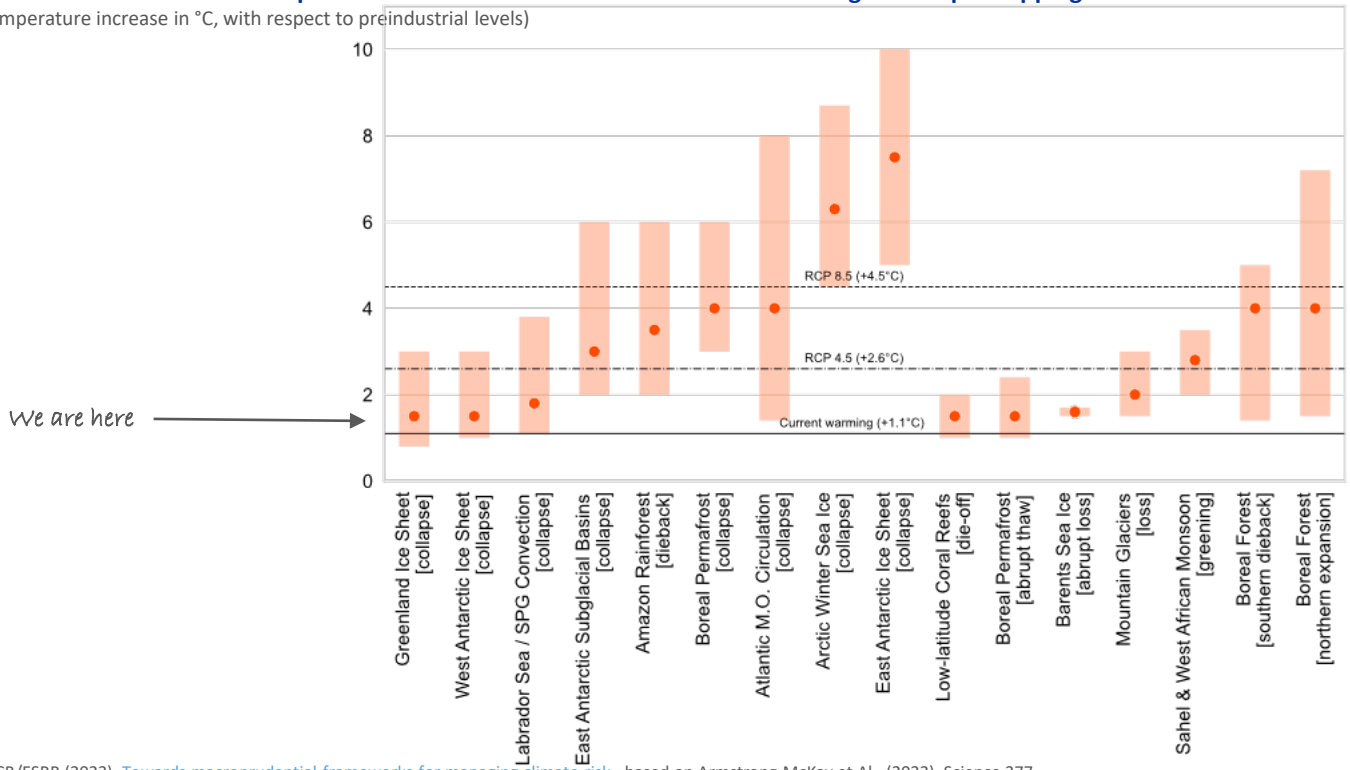


Sources: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk. Panel (a): National Oceanic and Atmospheric Administration (NOAA) via Climate Reanalyzer.org. Panel (b): NASA Earth Data.
Notes: Panel (a): Temperature anomaly is computed as a difference from 1982-2011 mean. Panel (b): Sea level variation is computed with respect to 1995-2015 mean.

We are already reaching tipping point temperature ranges

Literature-based estimates for temperature thresholds related to Global Core and Regional Impact tipping elements

(y-axis: Temperature increase in °C, with respect to preindustrial levels)



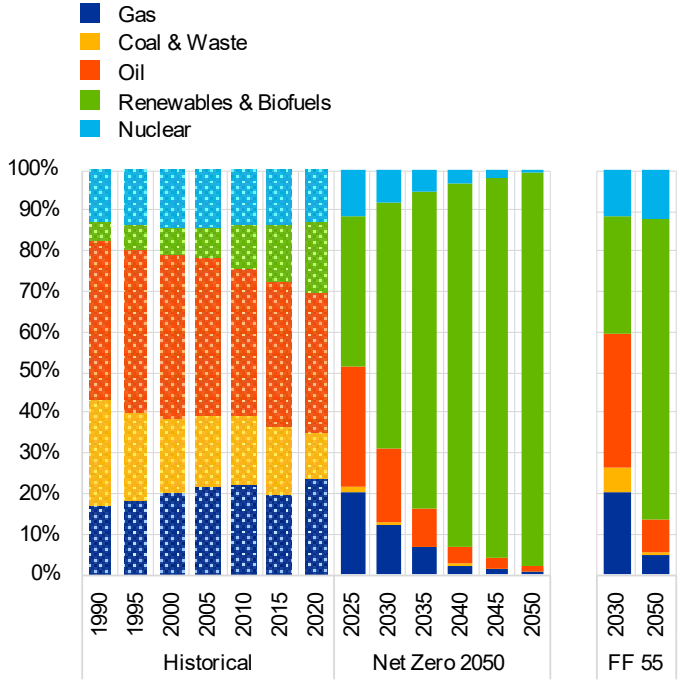
Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk., based on Armstrong McKay et Al., (2022), Science 377.

Notes: Literature-based estimates for temperature thresholds related to Global Core and Regional Impact tipping elements. Climate tipping points (CTPs) occur when change in large parts of the climate system – known as tipping elements – become self-perpetuating beyond a warming threshold. Triggering CTPs leads to significant, policy-relevant impacts, including substantial sea level rise from collapsing ice sheets, dieback of biodiverse biomes such as the Amazon rainforest or warm-water corals, and carbon release from thawing permafrost (Armstrong McKay et al., 2022). See also Dietz, S., Rising, J., Stoerk, T., and Wagner, G. (2021). Economic impacts of tipping points in the climate system (Proceedings of the National Academy of Sciences).

A stark energy transformation lies ahead, with strong country heterogeneity

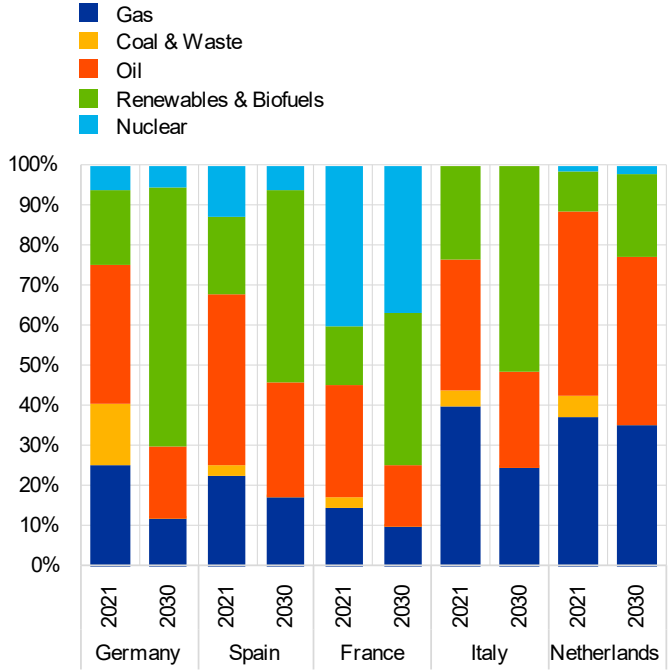
Historical and projected euro area energy mix

(y-axis: % of energy mix)



Historical and projected country-level energy mix

(y-axis: % of energy mix)



Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk, based on Eurostat Energy Balances, NGFS Climate Scenarios and JRC Energy Scenarios Interactive Tool.

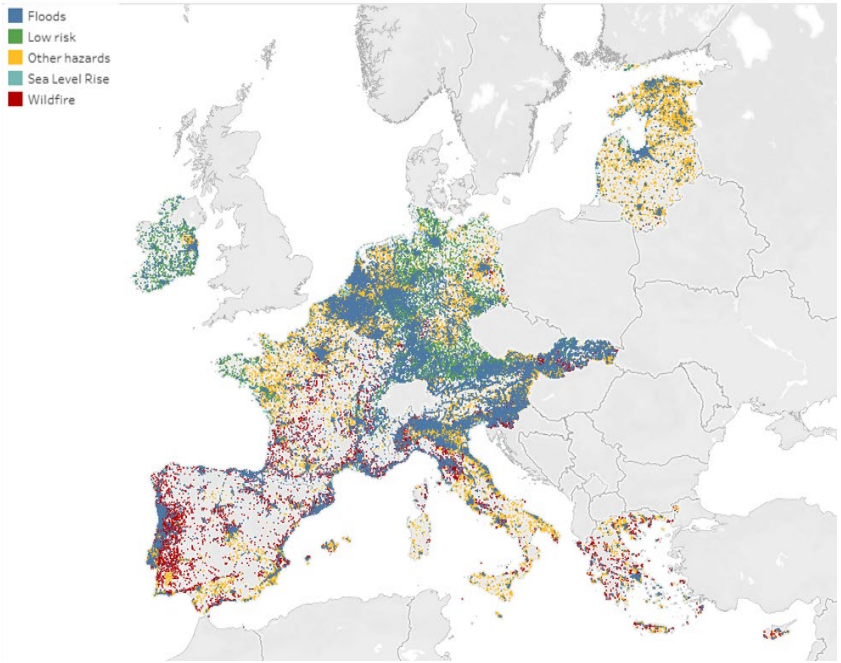
Notes: Panel (a): Projections based on the "Net Zero 2050" scenario from the NGFS. The energy mix compatible with the EU "fit for 55" package (FF 55) is calculated based on the latest projections elaborated by the European Commission and, in particular, on the EU Reference Scenario 2020. Panel (b): Country-level projections based on the "Net Zero 2050" scenario from the NGFS.

Surveillance framework for climate-related financial stability risks

ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.

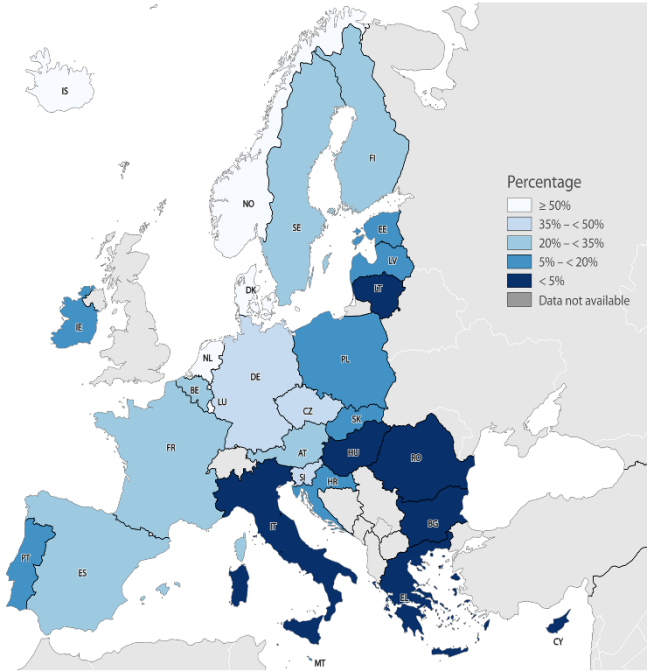
Climate physical risk hazard exposures differ markedly across regions, amid general underinsurance

Mapping firm exposures to physical hazards



Sources ECB/ESRB (2021), Climate-related risk and financial stability based on AnaCredit, 427, ECB calculations. Notes: Physical risk hazard scopes reflect a 20-year horizon.

Share of insured economic losses caused by weather-related events



Source: EIOPA dashboard on insurance protection gap for natural catastrophes, European Environment Agency CATDAT.

Banks remain the key custodian of emissions reductions for firms

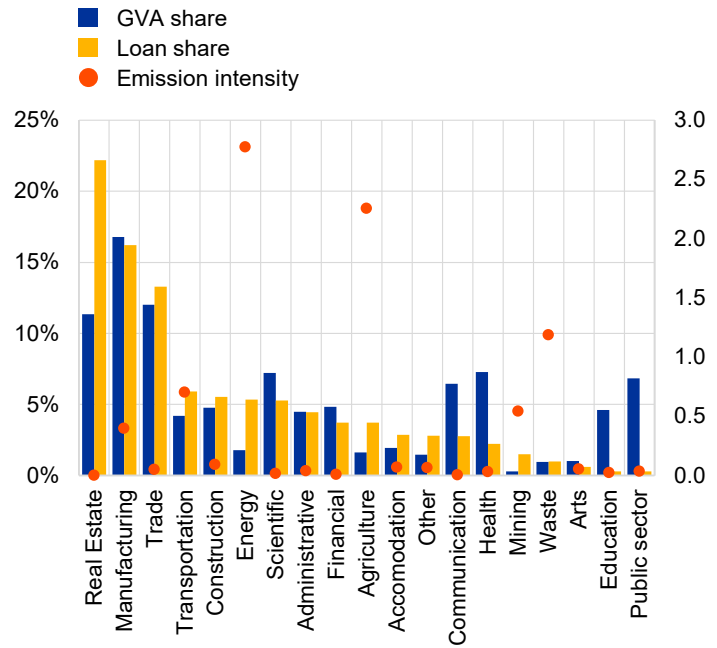
Exposure indicators for financial institutions

Indicator	Key insights
Weighted Average Carbon Intensity (WACI) and Bank Carbon Footprint (BCFP)	Assess exposure of the financial sector to high-emitting firms via loans and debt securities
Carbon-financing tilt	Credit-weighted emission intensity relative to a value-added-weighted emission intensity
Taxonomy alignment	Estimate the level of alignment of financial portfolios to the EU Taxonomy for sustainable activities
Concentrated emission exposures	Share of lending to certain sectors, or using a climate-weighted Herfindahl-Hirschman Index
Exposures to physical hazards: shift in return periods	Shift in return periods of river flooding for banks loan portfolios under different RCPs, in % of number of debtors

Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.
Notes: The list of indicators covers only indicators that are newly presented in this report. For a more comprehensive list of indicators, see separate Chartbook publication.

Euro area banks' lending towards emission-intensive sectors

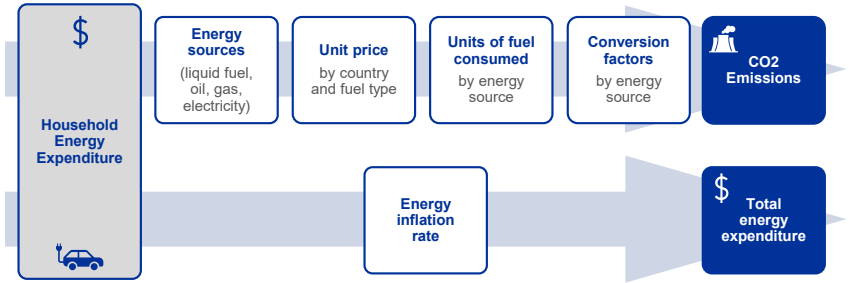
(y-scale: percentage; right-hand scale: Kg CO2e / EUR)



Sources: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk, based on Eurostat, ECB Consolidated Banking Data and ECB calculations.

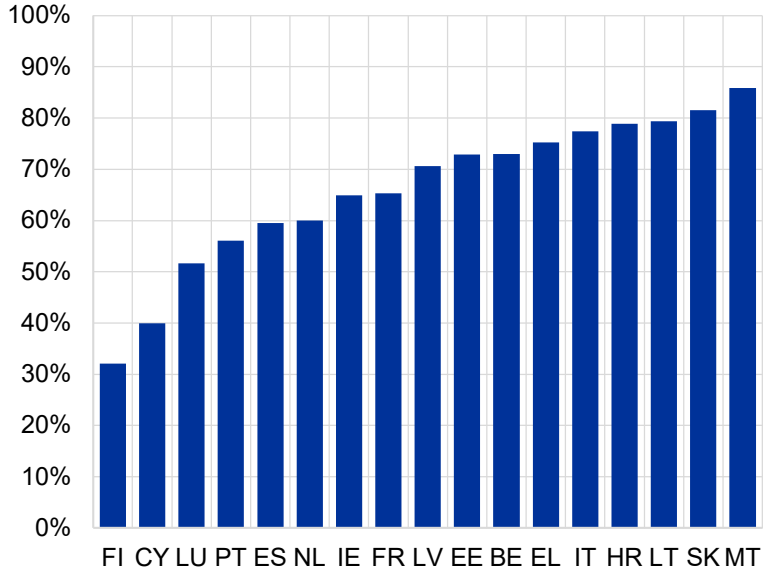
Household mortgage carbon intensity of mortgage finance high, albeit uneven across euro area countries

From household energy expenditure to carbon emissions



Share of high emitting households in outstanding mortgage balances

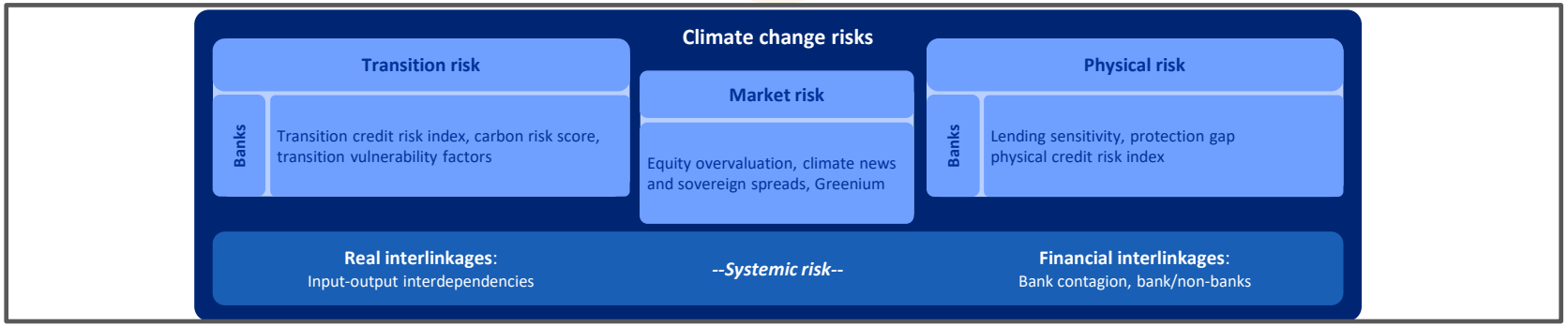
percentages



Sources: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk, based on own calculations using the Household Budget Survey Data 2015 (Eurostat), Statistics on Income and Living Conditions (Eurostat) and the Household Finance and Consumption Survey (ECB).

Notes: Energy expenditure is calculated using HBS fuel expenditures for electricity, gas and liquid fuels (heat and transport). Solid fuels are not considered due to missing data on type (coal, wood, etc.). HBS energy expenditures are converted into emissions using national energy price data (Eurostat and European Commission) and emission factors (Sustainable Energy Authority of Ireland and European Environmental Agency). Energy and emission estimates in HFCS and EU-SILC are based on regression model coefficients using HBS data. The set of covariates are the same for every country except NL, MT, CY and HR, due to data unavailability. High emission households (panel b) are defined based on the top quartile (within each country) of the emission distribution in the HBS 2015.

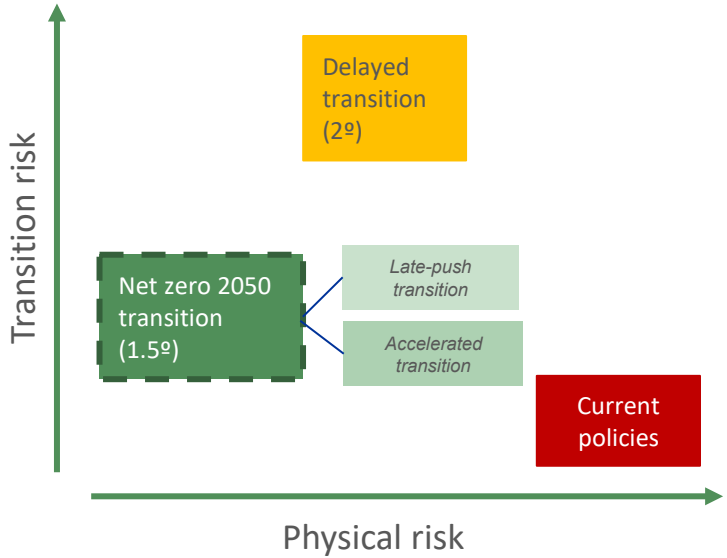
Surveillance framework for climate-related financial stability risks



ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.

Multiple forward looking metrics based on scenarios to understand prospective financial loss

Scenarios draw from Network for Greening the Financial System



- Scenario analyses explore trade-offs between physical and transition risk, and examine possible contours of climate transition
  - *ECB (2021): Top-down climate stress test (banks)*
  - *SSM (2022): Bottom-up climate stress test (banks)*
  - *ECB (2023): Short term transition dynamics (banks)*
  - *ECB/ESRB (2022): System-wide considerations*

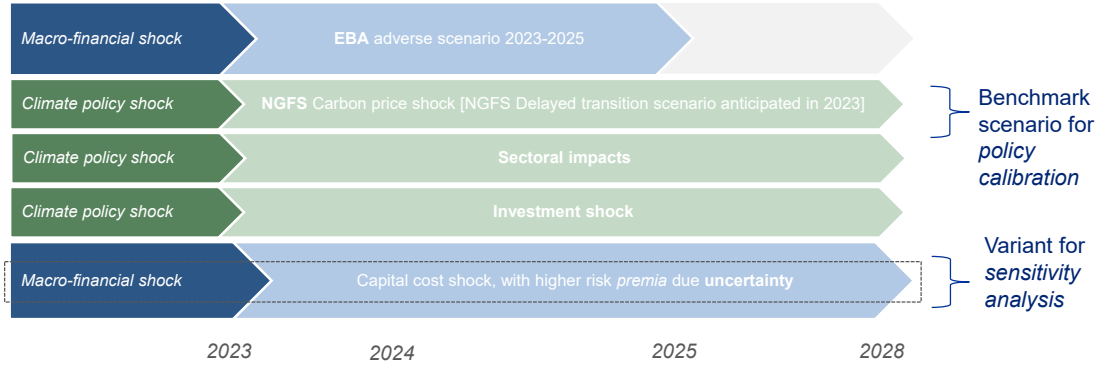
➢ *Results generally confirm that the path to reduced climate risk may be bumpy, with net benefits from climate action only accruing with time, amid strong distributional forces*

Source: ECB.

Focusing in on near(er)-term energy transition, and with it the ability to consider standard stress test

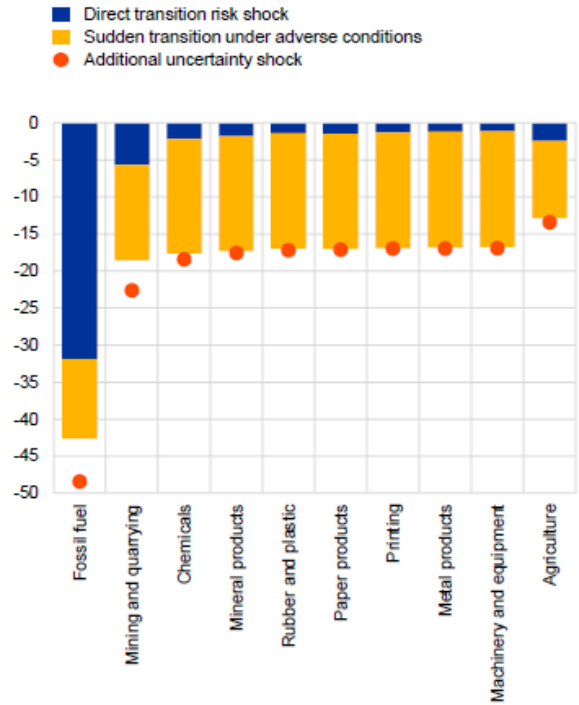
Interacting shocks

Illustrative scenario options



Impact on euro area economic activity

Sectoral gross value added (2027) (percentage, compared to baseline)



Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.

Notes: The two short-term scenarios proposed include a benchmark scenario assuming that the transition happens in a context of adverse macro-financial conditions, with heterogeneous impacts across sectors and requiring massive investments from both public and private sectors, and a second variant that also factors in the impact on the financial markets of the uncertainty associated with the transition. The EBA scenarios stop in 2025. After 2025, macro-financial variables are projected forward with the NGFS Delayed transition anticipated in 2023.

Systemic amplifier #1: Economic spillovers

Input-output linkages amplify physical risks across the globe

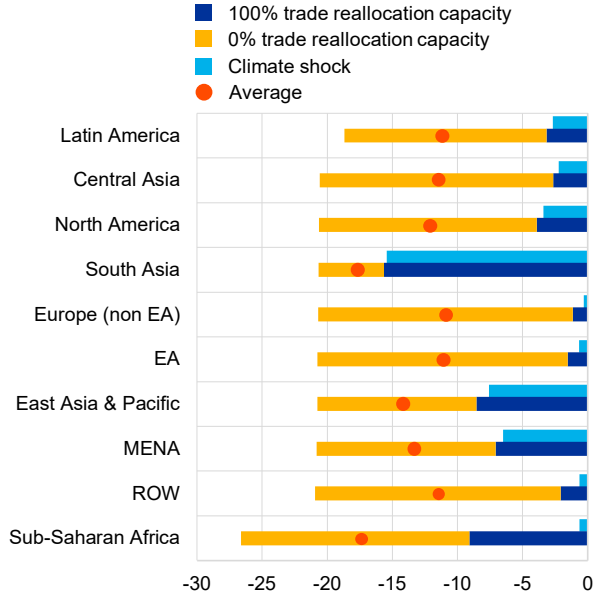
(Regional GDP losses are combined with a global Input-Output model with demand and production shocks (based on Pichler and Farmer, 2022))

S&P Global data: GDP-at-risk from climate change (country-level)

Input-output data (OECD) for 45 sectors and 71 countries

Output losses are amplified but can be mitigated by trade reallocation.

(GDP losses across world regions due to direct climate physical risk and amplified through trade interconnections (GDP changes in pp))



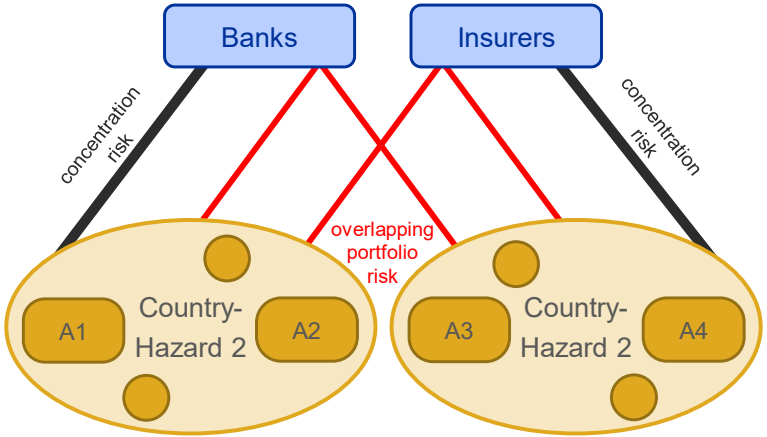
Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk., based on Sources: OECD, SP Global. A Leontief IO model has been extended to allow for supply- and demand shocks.

Notes: The amplified GDP losses through trade interconnection are simulated through an input-output model developed at the ECB. A 100% Trade Reallocation Capacity (in dark blue) implies no cost for reorganising supply chains across trading partners and 0% precludes trade reorganisation. An adverse climate scenario is considered, i.e. RCP 8.5 scenario by 2050 with no adaptation measures and where all country-specific hazards materialise simultaneously across the world

Systemic amplifier #2: Financial contagion

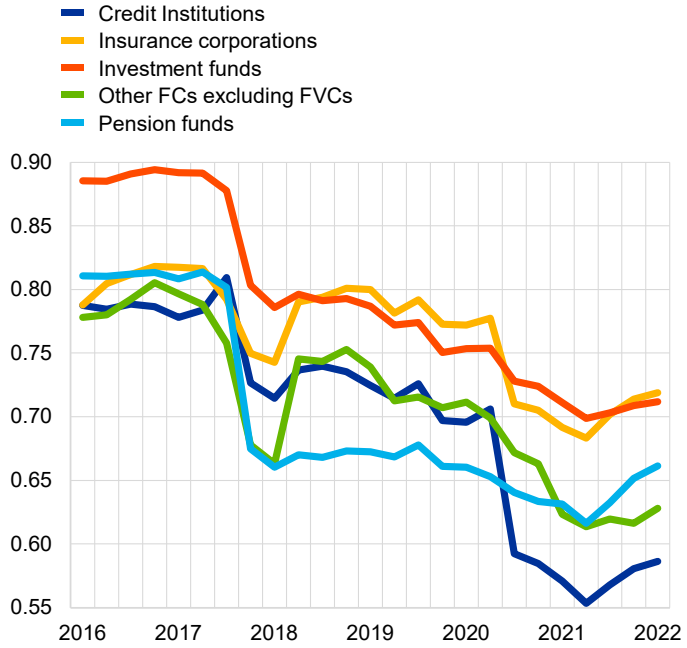
Concentration risk and overlapping portfolio risk

(Systemic risk through overlaps despite individual diversification)



Country-hazard related portfolio similarity across sectors

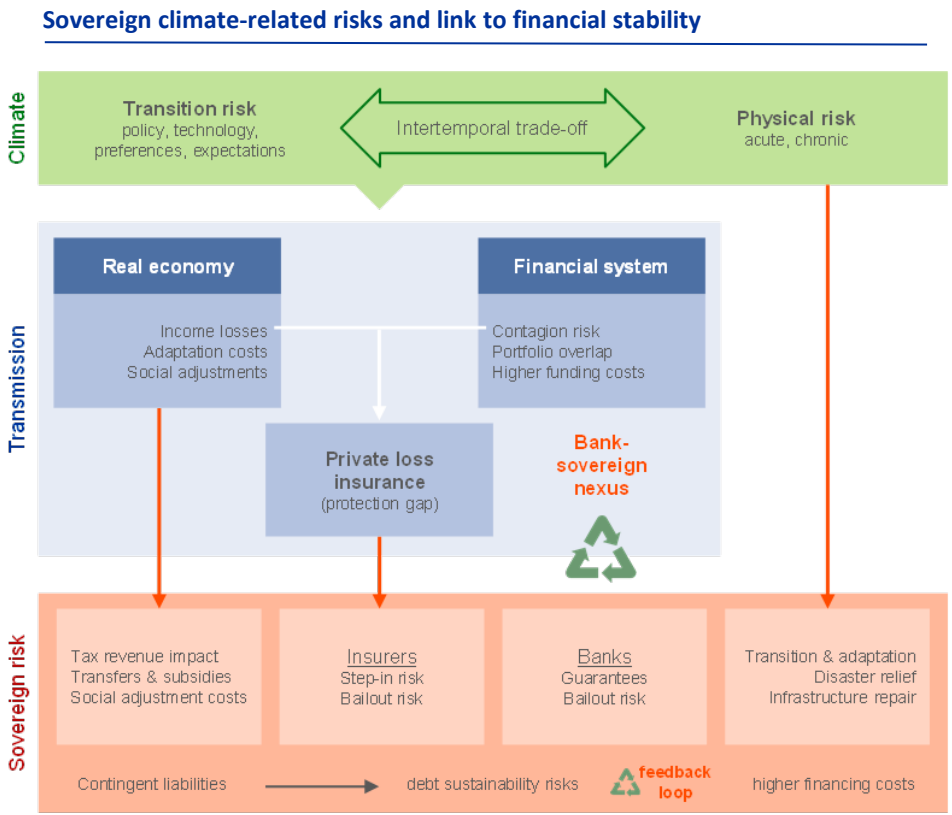
Country-hazard related portfolio similarity across financial sectors (Index; 0 - no portfolio overlap, and 1 - full portfolio similarity)



Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk., based on Sources: SHSS, Moody's, own calculations.

Notes: LHS: A1, A2 etc. represent different assets. The lines between banks and insurers as well as country hazards represent exposures. RHS: The physical risk-weighted portfolio similarity index measures similarity in overlapping portfolios across sectors to capture joint exposures to climate-related risks. More specifically, we calculate the cosine similarity index for each sector with the other sectors and take the average to get an index for each sector. NBFI = non-bank financial intermediaries, IC = insurance corporations, IF = investment funds, PF = pension funds.

Systemic amplifier #3: Risk transfer



ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.

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Why a macroprudential approach to address climate risks?

Classic systemic risk channels

- Spillovers
- Non-linearities
- Interconnections

Climate risks' unique features

- Concentration + correlation of risks
- Irreversibility of climate-related losses
- Unpriced externalities from lending to carbon-intensive entities, and risk build up
- Interaction btw. physical & transition risk

Risk of underestimation / late response

- Uncertainty over scale and timing
- Lack of data and unsuitability of backward-looking historical data
- Endogeneity of climate risk

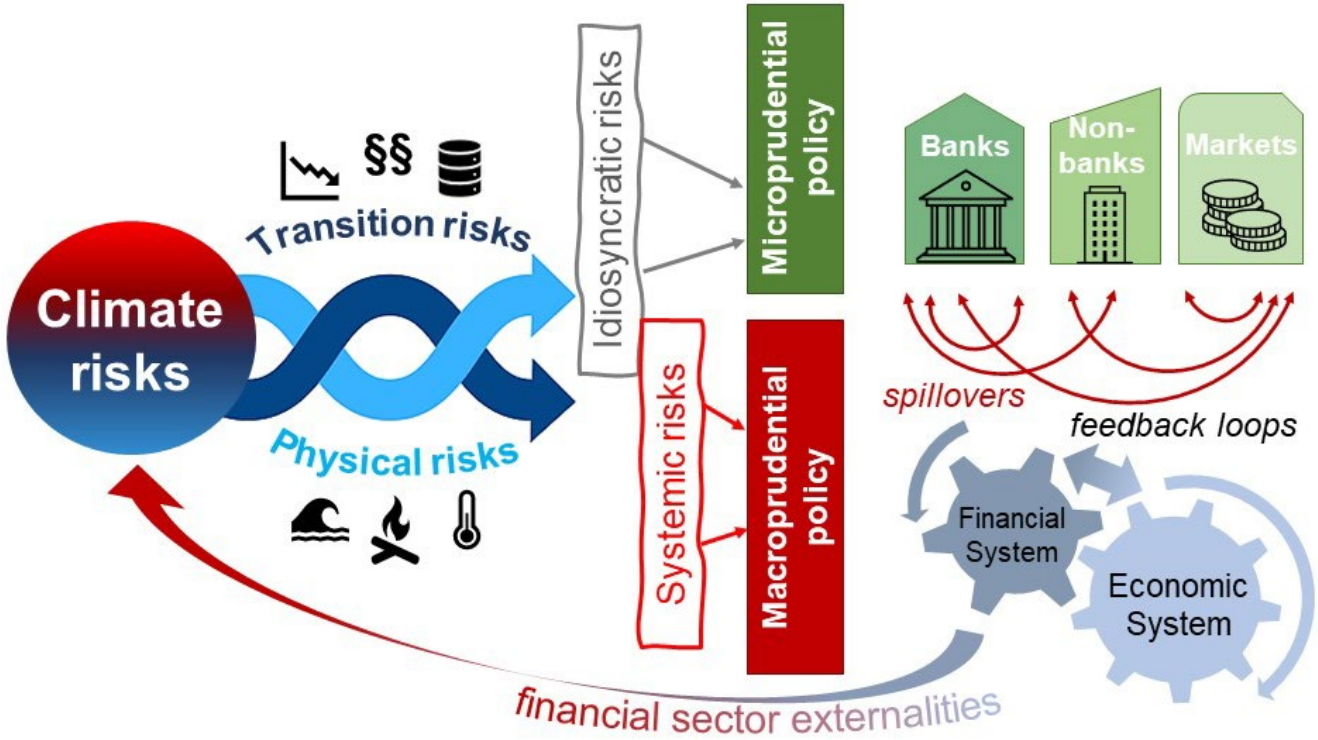
Macroprudential policy can address **systemic aspects of climate risk** by:

1. making the system **less prone to climate risks** by preventing the build-up of risks
2. building systemic **resilience to climate risks** by increasing loss-absorbing capacity
3. having a **system-wide perspective**, preventing the migration of risks across financial system
4. usefully **complementing supervisory efforts and microprudential measures**

Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk.. See also ECB blog: Climate risk, the macroprudential view (December 2023)

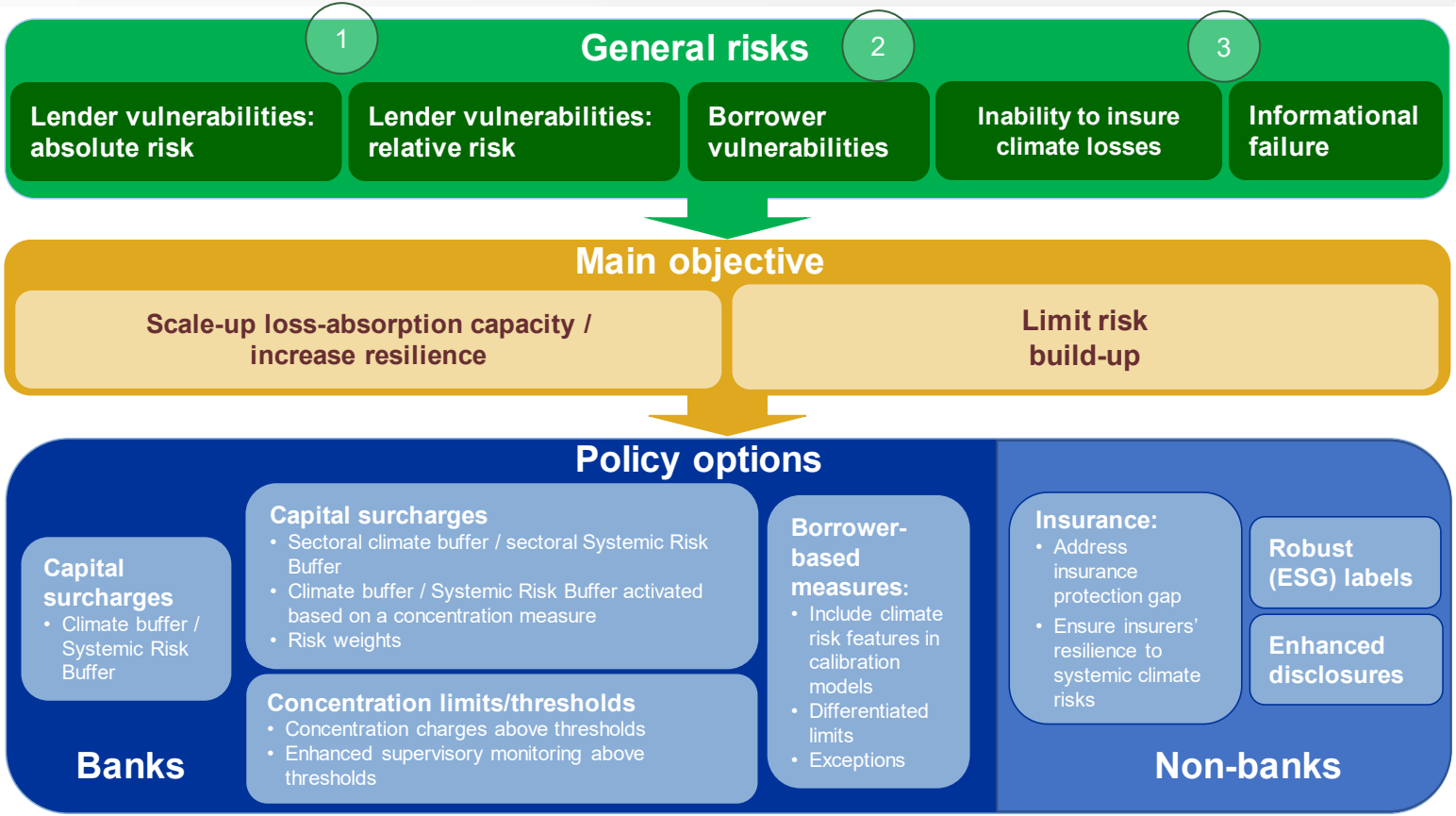
Features of a macroprudential strategy to address climate risks

Macroprudential policy as complementary to microprudential tools



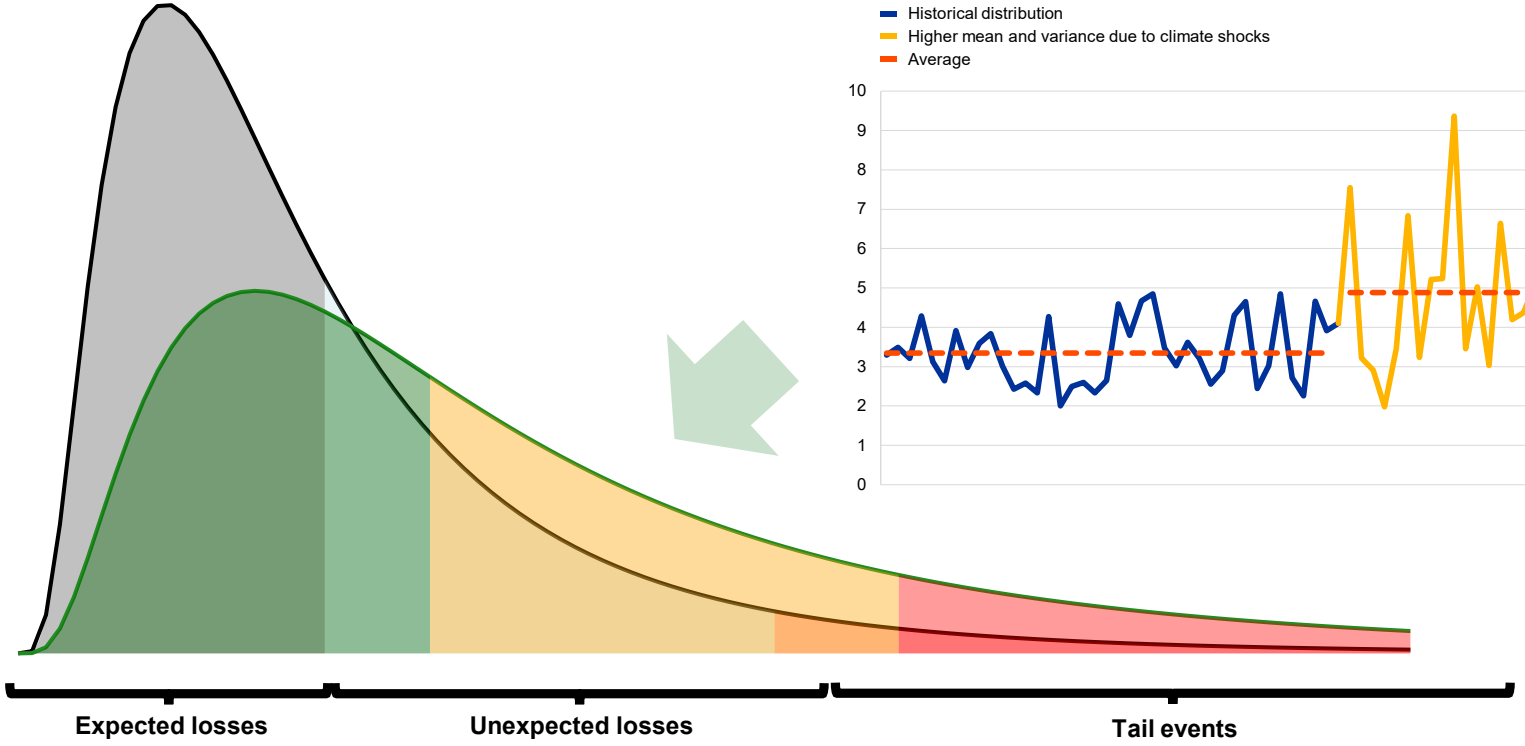
Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

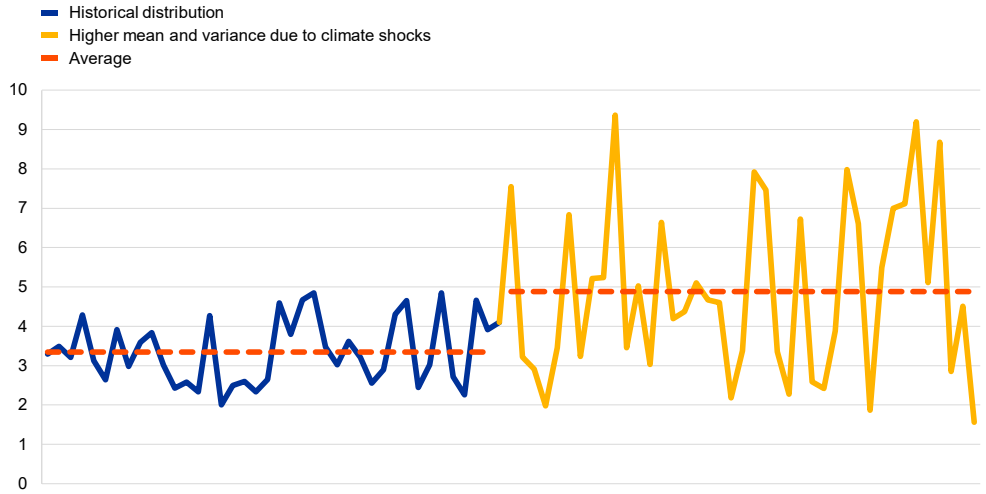
Main elements of a macroprudential framework for climate-related financial risk



Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

Capital to cover for (additional) unexpected loss?

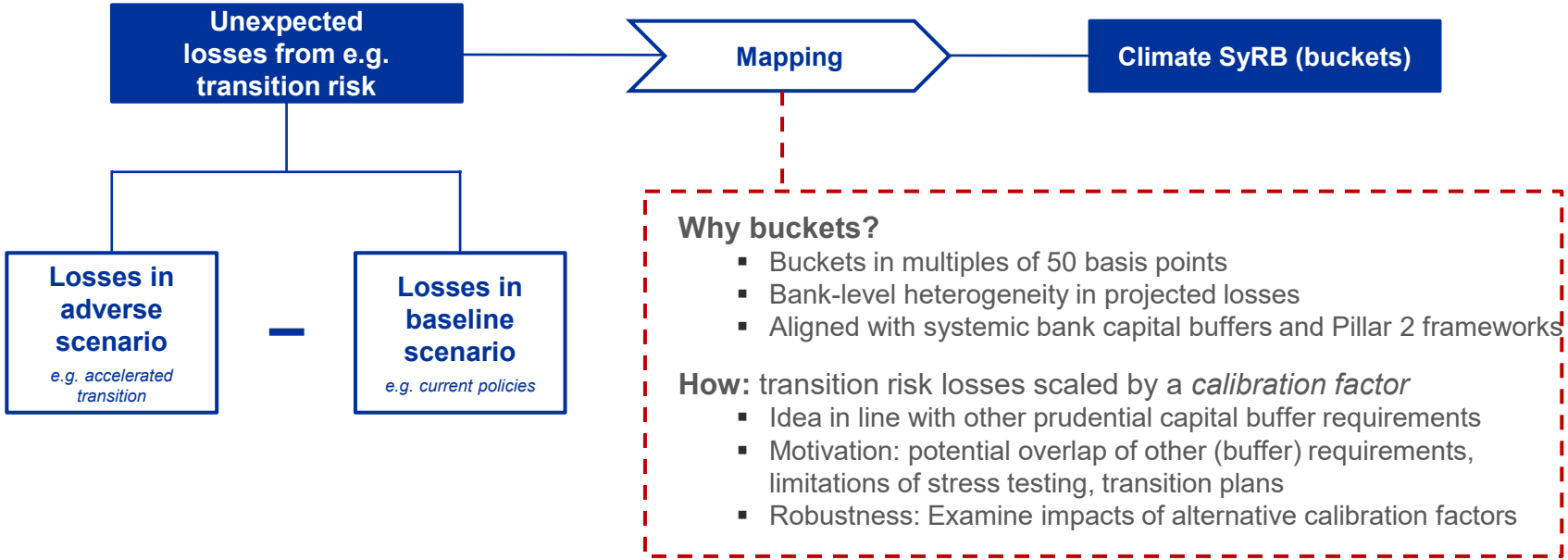




Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk, based on based on Holscher et al. (2022).

Illustration of how a systemic risk buffer could be implemented

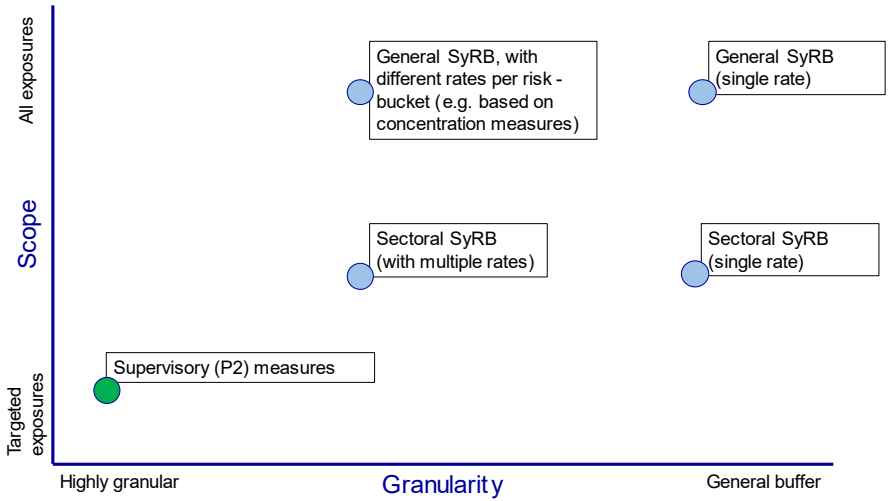
Isolating unexpected losses due to transition risk to calibrate the climate systemic risk buffer



Source: Bartsch, Busies, Emambakhsh, Michael Grill, Simoens, Spaggiari, and Tamburrini (2024), "*Designing a macroprudential capital buffer for climate-related risks*", ECB Working Paper (forthcoming)

Illustration of how a systemic risk buffer could be implemented

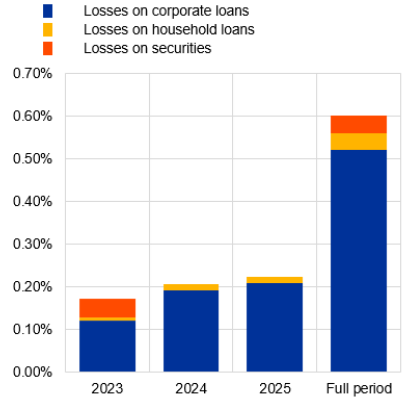
Stylized systemic risk buffer design options

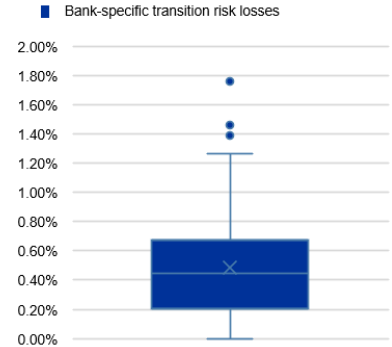


ECB illustrative SyRB calibration exercise based on transition risk

Based on second ECB top-down economy-wide climate stress test

107 euro area significant institutions, 3-year period (2023-2025)





Bucket	SyRB	N. banks CF=1	N. banks CF=0.5	N. banks CF=0.25
$< 0.25\%$	0 bps	33	65	96
$[0.25\%, 0.75\%[$	50 bps	56	40	11
$[0.75\%, 1.25\%[$	100 bps	13	2	0
$[1.25\%, 1.75\%[$	150 bps	3	0	0
$>= 1.75\%$	200 bps	2	0	0

Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

Source: Bartsch, Busies, Emambakhsh, Michael Grill, Simoens, Spaggiari, and Tamburrini (2024), *"Designing a macroprudential capital buffer for climate-related risks"*, ECB Working Paper (forthcoming)

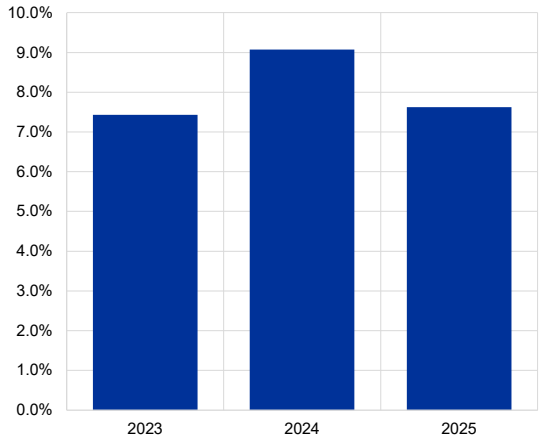
1 lender side

2 borrower side

Concentration measures

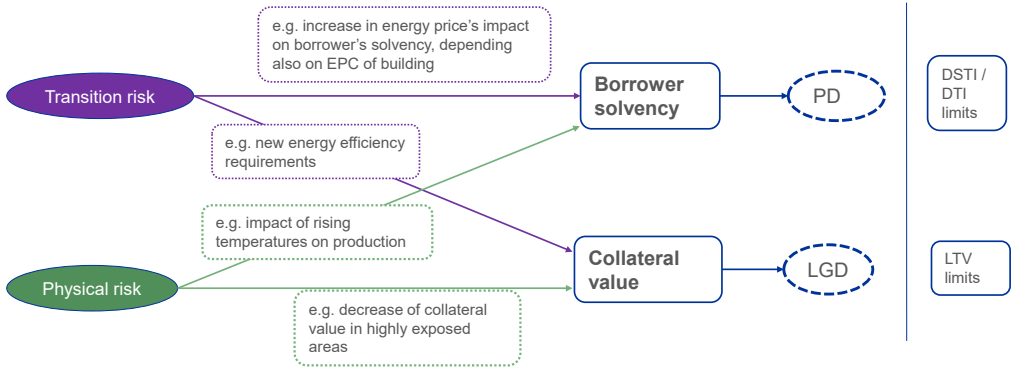
Projected decrease in cumulative losses caused by reducing concentration to the level of the threshold (75th percentile)

(x-axis: year; y-axis: percentage decrease in losses due to compliance)



Borrower based measures

Transmission channels of climate risk to borrow-based measures

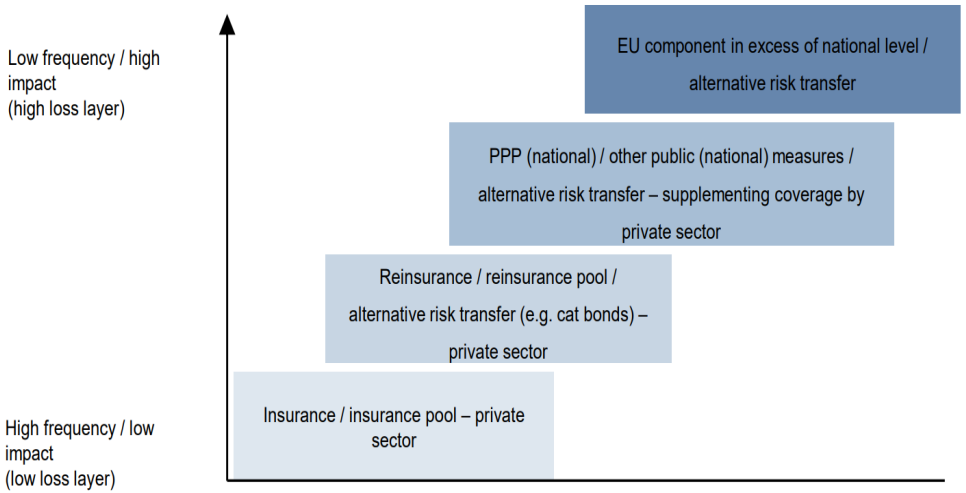


Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

Note: Sample of 100 SIs. Calculations based on the new 2023 ECB top-down. High emitting firms are defined as firms scoring above the 75th percentile of relative emissions. If the thresholds is exceeded, exposures to high emitters are pro rate redistributed to non-high emitting firms until the limit is satisfied. The change in expected losses due to diversification is then attributed to compliance with the limit.

Addressing risks in the non-banking sector

A ladder approach to catastrophe insurance



Addressing greenwashing risks

- Greenwashing can be a driver for the materialisation of several standard financial risks. Key elements to curb it:
  - (i) converge towards robust standards, definitions and labels in the sustainable finance sphere
  - (ii) close climate data gaps; and
  - (iii) enhance disclosure quality
- Some ongoing European initiatives:
  - Work of European supervisors on greenwashing
  - Work on disclosures (financial markets and corporate)
  - Strengthening basis for ESG ratings
  - Externally-verified European green bond standard.

Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

Outline

1 | Financial stability surveillance

- Climate shocks, exposures, risk
- Systemic amplifiers

2 | Macroprudential policy options

- Strategy
- Implementation

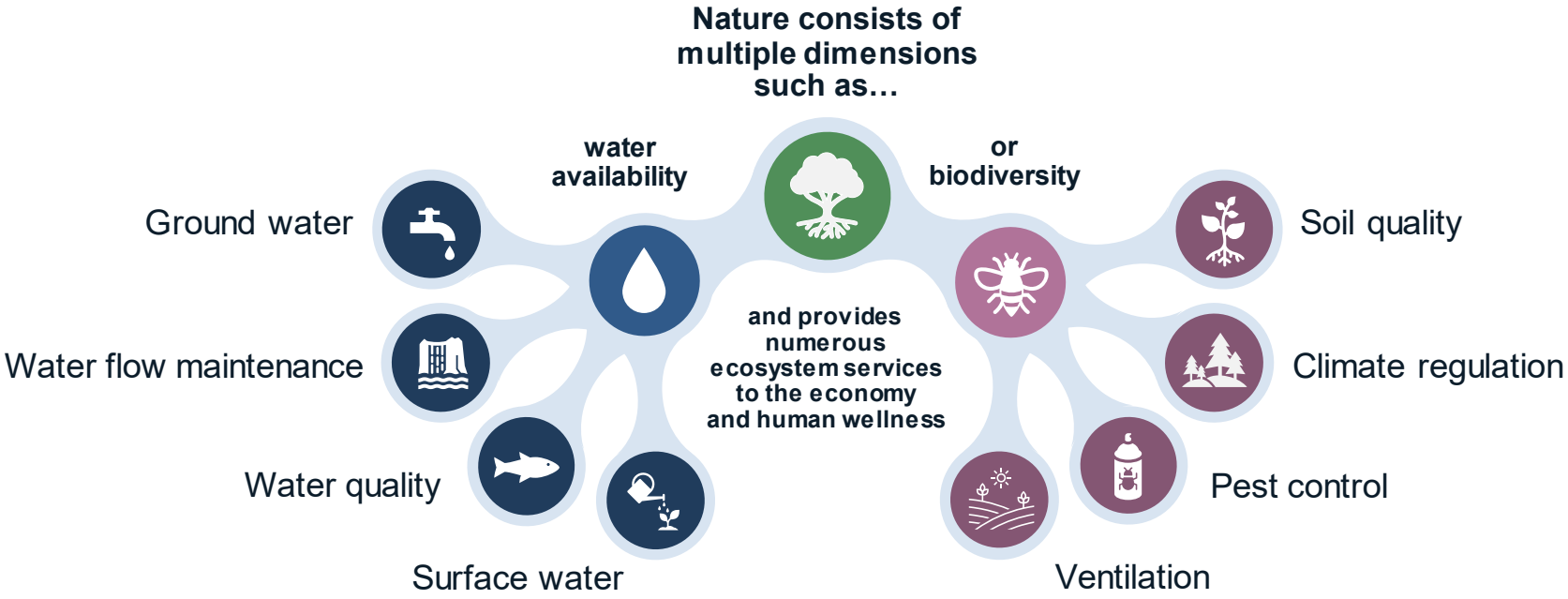
3 | Broader look at nature

- Concepts
- Exposures

4 | Summary

Definitions of nature and ecosystem services

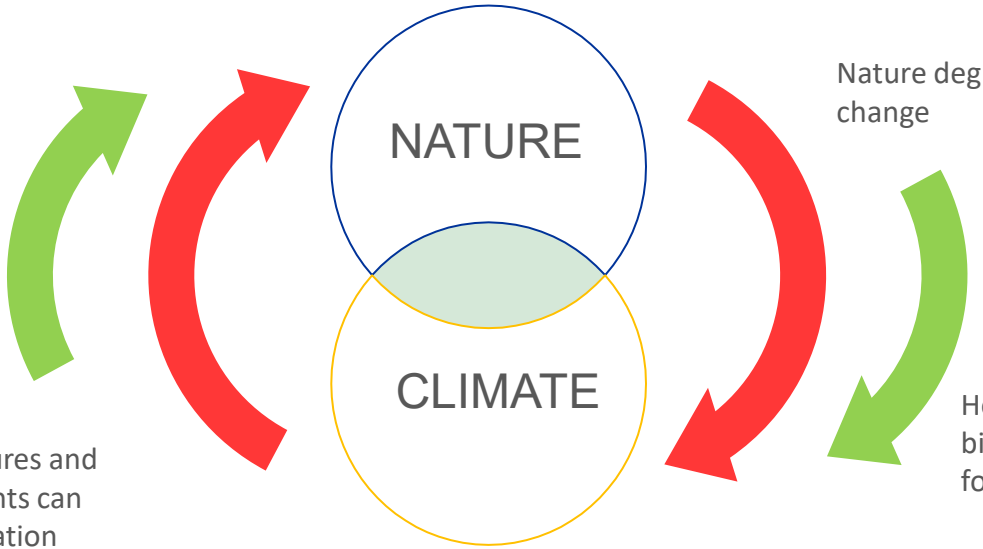
Nature encompasses multiple **natural assets** (e.g. water, biodiversity, etc), which in turn provide **ecosystem services** to the economy



Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

Climate-nature nexus

A controlled global warming and mitigation of climate change can help preserve ecosystems



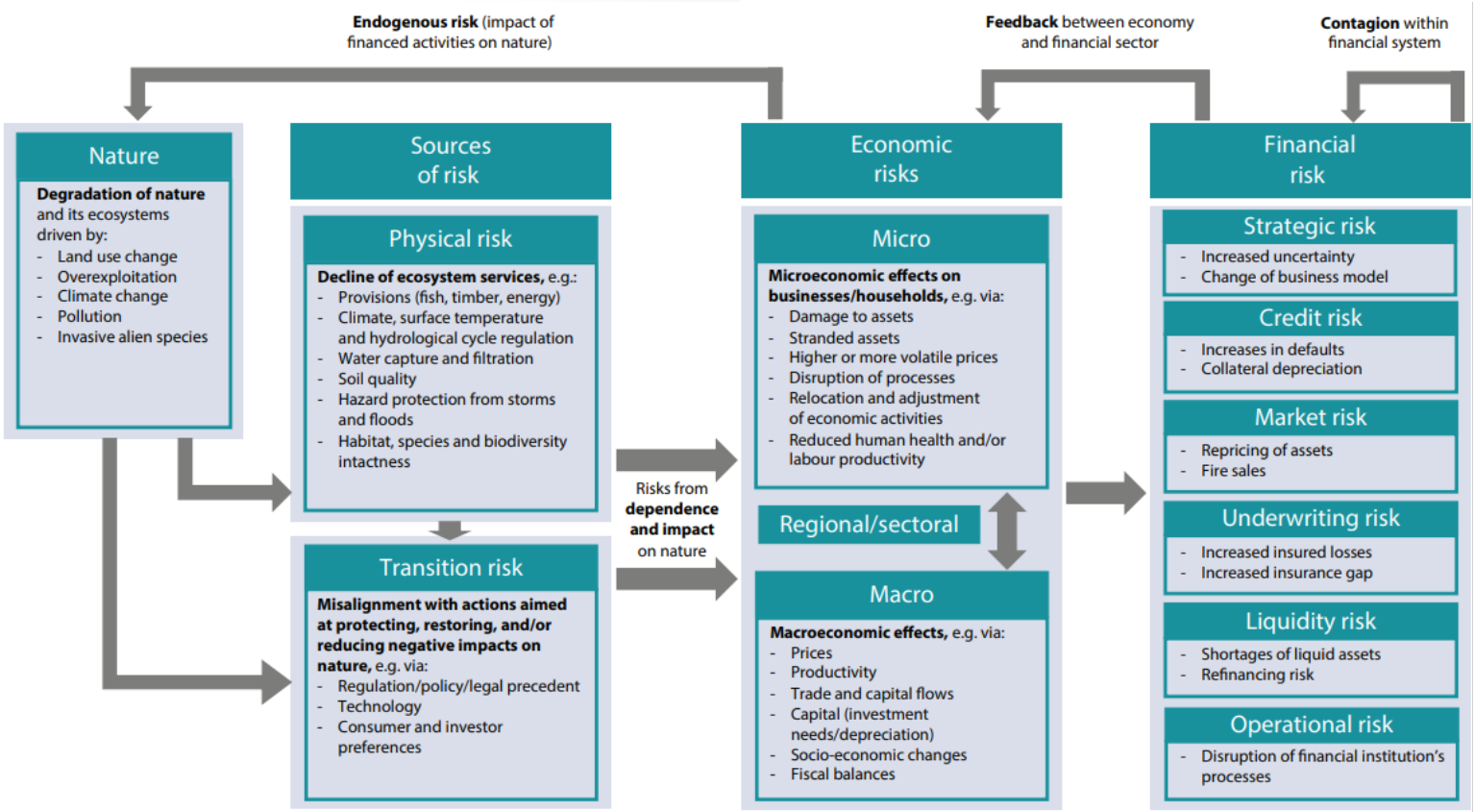
Nature degradation can speed climate change

Healthy nature and biodiversity are essential for limiting climate change

- Increasing temperatures and extreme climate events can cause nature degradation
- Policies aimed at mitigating climate change can negatively impact nature

Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

Transmission channels of nature-related risks



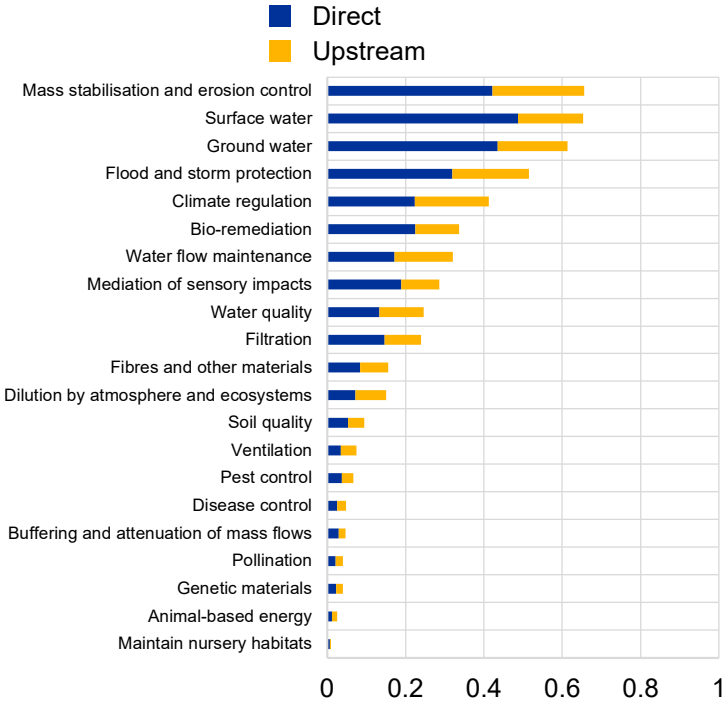
Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk

Bank and insurance exposures highly dependent on nature

Direct and indirect dependency on ecosystem services in the euro area

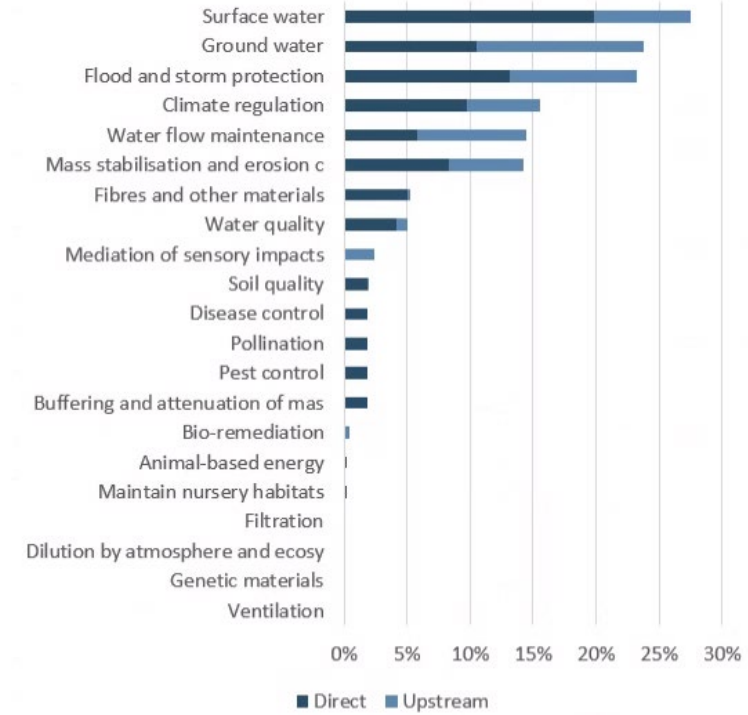
a. Banks

(total dependency score, Dec. 2021)



b. Insurers

(share of total direct investments in corporate bonds and equity, December 2022)



Source: ECB/ESRB (2023), Towards macroprudential frameworks for managing climate risk. Notes: Weighted average of the dependency scores based on relative sizes of loan portfolios.

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Main messages

Financial stability risk surveillance: *Unevenly distributed and path dependent, with scope for amplification*

- Climate **shocks** becoming increasingly salient, and vicinity of tipping points
- Financial **exposures** to climate are appear material albeit concentrated (regional, sectoral, and firm level), suggesting merits of a granular assessment
- Financial **risk** could ensue from the interplay of exposures with the evolution of financial vulnerability, with a suite of scenario analyses suggesting net benefits from an orderly transition accrue increasingly with time, with strong distributional forces at play
- Numerous systemic **amplifiers** could imply risk propagation and scope for financial instability, suggesting a bumpy path ahead

Macroprudential policy options: *An evidence-based approach to contain and mitigate systemic risk*

- ***Rationale***: Classic market failures, and some novel ones, can motivate macroprudential policy to tackle financial risk materialisation and buildup
- ***Strategy:*** An encompassing approach to address risk for the banking sector (absolute and relative), borrowers and non-bank financial intermediation
- ***Operationalisation****:* A starting point is offered by existing macroprudential instruments, even with limited adaptation
  - Promising role of systemic risk buffer and/ or concentration limits for banks, possibly complemented by borrower-based measures
  - A ladder approach could help tackle insurance protection gaps
  - Data gaps need to continue being addressed, to tackle informational market failures

A broader look at nature: *An initial look at concepts, and exposures*

- Nature degradation risk **interrelated** with climate, sharing with many conceptual similarities
- Exposures suggest material dependencies on **ecosystem services** for the EU financial sector, notably water and soil related