Climate risks: Data

Jaromir Benes jaromir.benes@gimm.institute
Tomas Motl tomas.motl@gimm.institute

gimm
Global Institute *for* Macroprudential Modeling

Data is one of the key problems

gi

- This finding is repeated *ad nauseum*: experience from pilot projects, BIS surveys, …
- This presentation gives overview of potentially useful data sources…
- … but note that these will still not be sufficient
- Work to improve data availability is one of the key challenges ahead
- Best measurements come from advanced economies, such as the EU
  - These can serve as a benchmark with judgmental adjustments in case domestic equivalents are missing.
- There are efforts ongoing to close the data gaps, at least partially
- **Key problems:**
  - Few established, generally accepted methodologies and reporting standards
  - Need for granular, **forward-looking** measurements
  - Mostly focus on credit risk, some attention to market risk, not much otherwise
  - Unclear how to measure exposure to future transition risks
- Even in **developed countries**, data suffers from:

- lack of consistent coverage - corporates vs households, public vs private enterprises
- sectoral heterogeneity
- gaps in terms of systemic risks

- Many measures rely on firm-level emission data, but:
  - **Firm-level GHG emissions are not well mapped yet:** For EU-domiciled firms, disclosed total emissions in 2019 amount around half of the amounts of Eurostat's annual Air Emissions Accounts.
  - **Large discrepancies exist** among providers of firm-level data

New reporting standards incoming

gi

New sustainability reporting standards issued by the IFRS in June 2023. (Free registration needed to download)

- Complement to the existing IFRS reporting standards
- Could close some of the gaps over time (years)
- Lots of lawyer speak, we will see about practical impact

Reporting entities will be required to disclose **new kinds of information:**

- Their assessment and strategy of climate risks
- Relevant metrics:
  - Absolute gross GHG emissions generated during the reporting period
    - Scope 1: Emissions from sources directly owned by the entity
    - Scope 2: Emissions from bought energy (electricity, steam, heat)
    - Scope 3: Emissions from the whole value chain
  - Climate-related transition risks
  - Climate-related physical risks
  - Reporting entities' climate-related targets
  - All other materially relevant indicators

Should alleviate much of the problems.

BIS paper on measurement methodologies gi

Published in 2021, but findings pretty much hold.

- We require **new, unique data**, different from what was traditionally collected
  - New for economists and financial regulators
  - Diverse across various types of climate risks
  - Not collected systematically yet (mostly)
- **What kind of data?**
  - Data describing physical and transition risks
    - Frequency and impact of wildfires, floods, droughts, ...
    - We need both historical data and forecasts
  - Vulnerability metrics - how exposed are financial institutions' balance sheets to these risks?
    - Physical locations of borrowers' operations, location of collateral, exposures to physical risks
    - GHG emission content of borrowers
    - Borrowers' sensitivity to energy prices
    - Borrowers' dependence on corporates outside the country
    - Sensitivity of non-credit assets to climate risks, incl. possible sensitivity of asset prices
  - Data that link vulnerability to financial metrics
    - Here, BIS means various parameter estimates, elasticities, etc.
- What **solutions** have been proposed?

    - Sector-level GHG emission data
    - Firm-level GHG emission data
    - "Carbon footprint" of bank lending
        - How much GHG emissions correspond to 1 USD of bank loan portfolio?
    - Various green ratings and scores
- The report is not terribly specific, but provides an overview of the problem

---

ECB / ESRB Paper

The paper and its Annex provide large number of specific metrics.

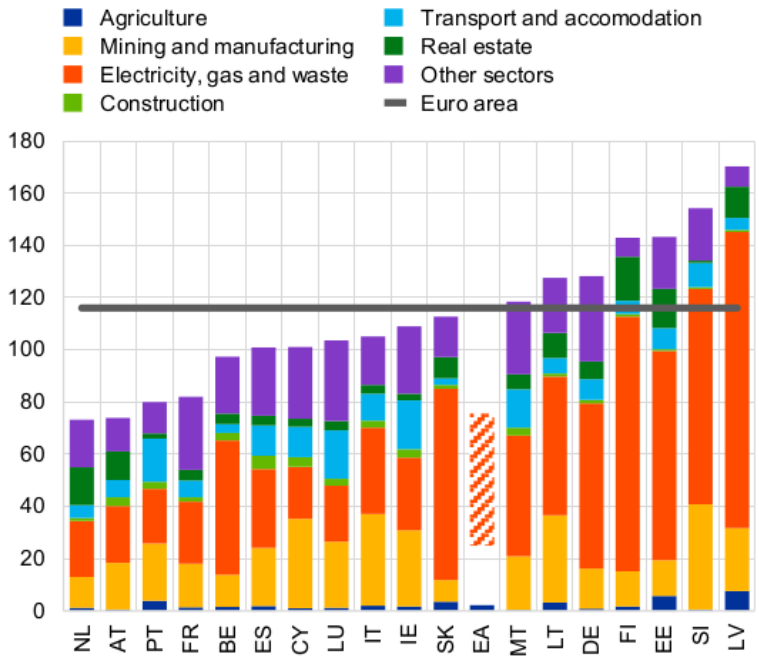
- Probably the most detailed source on possible data and metrics available
- Very long: 130 + 40 = 170 pages... but still does not provide any definitive answers or guidance, it's more of a wishlist
- Provides examples with information about possible sources, lots of charts, formulas for calculation, ...
- Can **serve as a benchmark** if you have nothing else available
- It is unclear how reliable is some of the data (esp on physical exposures)
- Main problem: these metrics are (mostly) not readily available, need to be constructed

Exposure metrics:

- GHG emissions of HHs, corporates, sovereigns - in practice, we mostly have data on corporates (HH data very limited)
- Firm level exposures:
  - GHG emissions per revenue / profit
  - EU ETS (cap-n-trade scheme) provides best info here
- Bank-level exposures:
  - Loan-weighted emission intensity: sectoral GHG-emissions divided by sectoral GVA, weighted by share of credit to that sector
  - IMF calls this indicator "Carbon Footprint-Adjusted Loans to Total Loans"
- Transition exposure coefficients (TEC):
  - Share of activities in each sector which need to transition, either because the activity is linked to fossil fuels or because it is particularly energy-inefficient
  - Portfolio transition risk exposure is obtained by applying to each loan or security the TEC associated

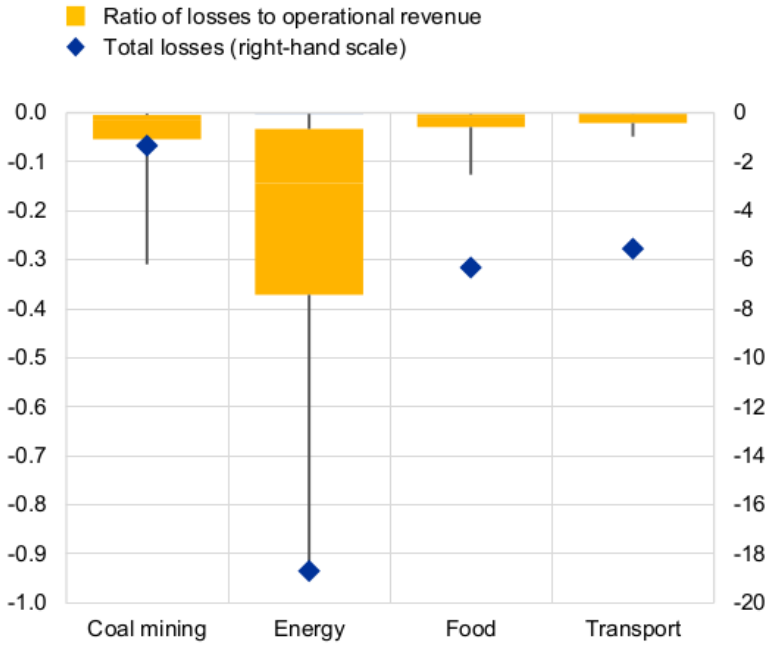
---

(y-axis: kg of CO2-equivalent tons per € 1,000 revenues, 2020)



b) Impact of a €100 increase in carbon prices on firms in EU ETS scope relative to operational revenue

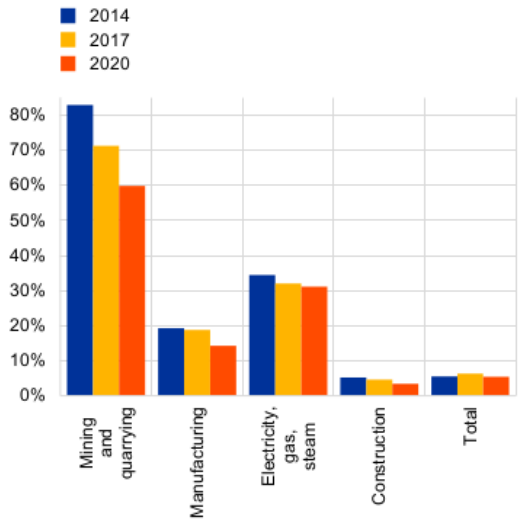
(percentages, by sector)



Transition exposure-based metrics

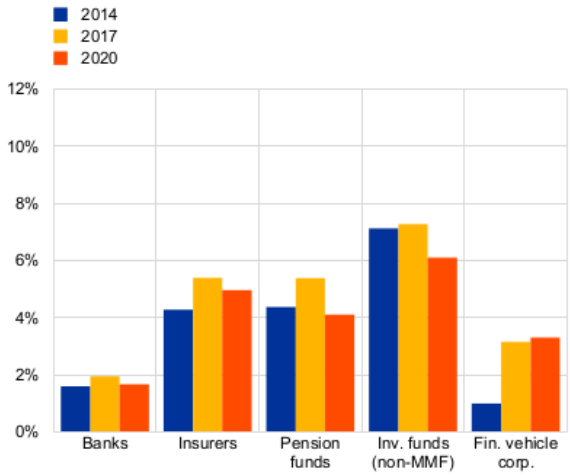
a) Share of transition risk exposure of financial investments into selected economic sectors

(percentages)



b) Share of transition risk exposure of selected financial investor types

(percentages)

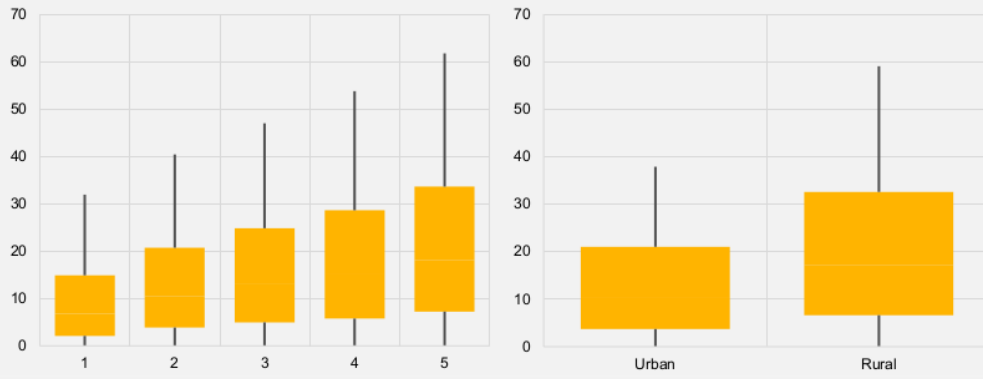


Sources: ECB Securities Holding Statistics and further calculations based on TECs proposed by Alessi and Battiston (2021).
Notes: The bars represent the share of bonds and equities exposed to transition risk based on the TEC coefficients developed

Chart A

Distribution of annual household energy emissions by gross income and location (urban/rural)

(tonnes of CO2 emissions per year; left panel: x axis – income quantiles, y axes both panels – annual household emissions)

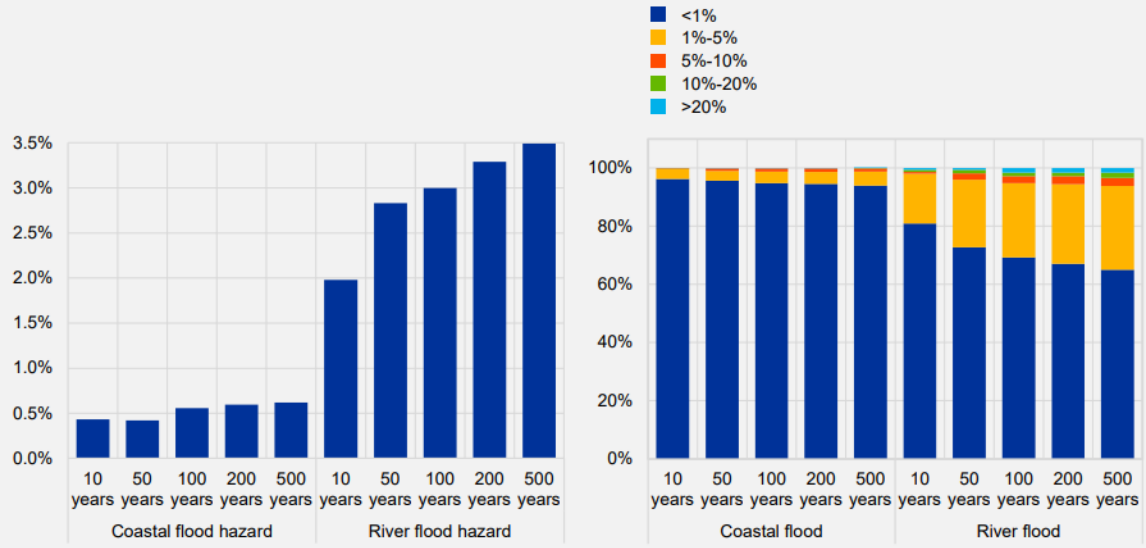


Source: Irish Central Statistics Office Household Budget Survey 2015/2016 and Project Team calculations.
Note: CO2 emissions are estimated using expenditure for electricity, gas, oil, petrol, diesel and solid fuels, common prices for each fuel in 2015/2016 and emission conversion factors for each fuel for Ireland.

Exposure to flood risk in Italy by return period

a) Share of bank loans to firms located in areas at (flood) risk relative to total credit to firms (percentages, AnaCredit loan exposures)

b) Distribution of share of total credit by Italian banks to firms by maximum expected (flood) credit risk and by return period (percentages, share of loan at risk)



Risk and vulnerability metrics:

Linking climate risk exposures to traditional sources of financial vulnerability to provide insight into financial risk relevant for financial institutions.

Transition-to-credit risk-intensity (TCI): combines bank loan exposure with firm exposure to emissions (transition risk).

$$TCI = \frac{1}{L} \sum_i \frac{E_i}{R_i} \cdot PD_i \cdot L_i$$

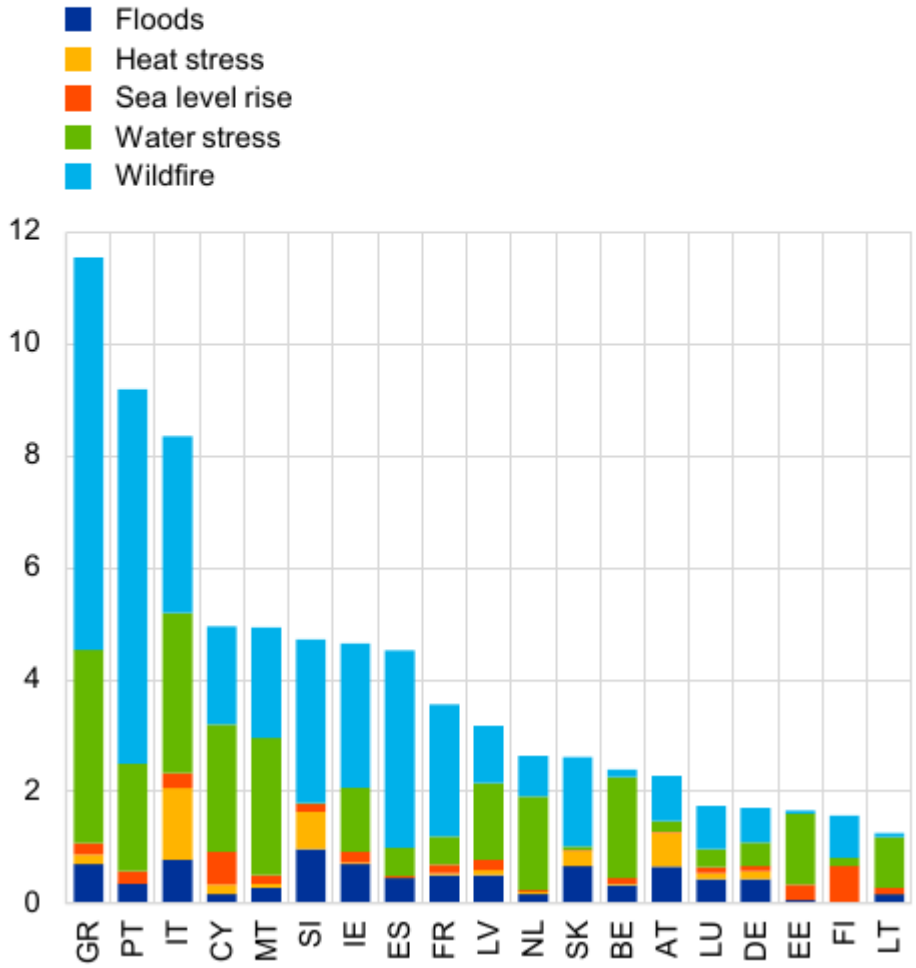
where

- E_i are emissions of firm i
- R_i are revenues
- PD_i is the probability of default
- L_i is bank exposure to firm i
- L is total bank exposure

Physical-to-credit risk-intensity (PCI) score: replaces emissions with (firm-level) vulnerability to natural disasters.

Share of loan exposures towards high risk borrowed to (PCI) tail risk firms in 2019

(y-axis: weighted by country-level loan exposures; x – axis euro area countries)



IMF Climate Dashboard

gi

- Probably the single best source available
- Aggregates also data from other sources, including NGFS
- You can download all available data for each country
- Let's explore

Other useful resources

gi

Could be useful, if only as inspiration.

- EU Climate Change database
- ResourceWatch data on GHG emissions by country, split into 6 sectors
- GermanWatch Index (link): maps country-level exposure to weather-related disasters, in terms of human and economic cost
- World Bank Country Climate profiles (link): not very quantitative, but interesting nevertheless
- ND-GAIN Index (link) measures a country's exposure, sensitivity and capacity to adapt to the climate change
  - Based on 70+ variables
- Georgia climate risk radar (link)
  - Top-down approach: Using available data to assess the potential climate risk of a sector
  - Using expert assessment to rank sectors in the Georgian economy
  - Great practical example that could be basis for future regulation, stress-testing, etc.

Figure 6: The Scoring System of the Risk Radar

NACE-Code	Sector			Scoring			Reference
	Physical Climate Risk	Acute		0-4 Weight 50%		0-4	1
		Chronic		0-4 Weight 50%			2
	Transition Climate Risk	GHG-Emission Contribution		0-4 Weight 50%		0-4	3
		Transitional Intensity	Probability of regulatory Change	0-4 Weight 25%	0-4 Weight 50%		4
			Economic Impact of regulatory Change	0-4 Weight 25%			5
			Technology Squeeze-out	0-4 Weight 25%			6
			Customer/ Consumer Behavior	0-4 Weight 25%			7
	Other ESG Risks	Loss of Biodiversity		+0,5		0-2	8
		Other Environmental Risks		+0,5			9
		Possible Human Rights Issues		+0,5			10
		Other Social Risks		+0,5			11
	ESG-Risk Score at Sector-Level					**0-10**	

Figure 8: Example of a Sector Profile

Ref.	Explanation of the Assessment	Score
1	The Global Climate Risk Index (Eckstein et al. 2021, 36) lists Georgia at rank 108 of the countries most affected by extreme weather events. This translates into an **obvious** danger (score 2). In contrast, EU4Climate (2021, 2) ranks Georgia "highly vulnerable to the effects of climate change", naming acute physical climate risks that include increased frequency and severity of flooding and landslides. This translates into an estimation of **significant** economic damage (score 3). As a compromise, the mean between both scores is used (**score 2.5**). Agriculture is the sector most exposed to extreme weather events, hence there is no further mitigation of the score for this sector.	2,5
2	The Climate Risk Country Profile compiled by World Bank Group and Asian Development Bank (2021, 2) expects an above-average temperature rise for Georgia as well as severe droughts and water shortages. In addition, due to glacier-shrinkage, the water supplies via rivers is threatened. This translates into **significant** economic consequences (**score 3**).	3
3	According to the National Greenhouse Gas Inventory Report of Georgia 1990-2017 (2021, 36 (2-20)), the sector accounts for the second highest GHG-emissions of all sectors (approx. 20%). As a comparison: Also the EU-Taxonomy (EU Technical Expert Group 2020, 12) lists this sectors GHG-emissions among the highest. GHG-Emission Contribution is thus considered to be **existential** (**score 4**).	4
4	One aspect of Georgia's 2030 Climate Change Strategy and 2021-2023 Action Plan (CSAP 2020) is to support development of low carbon approaches in agriculture sector. In contrast to other sectors, this objective is less concrete. However, there is a **significant** probability of regulation for the sector (**score 3**).	3
5	As the CSAP (2020) is less concrete with its objecives, it is plausible that the impact of the legislation will be **obvious** but not yet significant (**score 2**).	2
6	There is evidence of organic farming (Nadiradze, without date) being adopted as an alternative model to conventional farming with positive aspects concerning climate change mitigation and adaption. While it is said to be promoted by the government, currently the implementation seems **perceptible** but not yet a competition to conventional farming methodology (**score 1**).	1
7	As a consequence of the assessment under 6, the customer demand of organic food is estimated to be to date only **percebtible** (**score 1**).	1
8	It can be shown that monocultures, the use of pesticides and fertilizers as well as the practices of burning crop residues are reducing the rich biodiversity of Georgia (Müting 2017).	0,5
9	There is a significant problem of soil erosion due to strong winds in combination with extensive tillage using heavy machinery. This leads to a significant loss of the humus layer on top and thus to a loss of nutrients (Müting 2017).	0,5
10	No indication for human rights issues has been found for this sector.	0
11	There is indication that other social risks are caused especially concerning the use/misuse of pesticides.	0,5