

An experiment to measure physical climate risks in FDI between France and Italy

Mapping FDI vulnerability to
physical climate change risks



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Motivation

Climate change impact

- Increasing exposure to extreme weather events (floods, heatwaves, wildfires) causing significant economic losses (€162 billion in EU between 2021-2023).

FDI relevance

- Foreign Direct Investment (FDI) is a key driver of globalization, involving long-term investment commitments. Physical climate risks threaten the long-term viability of FDI. Implementing active climate-resilient strategies help mitigate risks.

Data gaps

- G20 Data Gaps initiative emphasizes need to improving measurement of climate change statistics (physical and transition risks, green house gas emissions).

Research gap

- Limited empirical literature on the role of physical climate risks in shaping FDI patterns.

Main objective

- Develop statistical methodological framework, with case study to test it

Our contribution

Main innovations

- **First firm-level framework to map FDI exposure to physical climate risks** (floods, wildfires, heat) using geospatial hazard data.
- **Addresses FDI domestic ownership chain complexity** in host country: considering affiliates and establishments
- **Links FDI firms' geo location with high-resolution climate risk maps** with risk assessments (historical projections contrasted with future climate scenarios).
- **Cross-sectional analysis:** economic activities (e.g. agriculture, manufacturing, mining) and regional climate disparities (e.g., French mediterranean wildfires vs. Italian northern floods) regarding FDI.

Policy-relevant insights

- Identifies more climate vulnerable economic activities/regions, guiding climate-resilient FDI strategies.
- Supports information on targeted policy interventions (e.g., adaptation investments).

Why this matters for statistical community

- Develop extensible statistical framework: showcase the feasibility to develop relevant FDI climate change indicators applicable to EU countries
- Actionable evidence: Moves beyond theoretical frameworks to empirical, data-driven insights.

Methodology (1)

Objective: measuring the exposure of bilateral FDI positions between FR and IT to physical climate risks.

Scope: Financial corporations excluded, except financial holding companies and head offices

- Indirect “balance sheet” exposure vs direct physical exposure
- Real estate is also excluded, due to data constraints (geolocation).

Focus: equity component of FDI

Structure: three phases:

- (1) decomposition of FDI enterprises into elementary units;
- (2) risk assessment of elementary units, based on geolocation;
- (3) aggregation of risk score at FDI level.

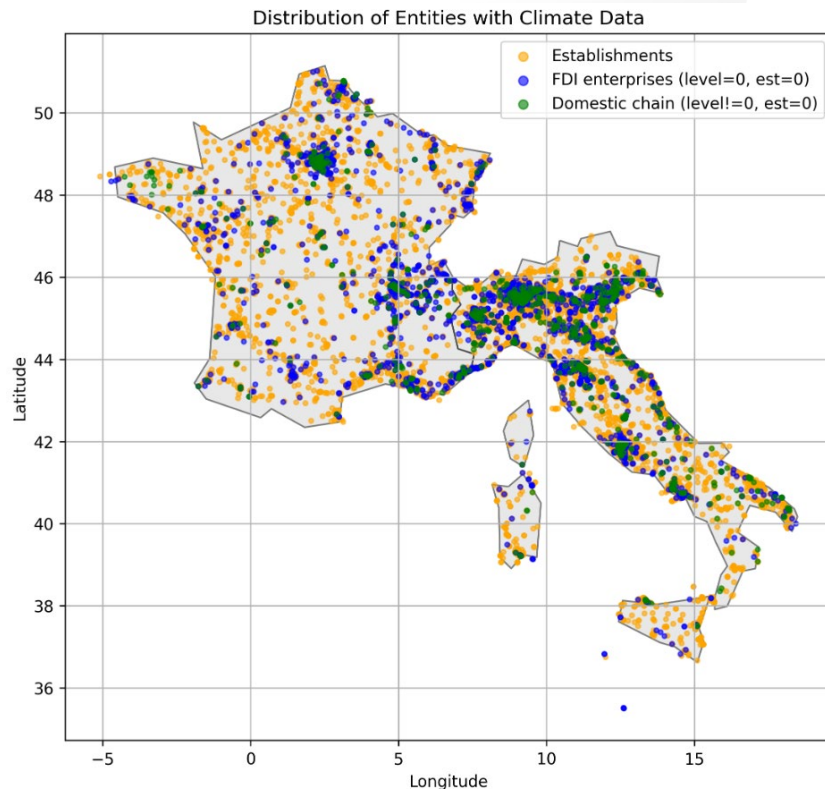
Methodology (2)

Phase 1: Top-down decomposition of inward bilateral FDI into elementary units



Phase 1 output: list of elementary units (DIE + subsidiaries + establishments), including their addresses and number of employees

Distribution of entities in the dataset



Country	French territory	Italian territory
Nr of DIE	1,545	2,413
Employees (total)	324,528	332,274
Bilateral FDI value (EUR mln)	13,811	41,521
% of total bilateral FDI (end 2022)	52%	55%

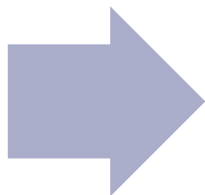
- DIEs and domestic chain units tend to cluster in big cities
- Establishments are more equally spread across the territories

Methodology (3)

Phase 2: assign climate risk scores to each elementary unit identified in phase 1.

Geocoding

For each elementary unit, use the address and [OpenStreetMap](#) to obtain latitude and longitude coordinates



Mapping each location with risk scores

Leverage the innovative dataset developed by the ESCB STC Expert Group on Climate Change, which enriched ECB's RIAD (Register of Institutions and Affiliates Dataset) with physical hazard data from Copernicus, EC Risk Data Hub, Delft University of Technology, IPCC, Aqueduct WRI.

RIAD+ allows to assign scores in various risk dimensions (wildfires, water stress...) to our set of firms in two ways:

[ECB SPS: Climate change-related statistical indicators](#)

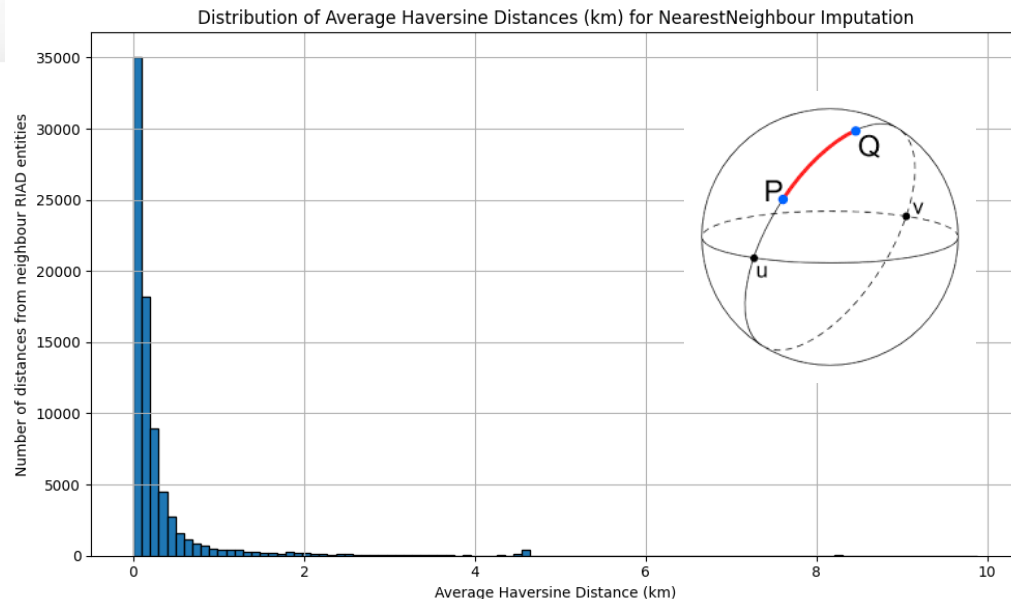
Directly: If the elementary unit is included in RIAD+, its risk scores are directly retrieved (~ 20% of entities are covered)

Indirectly: if the unit is not included, its risk scores are assigned through **spatial interpolation**, using 5 nearest neighbors in RIAD+

Methodology (4)

Spatial interpolation for missing risk scores:

- We compute haversine distance of potential neighbors. Through Ball Tree algorithm we select the nearest 5 and take their **median** score
- Justification: strong spatial autocorrelation of climate hazards and high density of RIAD+:
- Average haversine distance of nearest neighbors is very small. In 95% of cases is less than 1 km.



Phase 2 output: Risk scores computed at the elementary unit level, remapped to their original scales (probabilities, expected annual losses, etc.) to enable Phase 3 calculations.

Methodology (5)

Phase 3: aggregation of elementary units' risk scores into FDI positions.

Bottom-up, hierarchical consolidation of risk scores

Elementary unit → DIE:

- DIE's score is the weighted average of risk scores of establishments and affiliates, weighted by the relative number of employees

DIE → Economic activity (NACE)

- Industry score is the weighted average of its DIEs, weighted by their relative equity

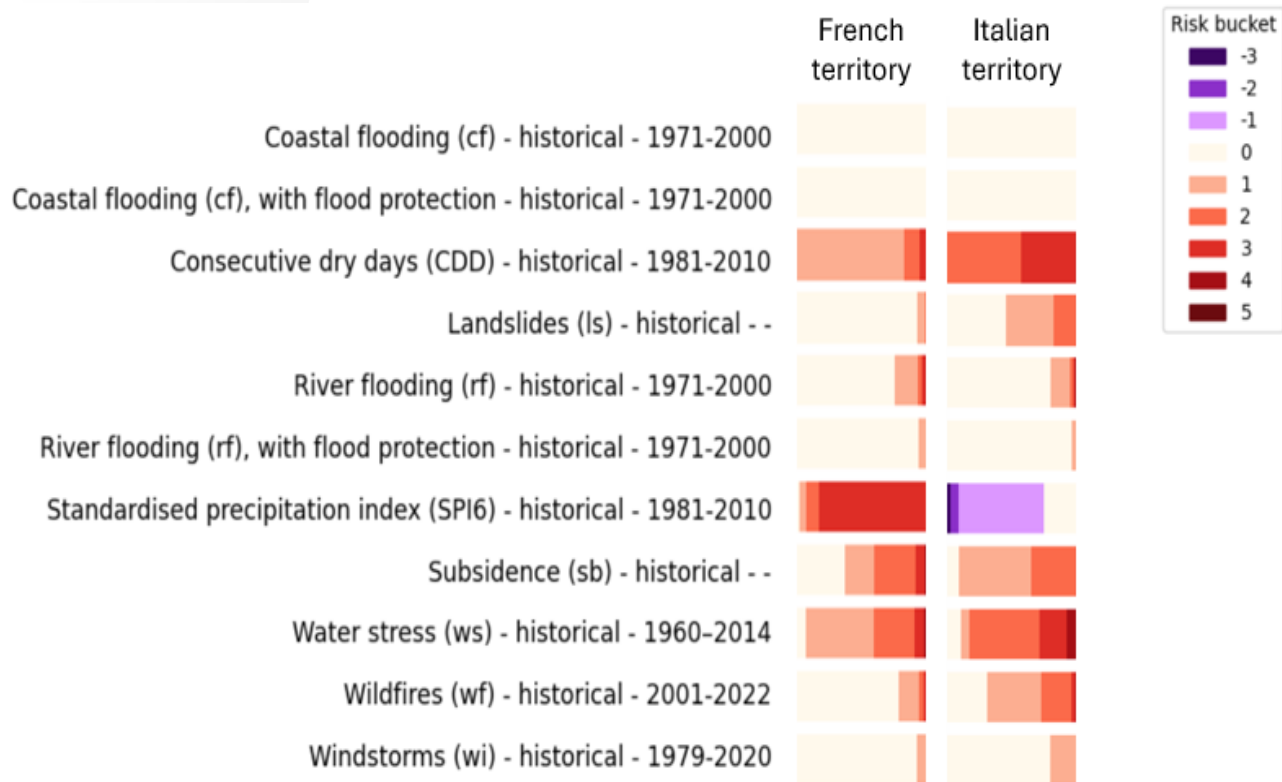
NACE → FDI inward position

- Combine NACE risk indicators into overall FDI exposure weighting each sector by its share of total FDI equity

Phase 3 output: Climate physical risk scores of FDI positions, with scores reassigned to their original ordinal values and detailed breakdowns.

Results: Exposure of bilateral FDI to climate risk dimensions

- Several climate scores have been computed both for historical and Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios
- Scores typically range: **0 (low risk) to 5 (high risk)**, except for Standardized precipitation index
- Bilateral FDI investments in France and Italy are exposed to different type of risks
- e.g. **French FDI in Italy is exposed to higher risk of drought** (negative SPI6 and higher nr of consecutive dry days)

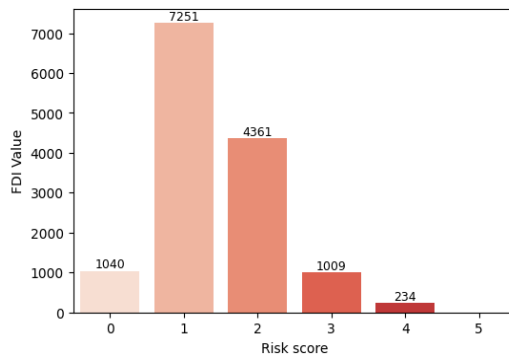


Results: FDI distribution by buckets of risks

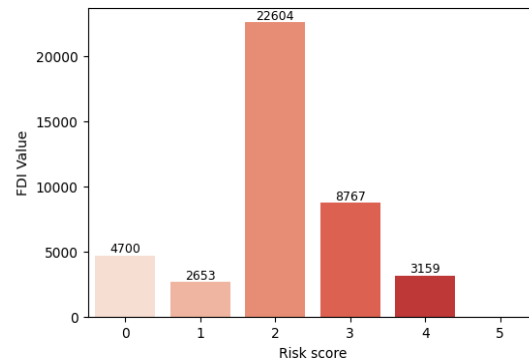
- FDI bilateral stocks allocated to different **buckets of risks**
- Some hazards affect very few enterprises
- **Scores with widest distribution across risk categories:** water stress, wildfires, consecutive dry days, subsidence, SPI

Water stress

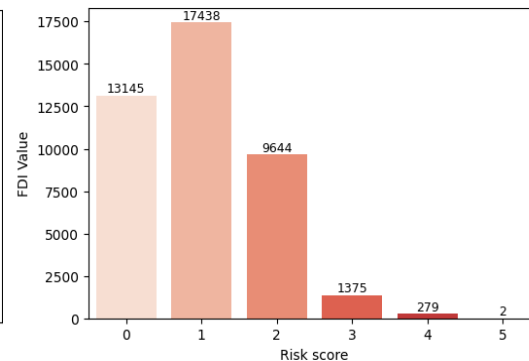
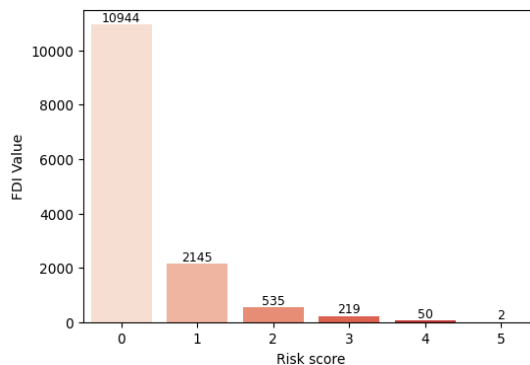
French territory



Italian territory

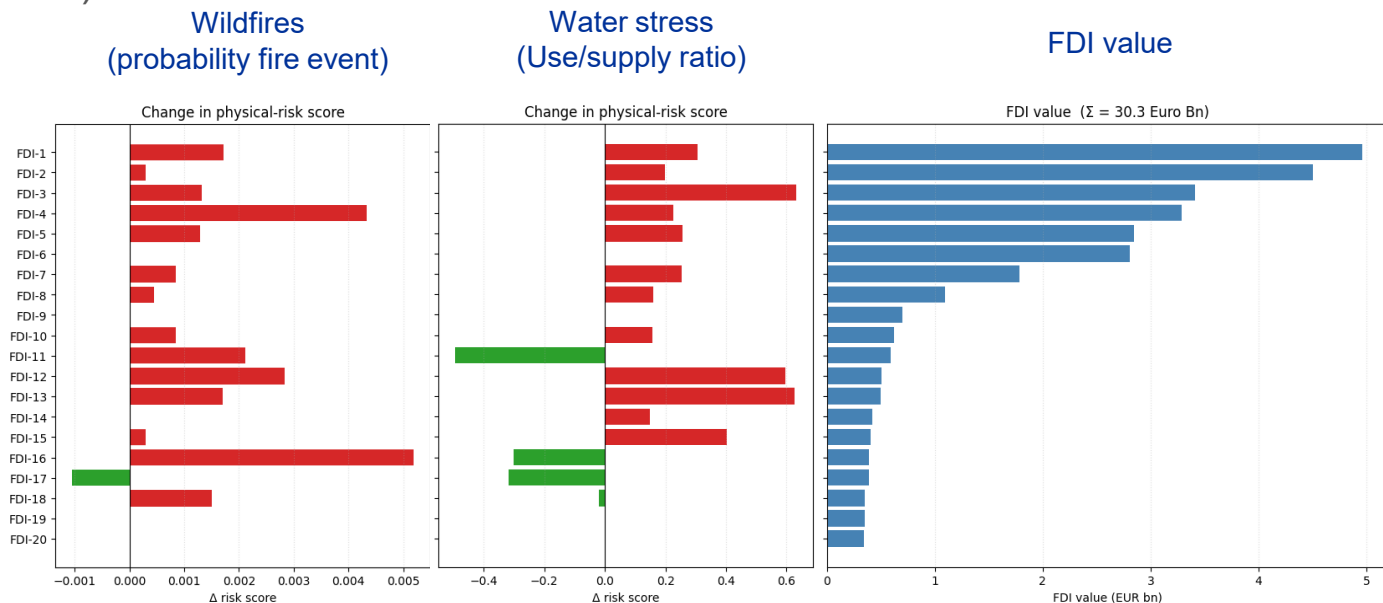


Wildfires



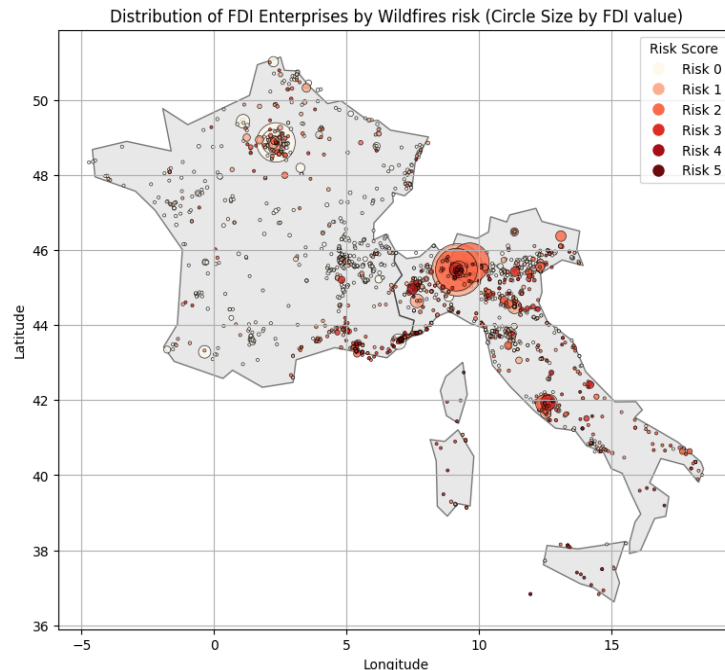
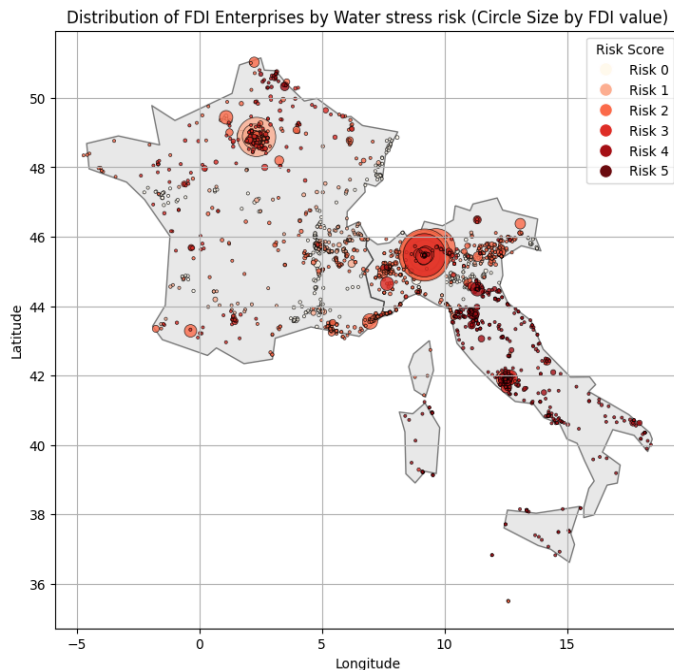
Results: The impact of subsidiaries and establishments

- Including subsidiaries and establishments **increases**, on average, the risk scores of the top 20 FDI enterprises (by FDI value)
- The top 20 FDI enterprises account for 55% of the total FDI value in the dataset (end-2022)



Results: Geographic distribution of risks

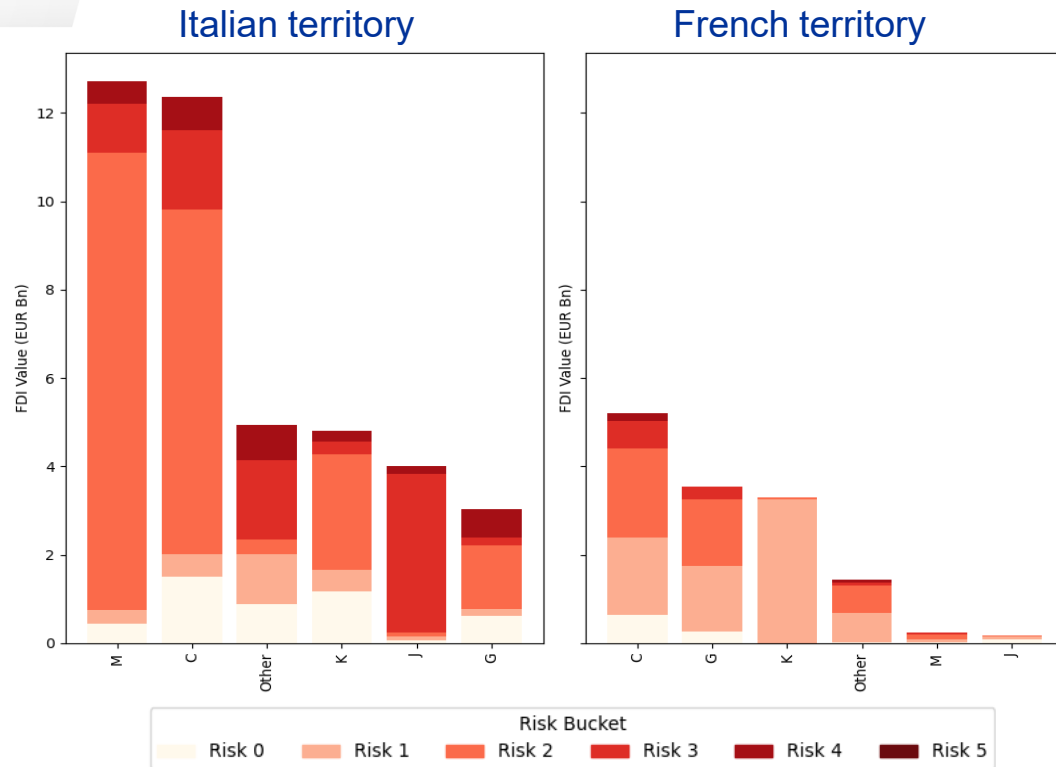
- In this dataset, regions where DIEs are exposed to higher risks tend to have lower FDI investments
- FDI enterprises located in the same area might have different risk scores due to the different distribution of subsidiaries or establishments



Results: Risk distribution across NACE activities

- NACE activities like agriculture or mining are highly exposed to water risk but account for a relatively small share of total FDI.
- The **most relevant activities** in terms of FDI and risk exposures are Manufacturing (**C**), Professional, scientific and technical activities (**M**), Wholesale and retail trade (**G**) and Information and communication (**J**).
- Financial and insurance activities (**K**) include financial holding companies and head offices.

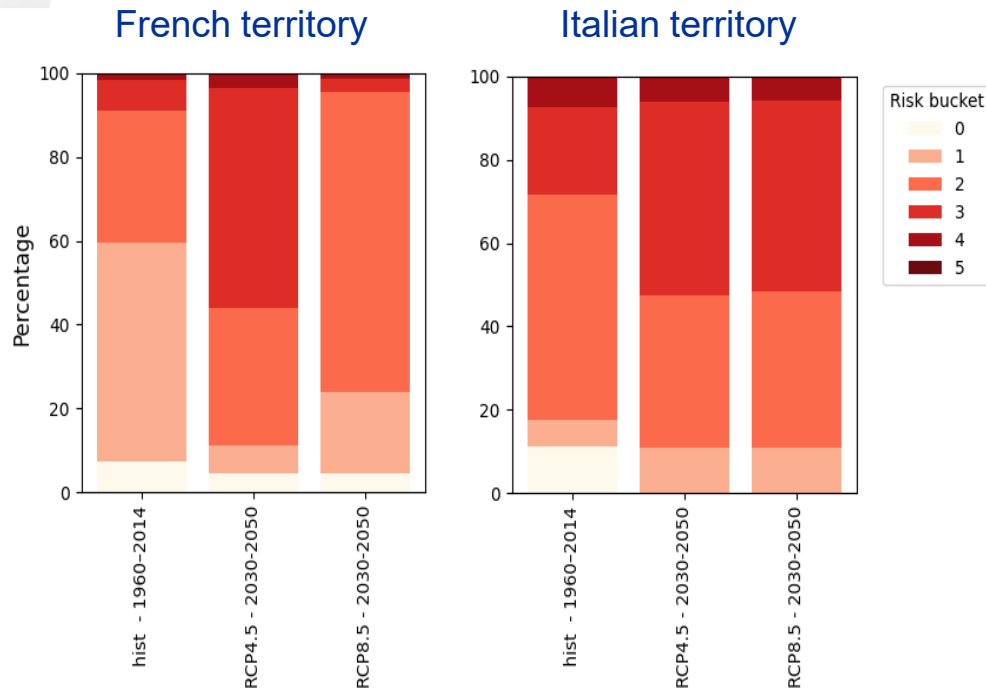
Water stress



Results: Risk evolution under RCP 4.5 and RCP 8.5

- For French FDI in Italy, the results show increasing exposure to water stress on both RCP 4.5 and 8.5 pathways.
- In contrast, for Italian FDI in France, the exposure is higher under the moderate-emission scenario than under the high-emission scenario.

Water stress



Conclusions and next steps

Key takeaways

- **Innovative methodological framework:** First firm-level methodology quantifying FDI exposure to physical climate risks (floods, wildfires, water stress) using geospatial hazard data.
- **Considering the domestic chain and establishments** is critical for accurate climate physical risk assessment.
- Applied to France–Italy bilateral FDI: reveals geographic concentration of acute risks (e.g. wildfires) and broader distribution of chronic risks (e.g. water stress).
- **Economic activity heterogeneity:** Some NACE activities like agriculture or mining are highly exposed to physical risk but account for a relatively small share of total FDI.
- **Policy Implications:** High-risk regions and specific industries require targeted adaptation strategies to protect FDI stocks. Investors must account for climate risks in long-term strategy, prioritizing resilience in vulnerable activities/locations.

Limitations and challenges

- Data gaps in geolocation accuracy, firm-level asset/employment data, and effects of erratic and stochastic climate events remains challenging to address.
- Indirect exposure of FDI in financial sector (banking and insurance).
- Local hazards maps for acute risks are usually delayed with respect to updates of the global climate models.

Future directions

- Pursue climate experts to develop expected annual losses for physical hazard risks and link it with FDI for composite physical risk statistics expressed in probability monetary losses.
- Directly link the location of FDI elementary units and detailed physical hazard maps (by-passing the use of RIAD).
- Explore "FDI climate distance" to assess misalignment of resilience strategies between direct investors and direct investment enterprises.
- Perform the analysis for several years (timeseries perspective).

Thank you!

Appendix

Literature review

Theoretical FDI frameworks

- International risk theory (Buckley et al., 2016)
- Dunning's ownership, location and internalization (OLI paradigm) (Shear et al., 2023)

Empirical evidence

- Negative impact of physical climate risks on FDI inflows (Gu and Hale, 2023; Jihad Ait Soussane et al., 2022)
- "Climate risk distance" (Xing et al., 2022): home vs. host risk matters with FDI flows higher when home country has greater climate risk
- Economic activity heterogeneity: Agriculture, forestry, fishing, mining, construction and manufacturing most vulnerable
- Geographical disparities: Higher risks in Caribbean, Middle East, Southeast Asia (Li et al. 2022) and in other developing countries

Methodological approaches

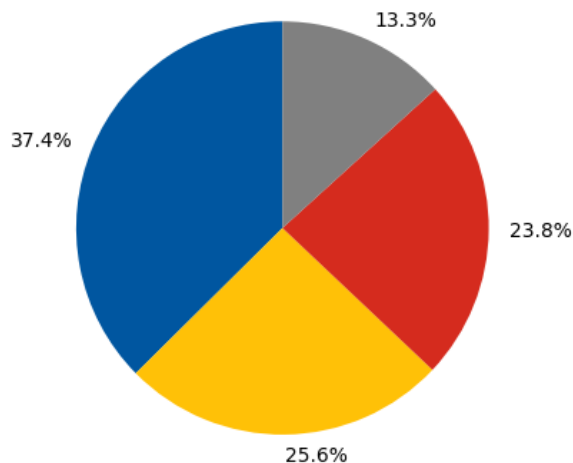
- Panel econometric models
- Limited firm-level analyses
- Integration of geospatial climate risk data with facility-level information

Research gaps

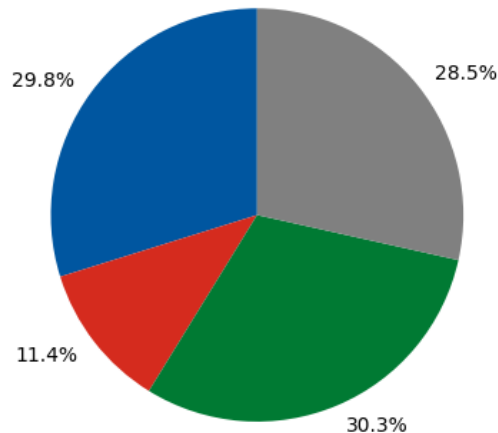
- Limited firm-level measurement between FDI and physical climate risks at geographical and economic activity levels

Results: Descriptive statistics on FDI

Italian FDI in French Sectors



French FDI in Italian sectors



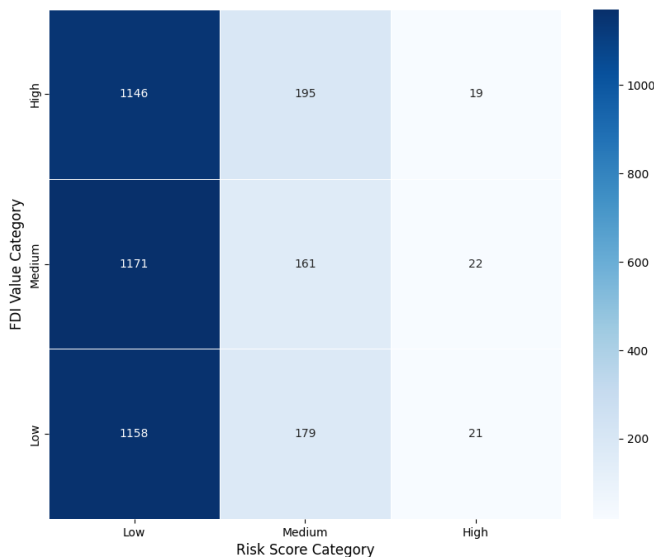
NACE Sectors

- C - Manufacturing
- G - Wholesale and retail trade; repair of motor vehicles
- K - Financial and insurance activities*
- M - Professional, scientific and technical activities
- Other

Results: Clustering

- Wildfire risk seems to affect similarly small and large FDI enterprises (localized risk)
- Water stress is affecting smaller FDI enterprises proportionally more than larger ones

Nr of FDI enterprises by FDI Value and Wildfires Risk Score



Nr of FDI enterprises by FDI Value and Water stress Risk Score

