Climate risks and firms

A new methodology for assessing physical risks

Michele Loberto, Riccardo Russo

Banca d'Italia
Dipartimento di Economia e Statistica

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Motivation

- Spatial accuracy of assets location and hazards maps is crucial for assessing climate-related physical risks, in particular for floods
- Most studies on floods and firms face challenges in this respect:
  - Distribution of firms' activity across different sites (locations, employees, value added)
  - Private investments in adaptation
  - Hazard maps
  - Identification of firms damaged by extreme events (floods)

This paper

- This paper tackles two issues:
  - Distribution of firms' activity across different sites
  - Private investments in adaptation
  - Hazard maps
  - Identification of firms damaged by floods
- Are the measurement errors in these dimensions negligible or significant?

Spatial accuracy matters (I)

- **Distribution of firms' activity** across different sites:
  - May be known in specific contexts, such as a geographic area (e.g. NYC - Indaco et al, 2021) or industry sector (e.g. car industry - Castro-Vincenzi, 2022)
  - On the broad scale is mostly unknown, e.g. ECB's report on climate change-related indicators in which accurate data are available for few countries
- We will leverage on the **Business Register** dataset (Infocamere) $\rightarrow$ company legal address (headquarters) + secondary units (e.g. factories, warehouses) + employees at the municipal level

Spatial accuracy matters (II)

- **Identification of flood affected areas** - assessments are usually made on inaccurate, low-resolution data:
  - Darmouth Flood Observatory often provides the centroid of the flooded area (Kocornik-Mina et al, 2020; Castro-Vincenzi, 2022)
  - JRC Risk Data Hub and EM-DAT assign flooded status to whole administrative units (Fatica et al., 2022, Gandhi et al. 2022)
  - Ad-hoc sources at municipality level and rainfall data (Coelli e Manasse, 2014)

$\Longrightarrow$ **Flooded status cannot be assessed at the firm level**

- Our evaluation is based on **Copernicus Emergency Management Service** (CEMS)

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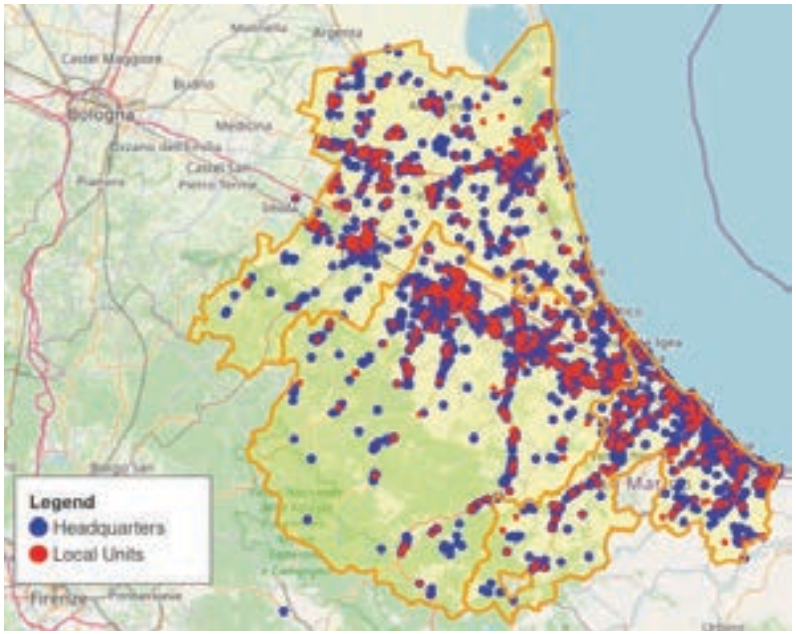
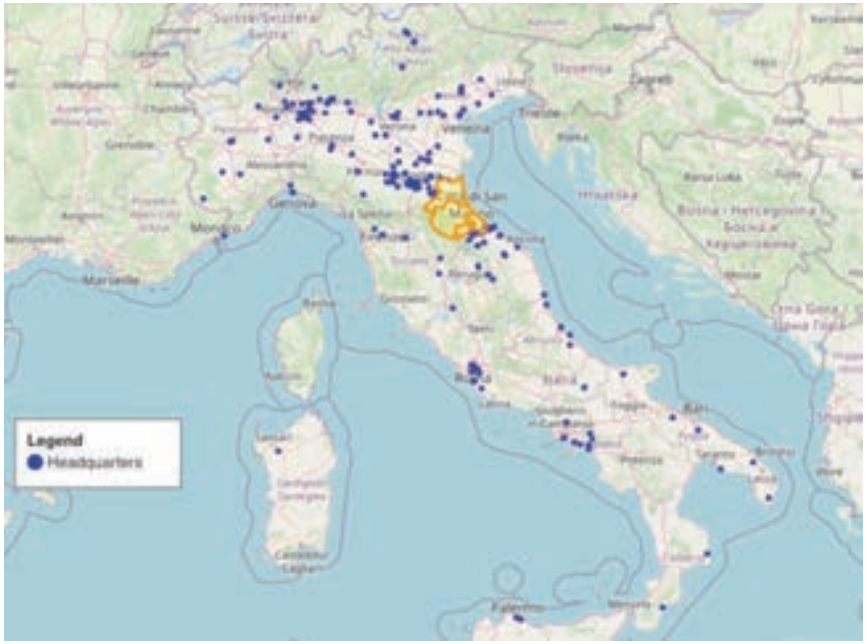
The data

Business register data

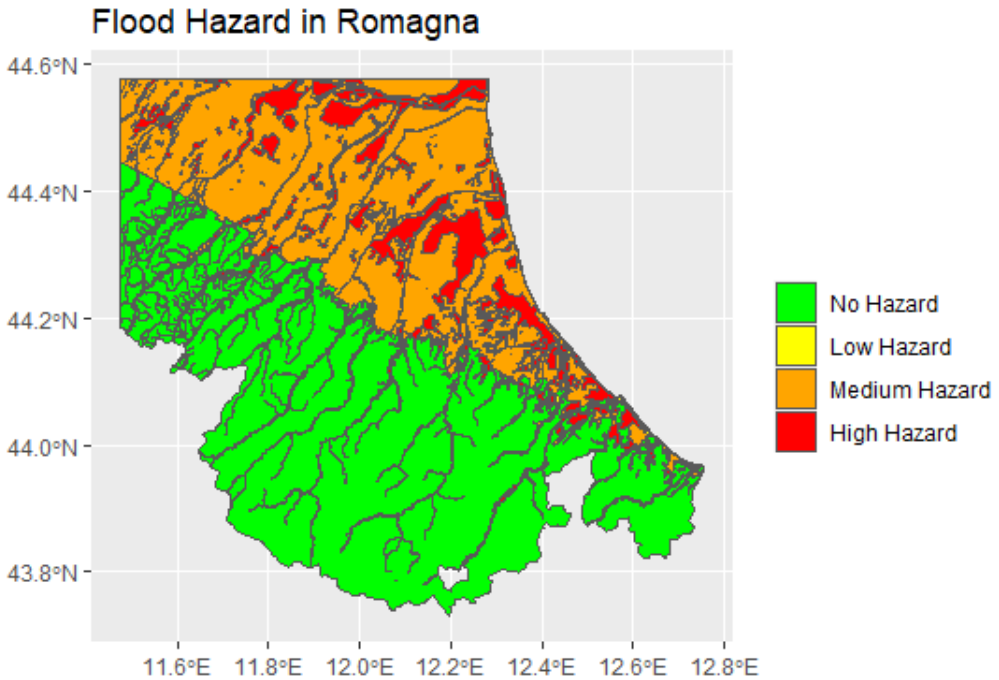




- We select from the business register (InfoCamere) **manufacturing** companies based in Romagna or operating at least one site in Romagna
- Florid manufacturing district (4k companies, 9k business sites, 80k employees)

Flood hazard data

- To evaluate flood risk in Romagna region we used flood hazard maps (from ISPRA)
  - They are known to be accurate in this area
  - In May 2023 a vast flood event hit the region → ex-post evaluation of these maps

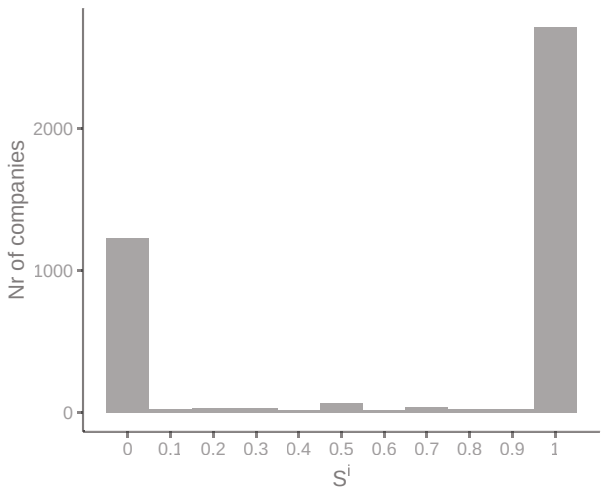


Flood exposure indicators

Methodology for the assessment of physical risk (I)

The idea is to use the number of employees in each branch to weight the relative expositions in a unique indicator, e.g.:

- Company i has headquarters H in a safe area and one branch B in a dangerous area
- 100 employees in H, 100 employees in B $\rightarrow$ **50%** employees exposed
- We can use this share S^i = **0.5** as compound indicator for Company i



- 7% of companies show partial exposure (S^i != {0,1})
- However, these tend to be larger and account for 57% of employees in the sample

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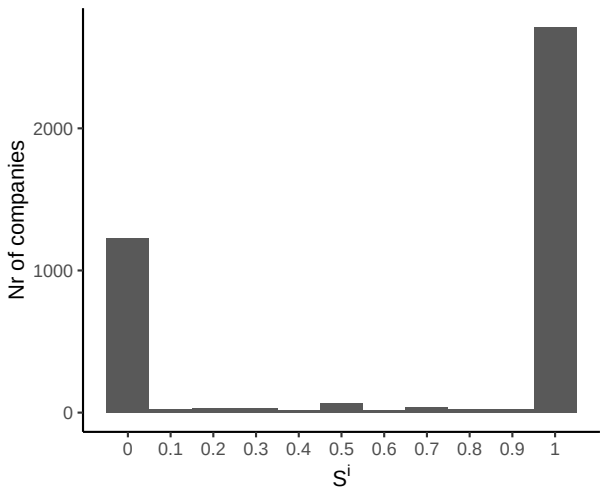

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Accounting for local units matter

We compare our methodology to an approach based on headquarters only

- **HQ only**: all employees assigned to HQ location

	Exposure to any flood hazard		
	Full	Partial	Null
HQ only	2775	-	1382
HQ + local units	2655	307	1195

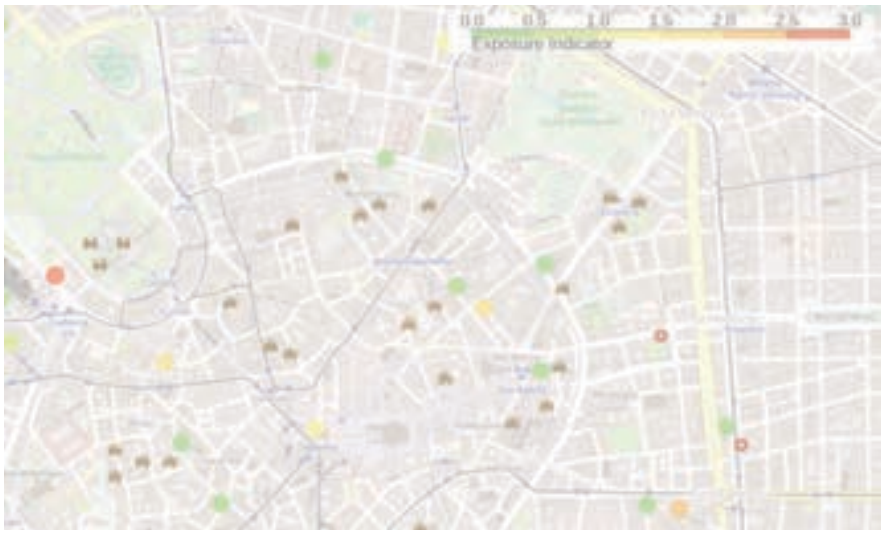
- Overestimate of *'safe'* companies (+16%)
- The 187 companies that would incorrectly be considered safe represent **30% of employees** in our sample

$\Longrightarrow$ **Accounting for local units is crucial, in particular for large firms**

Methodology for the assessment of physical risk (II)

Different procedure if k hazard levels are introduced, e.g.:

- k=N (no risk), k=L (low), k=M (medium), k=H (high)
- We compute an exposure indicator E_i ranging from 0 (no employees in danger) to 3 (all employees exposed to high hazard)



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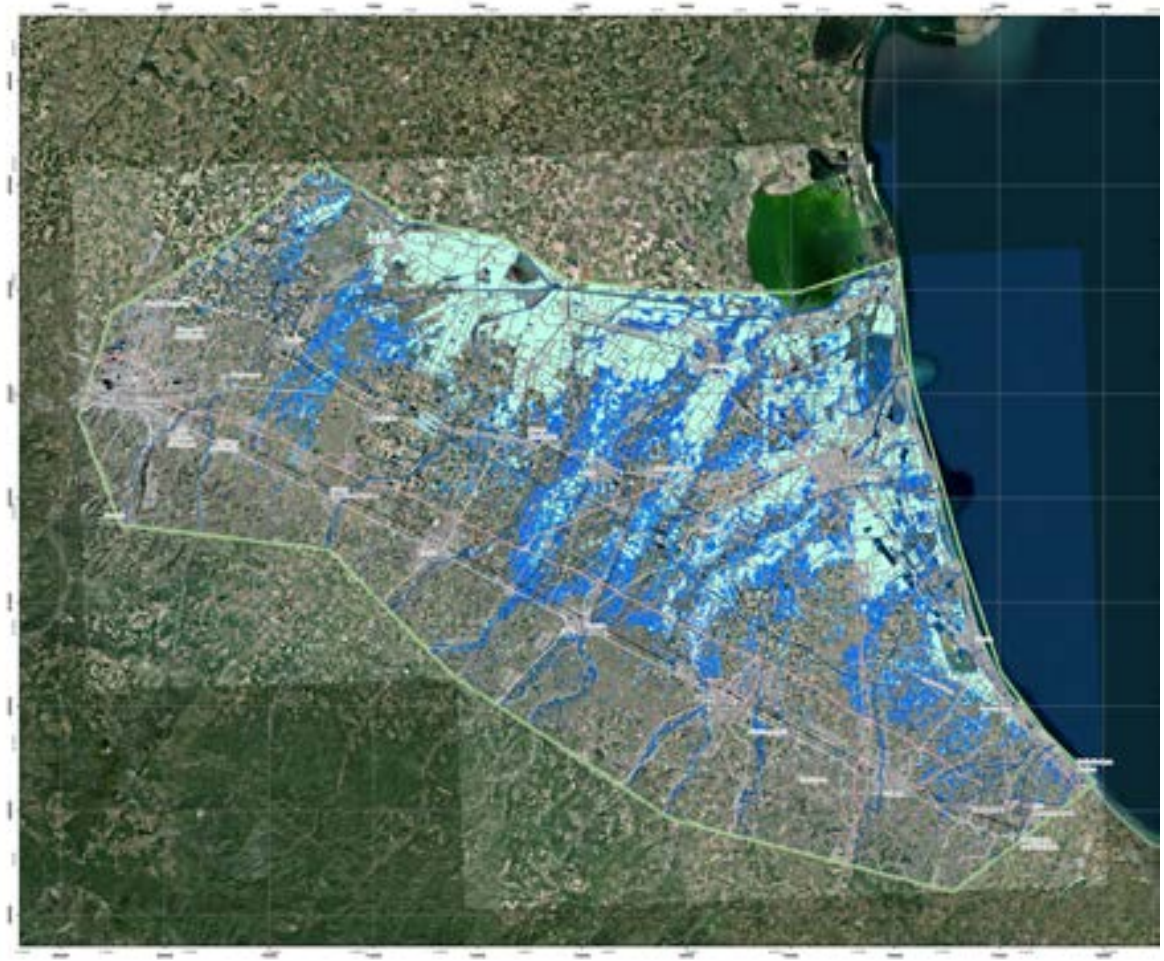
Identification of flooded firms

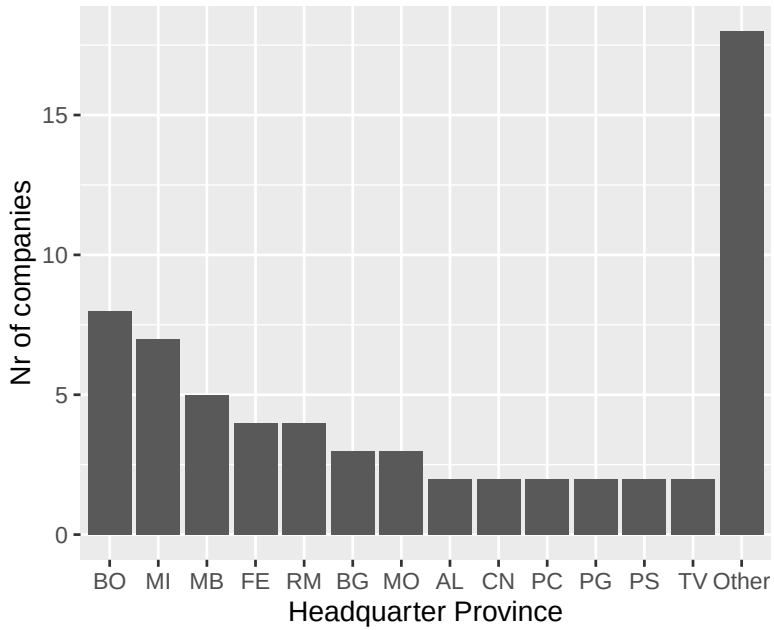
CEMS - Risk and Recovery mapping



- Source: Copernicus Emergency Management Service
- Based on satellite, in situ (ground) and model data
- Flooded area detected with $> 98\%$ accuracy, $\sim$ 10m resolution

2023 Flood Impact (I)

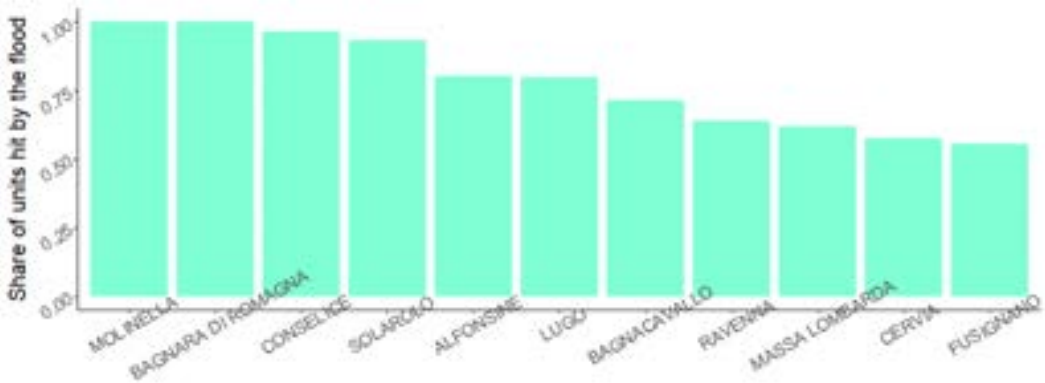
- 10m resolution allows us to discriminate flooded and non-flooded companies, even when they are close to each other
- $\sim$ 1200 sites ($\sim$ 18000 employees) hit by the flood
  - 99% in medium to high hazard areas $\rightarrow$ sensitivity of ISPRA maps
  - $\sim$ 10% of companies hit by the flood have headquarters outside Romagna $\rightarrow$ spillover outside affected regions

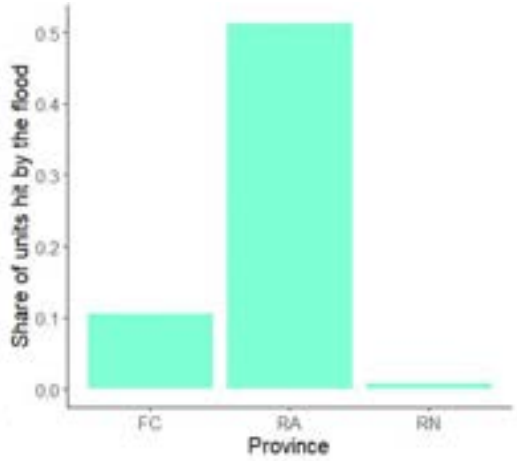


2023 Flood Impact (II)

- We estimated the exact share of flooded companies **at municipality and province level**
- Compared to standard datasets (e.g., EM-DAT), there is a substantial reduction in measurement error

$\Longrightarrow$ **Within-municipality variation of flooded status**

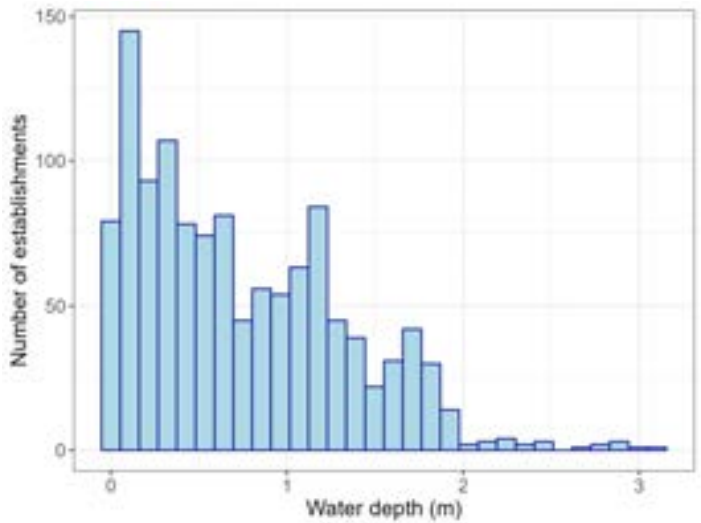




2023 Flood Impact (III)

- CEMS maps allow us to evaluate flood severity by mean of the maximum water level reached during the flood **at unit level**
- The median water depth was 0.6m, but for some firms it exceeded 2m

$\Longrightarrow$ **Evaluation of event intensity at site level**



Conclusions and Outlook

- Assessing how climate-related hazards affect firms can be hindered by measurement issues:
  - Not accounting for the distribution of firms' activity across different sites introduces significant measurement error
  - New data sources allow a more accurate identification of firms hit by climate-related extreme events
- Do these sources of measurement error matter?
  - Future work: match 2023 balance sheets to CEMS data on flooding status and intensity to estimate the economic impact of the event

THANK YOU