Renewed supervisory challenges in light of tightened financial conditions and economic slowdown

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Session 8: Stress Testing of risks stemming from climate change: a viable approach

Presentations by:
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Daniel Hardy – Vienna Institute for International Economic Research
Assessing Financial Risks from Climate Impacts – An EMDE perspective

FinSAC Annual Conference Vienna
A growing number of central banks and supervisors is conducting climate financial risk assessment

Information on 67 climate scenario analysis exercises was obtained by NGFS-FSB survey in 2022, most conducted within last year.

Almost 90% of the exercises explored the implications of transition risk, and about two-thirds explored physical risk.
Climate stress tests link physical and transition scenarios to outcomes or losses in the financial sector

1. Vulnerability
   - Sectoral exposures
   - Regional exposures

2. Scenarios
   - Physical risk
   - Transition risk

3. Impact modelling
   - Macro approaches
   - Meso/micro approaches

4. Outcome / loss
   - Capital
   - Profitability
Multiple variants of climate stress tests are possible and currently conducted

<table>
<thead>
<tr>
<th>Bottom-up vs. top-down</th>
<th>Macro vs. micro approach</th>
<th>Static vs. dynamic balance sheet approach</th>
</tr>
</thead>
</table>
| • **Bottom-up exercises,** central bank or supervisor defines scenarios and methodological rules. Financial institutions then run the scenarios against their balance sheet, using internal data and models.  
• **Top-down exercise** run entirely by central bank or supervisor, without involvement of financial institutions. | • **The macro approach** relies on macroeconomic models (e.g., DSGE, CGE) to simulate the impact of climate shocks on macro and financial variables. Models could differ with respect to the sectoral and geographical granularity.  
• **The micro approach** directly examines the financial performance of affected sectors, to which FIs are exposed. This approach has a very high requirement for granularity of data and industry-specific knowledge. | • **Static balance sheet** assumption with balance sheets ‘frozen’ over time, allowing only balance sheet changes that result directly from risks materializing in the scenario (e.g. assets going into default).  
• **Dynamic balance sheet** assumption allows balance sheets to change over time, either because counterparty characteristics change (e.g. reduction in emissions or gaining market share), or because of portfolio allocation change. |

EMDEs face specific climate-related challenges but important to get started

High vulnerability of EMDEs to climate risk but low macro-financial capacity EMDEs to deal with impacts

*Climate vulnerability per region (1995-2017)*

- Despite increasing awareness and emerging work on climate risk analyses, supervisory and regulatory approaches to address the risk are in their infancy in most EMDEs.

- Central banks in EMDEs face challenges including limited capacity and data to assess climate risks and implement responses.

- The diverse nature of EMDE financial sectors (different type of risks, data, capacity, etc.) requires tailored approaches to manage local climate risks.

- But climate risk assessment can be done at various levels of granularity and is a learning-by doing process (insights on data gaps, etc.) for all participants.

⇒ Important to get started
The World Bank is supporting efforts to green the financial sector in 60+ countries through technical assistance, analytical and lending activities.

**Morocco**
- Climate risk analysis
- Climate risk guidelines
- Training & capacity building

**South Africa**
- FSAP climate risk analysis
- Advisory climate risk analysis
- Training/capacity building

**Mexico**
- FSAP Climate risk analysis
- ESG risk guidelines

**Philippines**
- FSAP climate risk analysis
- Transition risk analysis
- Development policy operation

**Colombia**
- Climate risk analysis
- Climate risk guidelines
- Taxonomy and capacity building

**Malaysia**
- Nature risk analysis
- Training/capacity building

**Examples of World Bank climate risk analysis work**
The Philippines: From Climate Analytics and TA to WBG investment operations

FSAP Climate Risk & Opportunity analysis
WB diagnostic of the **policy and regulatory framework** to manage risks and simulate green finance markets.
Joint WB IMF climate **physical risk stress test** of the banking sector. Also informed CCDR

2019-2020

30by30zero - TA & investment to scale private sector climate finance
Award winning joint IFC / WB program to **scale climate finance**. WB TA for climate risk regulations, taxonomy development and green finance incentives (WB). IFC providing TA and blended finance investments in banks.

2021-present

Climate finance and resilience in Development Policy Financing
World Bank financing with first-of-its-kind **greening financial sector pillars and prior actions**, informed by FSAP and TA recommendations on climate risk management and climate finance

2022-2023
Colombia: Multiple instruments for climate impact

01 Methodology to incorporate ESG aspects in infrastructure projects

02 Blended Finance strategy for local Development Bank (FDN)

03 ESG Guidelines Investors / Issuers
   Integrating ESG factors in investment practices and investor and corporate reporting – supported by SSB work on new sustainability standards

04 Green taxonomy
   World Bank IFC support for a taxonomy of economic activities to label and monitor green investments

05 Green instruments
   Support to the issuance of a green bond for Bus Rapid Transit in the municipality of Bogota

06 Development of Carbon credit markets

07 Green banking regulations
   TA for the banking regulator - stress testing climate risks and developing climate risk management and reporting guidelines
Morocco: Greening the Banking Sector by supporting the central bank

- **Assessing climate-related financial risks for the banking sector**
  - Scenario analysis exercise with Bank Al Maghrib covering climate physical and transition risks to stress resilience of banking sector

- **Training and awareness program**
  - Providing support to build supervisory and industry capacity on climate risk and green finance

- **Climate risk guidance for banks**
  - Sector guidelines for climate risk management, scenario analysis & stress testing, and reporting standards

- **Benchmarking policy developments**
  - Assess and identify green finance policy priorities as part of the Country Climate and Development Report (CCDR)

- **Green taxonomy**
  - Supporting authorities developing a green taxonomy to classify green (and climate risky) investment products and financial flows
Climate analysis is not an end in itself but a building block for a supervisory approach

01 Raise awareness and build capacity
For supervisors, financial institutions, and policymakers

02 Bridge data and modeling gaps
Informing disclosure and regulatory reporting, and advanced modeling of climate risk

03 Inform supervisory approach
Enabling a risk-based supervisory approach by identifying the most vulnerable sectors and firms
Scenario analysis and stress testing face challenges that need to be addressed

01 Addressing data gaps

02 Better incorporating climate change in modeling approaches

03 Building capacity to conduct scenario analysis and stress testing
Annex
Cross-country analyses show climate-related NPL impacts aren’t just theoretical.

**Estimated effects of disaster episodes on NPLs (184 countries – 1980-2019)**

- 2.3% increase in NPL ratio

**Country case: Philippines**
Impacts of a 1 ppt increase in the damage ratio

2.3% increase in NPL ratio

Toolkits for Policymakers to Green the Financial System

- Menu of options
- High-level guidance
- Based on good practice and country experience

**Strategy and coordination**: Green Finance Roadmap, National Climate Finance Strategy, Build skills & capacity: National Taskforce, International Networks, Paris Alignment by FIs

**Regulation & central banks**: Climate & Env. Risk Analysis, Supervisory Practice, Supervisory Guidance, Greening Central Bank Activities

**Transparency**: Disclosure & Reporting, Taxonomy

**Green(ing) FIs**: Greening NDBs, New Green Bank/Finance Entity

**Greening NDBs**

**Tools and instruments**: Corporate Green Bonds, Sovereign Green Bonds, Blended Finance Products, Green/Sustainability-linked Loans

**Tools and instruments**

**Green Finance Toolkits for Policymakers**

*World Bank Group*
FSB-NGFS (2022) survey results on motivation for conducting climate risk assessment

![Bar chart showing the main purpose of climate scenario analysis exercises](image)

### Main purpose of climate scenario analysis exercises

- To assess how climate risk could impact financial stability (macropru): 49
- To assess how climate risk could impact individual financial institutions (micropru): 40
- To assess how climate risk could affect the macroeconomy: 17
- To develop climate scenario analysis capabilities in financial institutions: 26
- To develop climate scenario analysis capabilities in your organisation: 47
- To facilitate dialogue with the industry about climate-related financial vulnerabilities: 39
- Other: 11

**Source:** FSB-NGFS survey
The OeNB Pilot Climate Risk Stress Test

FinSAC Conference on “Renewed supervisory challenges in light of tightened financial conditions and economic slowdown”

Vienna, 10 May 2023

Ralph Spitzer *)
OeNB / Supervision Policy and Strategy Division

*) The views expressed in this presentation are those of the author and not necessarily those of the OeNB or the Eurosystem.
Result: Carbon pricing not a risk to Austrian financial stability

- **2021 EBA baseline** as a reference scenario
- Calculate **additional impact** from carbon pricing
- 5Y deviation from baseline 70 bps (orderly) and 267 bps (disorderly)
- **Main observations:**
  - Limited exposure to highly affected sectors
  - AT exposures are less affected by transitions risks than CESEE exposures
  - Strong baseline scenario (post crisis)
General approach

- **Pilot exercise** at system and individual bank level
- **Extends** proven OeNB top-down stress test infrastructure (corporate insolvency model, ARNIE)
- Uses (relatively well) **established data sources**
- Focus on **transition risk** with front-loaded carbon price shock as main risk driver
- **Compatible time horizon** of 5y (2021 – 2025)
- Focus on modelling **credit risk impact** with Austrian and foreign exposures
- Additional **market risk module**

→ Link: https://www.oenb.at/dam/jcr:2c2077e8-9729-441a-bb43-3b7a50ec2228/05_FSR_42_OeNB-climate-risk-stress-test.pdf
Carbon price scenario definition aligned with NGFS narratives

- ECB/EBA macroeconomic scenario baseline (ST 2021) as starting point
- **Orderly and disorderly** transition shocks (inspired by NGFS narrative)
- Carbon price introduced as **additional tax** in all EU countries, on all GHGs in all sectors
- Inclusion of a **carbon border adjustment mechanism** (CBAM)
1 Sectoral carbon price model – Stylized view

- **Multi-Regional Input-Output Analysis** with 21 NACE sectors for 27 EU countries
- Latest available input-output data for 2019 from FIGARO database, Emission data from Eurostat
2 Sectoral corporate insolvency model – Stylized view

Insolvency triggers

- Solvency
- Liquidity

Profit & Loss Statement

<table>
<thead>
<tr>
<th>Income Items</th>
<th>Expense Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>

Balance Sheet

- Cash & Bank deposits
- Equity

- 5 additional asset items
- 5 additional liability items

Cash-flow

Profit / Loss

Turnover shock

Carbon shock

Carbon Price Model

Macro scenario

Carbon price scenario

(turnover shock)

Macro scenario

Carbon price scenario

Profit & Loss Statement

CF indirect method

(neutralise non-cash components)

Link: https://www.oenb.at/dam/jcr:72edc4bb-aab0-4593-aa2f-b102365c8c0a/06_FSR_40_Modeling_the_COVID-19_effects_.pdf

Link: https://www.oenb.at/dam/jcr:560528ca-26fc-4d1e-ad2c-9b01e4b1287b/06_mop_Q4_20-Q1_21_Have-mitigating-measures-helped.pdf
Strengths and weaknesses of our framework

Strengths
• Consistent framework with NGFS scenario narratives
• Sectoral I/O analysis approach stable and reduces complexity
• Uses strengths of existing OeNB ST framework (insolvency model & ARNIE)
• Relatively simple and transparent

Weaknesses
• EBA baseline scenario not consistent with carbon price shock scenario
• No tax redistribution, no technological change, no product substitution
• Static assumptions: 1) Misses dynamic interactions of a general equilibrium macro model, 2) bank level: no growth, no portfolio rebalancing, 3) company level: no newly founded companies
Climate risk stress testing – What is it good for?

Good for …

• Creating awareness, thinking about risks and channels
• Incentivising banks to
  • improve own climate risk identification and assessment capabilities
  • improve risk governance
  • actively manage concentration risk and adjust business strategy
  • adequately reflect climate risks in loan pricing
  • collect better and more relevant data (energy performance certificates, carbon intensity, …)
• Short-to-medium term projections with relative risk rankings (with a lot of caveats)

Not so good for …

• Long-term projections (even with a lot of caveats)
• Saving the world – Central banks cannot compensate for policy inaction
References


Sectoral Carbon Price Model shows most affected sectors & regions

**Turnover Losses**

*at an additional EU-wide carbon price of 130€/t CO2e*

- A - Agriculture, forestry and fishing
- B - Mining and quarrying
- C - Manufacturing
- D - Electricity, gas, steam and air conditioning supply
- E - Water supply & sewerage
- F - Construction
- G - Trade
- H - Transportation and storage
- I - Accommodation and food services
- J - Information and communication
- L - Real estate
- M - Professional, scientific & techn. Services
- N - Administrative and support services
- P - Education
- Q - Human health and social work activities
- R - Arts, entertainment and recreation
- S - Other service activities

**Cost Changes**

*at an additional EU-wide carbon price of 130€/t CO2e*
# Insolvency rates: Agriculture and transportation most affected

## Cumulative annual insolvency rates of Austrian non-financial corporates

<table>
<thead>
<tr>
<th>Insolvency rates in percentage points</th>
<th>Agriculture, forestry and fishing (A)</th>
<th>Mining and quarrying (B)</th>
<th>Manufacturing (C)</th>
<th>Electricity, gas, steam and air conditioning supply (D)</th>
<th>Water supply and sewerage (E)</th>
<th>Construction (F)</th>
<th>Trade (G)</th>
<th>Transportation and storage (H)</th>
<th>Accommodation and food services (I)</th>
<th>Information and communication (J)</th>
<th>Real estate (L)</th>
<th>Professional, scientific, and technical Services (M)</th>
<th>Administrative and support services (N)</th>
<th>Education (P)</th>
<th>Human health and social work activities (Q)</th>
<th>Art, entertainment, and recreation (R)</th>
<th>Other service activities (S)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, forestry and fishing (A)</td>
<td>0.8% 0.2 0.0 0.3 0.5 0.9 1.4 0.0 2.5 5.8 10.0 15.9</td>
<td>0.6% 0.5 0.0 0.1 0.2 0.2 0.1 0.2 0.3 0.4 0.6</td>
<td>15.4% 0.7 0.0 0.1 0.2 0.3 0.5 0.0 0.4 0.8 1.4 2.1</td>
<td>2.8% 0.3 0.0 0.1 0.1 0.2 0.2 0.0 0.1 0.3 0.7 1.2</td>
<td>1.0% 0.7 0.0 0.3 0.7 1.1 1.6 0.2 1.3 2.6 3.9 5.2</td>
<td>8.7% 2.0 0.0 0.1 0.3 0.5 0.7 0.0 0.4 0.8 1.2 1.7</td>
<td>10.1% 1.0 0.0 0.3 0.3 0.4 0.4 0.0 1.1 1.4 1.5 1.7</td>
<td>3.3% 2.6 0.3 0.9 1.6 2.3 2.9 1.7 4.5 7.6 10.3 12.9</td>
<td>4.3% 2.0 0.0 0.3 0.5 0.7 0.9 0.0 1.2 1.8 2.5 3.2</td>
<td>1.9% 0.6 0.0 0.0 0.1 0.1 0.1 0.1 0.2 0.3 0.3 0.4</td>
<td>29.9% 0.3 0.0 0.0 0.0 0.0 0.1 0.0 0.1 0.2 0.2 0.2</td>
<td>14.9% 0.5 0.0 0.0 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.3</td>
<td>3.0% 1.6 0.1 0.2 0.3 0.3 0.4 0.3 0.7 0.8 0.9 1.0</td>
<td>0.1% 0.4 0.0 0.0 0.0 0.0 0.0 0.0 0.1 0.1 0.1 0.1</td>
<td>1.7% 0.4 0.0 0.0 0.0 0.0 0.2 0.0 0.0 0.0 0.0 0.4</td>
<td>0.4% 0.6 0.1 0.4 0.8 1.2 1.6 0.5 1.3 2.2 2.9 3.7</td>
<td>0.9% 0.7 0.0 0.2 0.4 0.5 0.8 0.2 0.6 1.0 1.3 1.8</td>
<td>100.0% 0.9 0.0 0.2 0.3 0.4 0.6 0.0 0.8 1.3 1.8 2.5</td>
</tr>
</tbody>
</table>

Source: KSV 1870, OeNB, Authors’ calculations.
Danke für Ihre Aufmerksamkeit

Thank you for your attention

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OeNB
What's The Cost Of Saving The Planet For Banks?

Jozef KALMAN, Jan KLACSO, Reiner MARTIN, Roman VASIL, Juraj ZEMAN

National Bank of Slovakia

FinSAC Annual Conference
May 10, 2023
Climate change is a source of financial risk → central banks have an interest in stability of financial system.

Key question I: Through which channels are climate change risks affecting the financial system, and how can they be properly assessed?

Key question II: How much could these risks costs the financial system?

The questions at hand cannot be adequately answered by recent stress-testing frameworks.

Thus, there is a need to develop new instruments and upgrade existing ones.
Agenda

1. Backdrop
2. Framework
3. Results Households
4. Non-Financial Corporations
5. Conclusion
6. Appendix
• HH and NFC loans dominate SK banks’ balance sheets.

• Indirect transition risk is prominent.
  
  • SK banking sector has relatively low credit exposure to high-emitting sectors → transformation to a NZC economy does not pose a significant direct risk.
  
  • The transformation to a NZC economy will cause structural changes in the economy → indirect risks to financial stability.

• SK industry is energy intensive → profitability is sensitive to energy prices.

**Figure 1:** Asset structure of the Slovak banking sector’s balance sheet

Source: NBS
Outline of NBS Stress Testing Framework

- Standard top-down solvency ST model used by NBS.
- Using supervisory bank-by-bank data for eleven banks.
- Focus on credit-risk.
- Model description is available in Klacso 2014.
Six scenarios are based on different assumptions about the evolution of climate policy, temperature, and emissions.

The transition risk is well-captured by the Divergent NZ and NZ 2050 scenarios.

We integrate NGFS scenarios into our stress-testing model, using the macro financial variables from the scenarios as an input.

Focus on a short-term horizon reduce the effect of high modeling uncertainty in the results.
Unemployment rate is a main driver of households’ credit risk.

The increase in unemployment rate is larger under DNZ compared to NZ 2050.

Reason is success rate of substituting emission-intensive sectors at the start of the transition period.

Peak increase occurs one year post-shock in both cases.

If a default occurs, the value of collateral is considered.

**Figure 3: Unemployment rate - difference compared to baseline**

Source: Authors’ own calculation, NGFS.
Note: GCAM5.3_NGFS and MESSAGE-GLOBIOM 1.1 are IAM models.
**Alternative Scenarios Including Energy Price Increase**

- The main driver of the scenarios are ↑ emission costs.
- ↑ energy costs result in a reduction in energy use.
- This is mostly offset by improvement in energy efficiency.
- What if: in the short-run, ↑ energy costs → ↑ energy prices for households if there is a lag in the use of alternative sources.
- Scenarios: energy costs to households ↑ by 20%, 50% or 100% of gas price increase.

**Figure 4:** Gas price increase compared to the baseline

Source: Authors’ own calculation, NGFS
Note: GCAM5.3_NGFS and MESSAGE-GLOBIOM 1.1 are IAM models.
Household Credit Risk

**Figure 5:** Results of the Divergent Net Zero scenario compared to conventional stress testing

Source: NBS, Authors’ own calculation.
Note: All results are provided relative to the baseline, as a percentage of the outstanding amount of loans. GCAM5.3, NGFS and MESSAGE-GLOBIOM 1.1 are IAM models.

**Figure 6:** Increasing energy prices - losses from loans to households

Source: NBS, Authors’ own calculation.
Note: All results are provided relative to the baseline, as a percentage of the outstanding amount of loans. GCAM5.3, NGFS and MESSAGE-GLOBIOM 1.1 are IAM models.
High-emitting companies/sectors are more affected by the scenarios as the shock to GDP is mainly driven by the emission prices.

We use a transition vulnerability factor (TVF) for each sector, calculated based on their CO2 emissions for producing goods and services.

Then TVF * GDP shock to account for each company/sector’s emission production and ownership.

Companies’ revenues are linked to development of GDP.

The profitability of companies is affected in two ways - an ↑ in costs and a ↓ in revenues.

**Figure 7:** GDP – difference compare to baseline

Source: Authors' own calculation, NGFS.
Note: GCAM5.3 NGFS and MESSAGE-GLOBIOM 1.1 are IAM models.
**Non-Financial Corporations Credit Risk**

**Figure 8:** Results of the Divergent Net Zero scenario compared to conventional stress testing

Source: NBS, Authors’ own calculation.
Note: All results are provided relative to the baseline, as a percentage of the outstanding amount of loans.
GCAM5.3_NGFS and MESSAGE-GLOBIOM 1.1 are IAM models.

**Figure 9:** Increasing energy prices - losses from loans to NFCs

Source: NBS, Authors’ own calculation.
Note: All results are provided relative to the baseline, as a percentage of the outstanding amount of loans.
GCAM5.3_NGFS and MESSAGE-GLOBIOM 1.1 are IAM models.
Default of High-Emission Intensive NFCs

- Sectors are ranked in descending order based on TVF, and we assess the impact of default on five, ten, and twelve sectors.

**Figure 10**: Default of emission intense sectors - losses from loans to households

Source: NBS, Authors' own calculation.  
Note: All results are provided relative to the baseline, as a percentage of the outstanding amount of loans.

**Figure 11**: Default of emission intense sectors - losses from loans to NFCs

Source: NBS, Authors’ own calculation.  
Note: All results are provided relative to the baseline, as a percentage of the outstanding amount of loans.
Conclusions

- We assessed the indirect impact of transition risks on the banking sector using NGFS scenarios over a four-year horizon.

- A relatively smooth substitution – *Net Zero 2050* – of emission-intensive sectors results in relatively low indirect costs for banks,

- while an uneven transition – *Divergent Net Zero* – generates significantly higher losses that occasionally exceed adverse scenario outcomes of conventional stress testing.

- Increased energy prices in the short-run may have a significant impact on households’ credit risk if there is not enough alternative energy supply.

- Similarly, if companies cannot adjust sales prices, increased energy prices may significantly affect the credit risk of non-financial corporations.
Thank you for your attention!
Figure 12: Outline of NBS stress test framework

Source: NBS
Appendix 2

**Table 1: Estimated Transition vulnerability factor for first fifteen Slovak sectors**

<table>
<thead>
<tr>
<th>Sector</th>
<th>TVF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing and basic metals</td>
<td>7.52</td>
</tr>
<tr>
<td>Manufacture other non-metallic mineral products</td>
<td>4.52</td>
</tr>
<tr>
<td>Manufacture of fabricated metal products, except machinery and equipment</td>
<td>3.54</td>
</tr>
<tr>
<td>Electricity, gas, steam and air conditioning supply</td>
<td>3.47</td>
</tr>
<tr>
<td>Manufacture of chemicals and chemical products</td>
<td>3.38</td>
</tr>
<tr>
<td>Manufacture of coke and refined petroleum products</td>
<td>2.41</td>
</tr>
<tr>
<td>Land transport and transport via pipeline</td>
<td>2.38</td>
</tr>
<tr>
<td>Manufacture of electrical equipment</td>
<td>2.37</td>
</tr>
<tr>
<td>Postal and courier activities</td>
<td>2.23</td>
</tr>
<tr>
<td>Construction</td>
<td>2.07</td>
</tr>
<tr>
<td>Manufacture of machinery and equipment n.e.c.</td>
<td>1.95</td>
</tr>
<tr>
<td>Manufacture of rubber and plastic products</td>
<td>1.91</td>
</tr>
<tr>
<td>Manufacture of other transport equipment</td>
<td>1.83</td>
</tr>
<tr>
<td>Air transport</td>
<td>1.79</td>
</tr>
<tr>
<td>Manufacture of motor vehicles, trailers and semi-trailers</td>
<td>1.70</td>
</tr>
</tbody>
</table>

Source: Authors’ own calculation based on Vermeulen et al. 2018
Data Challenges in Climate Change Stress Testing

May 2023

Daniel C. Hardy
The Vienna Institute for International Economic Research
International Monetary Fund (Ret.)
dclhardy@gmail.com
Addressing data challenges

• Primary data
  – Dissemination by firms
  – Questionnaires
    • Firms
    • Households
  – Collected by banks
    • Questionnaires for loan evaluation
  – Common platform
    • e.g., Austrian banks’ project
Addressing data challenges

- **Secondary data**
  - Average by sector
  - Average by region
  - Scaling up from sub-sample
    - Can indicate range
  - Data from other countries
    - Can indicate range
  - Environment-enhanced input-output tables
  - Non-economic databases
    - e.g., on weather events
Some secondary sources

- **NGFS Directory**
  - [https://ngfs.dev.masdkp.io](https://ngfs.dev.masdkp.io)

- **NBR survey October 2022**

- **CDP**
  - [https://www.cdp.net/en/data](https://www.cdp.net/en/data)

- **Greenhouse Gas Protocol inventory of Life Cycle Databases**
  - [https://ghgprotocol.org/life-cycle-databases](https://ghgprotocol.org/life-cycle-databases)

- **European Platform on LCA | EPLCA**

- **EU Building Stock Observatory**
ECB

‘The Macroprudential Challenge of Climate Change’ and Annex, July 2022

‘Climate-related risk and financial stability,’ July 2021

• Use gap between firm emissions and allowance under the European Emissions Trading System. For covered firms, shows exposure to carbon tax increase

• Base exposure on estimated average sectoral CO2E

• Use external EU taxonomy alignments estimated at NACE four-digit sector level
ECB

• Correlate common variables in the national household budget survey and mortgage loan-level monitoring database to estimate energy expenditure and emissions by household and property characteristic

• Use input-output tables to estimate effect of a large reduction in hydrocarbon supply and/or a reduction in demand

• Estimate flood risk for location of firm headquarters based on information from geographic survey and available depth-damage curves
ECB

a) Loan-weighted Scope 1 emission intensity by sector and country

(y-axis: kg of CO2e per euro of GVA, 2020)

Heat stress

© 2021 Mapbox © OpenStreetMap
Take aways

• Data challenges severe but not insurmountable
  – Physical risks especially challenging
  – ‘Tail’ of distribution of impacts especially challenging

• Data availability improving
  – Authorities and banks can take action

• Need to combine data from several sources

• Need to acknowledge uncertainties and gaps

• Judgement
  – Use ‘heroic assumptions’ to capture major risk factors
  – Start with near-term, measurable risks