European Commission

Floods and firms: vulnerabilities and resilience to natural disasters in Europe

Serena Fatica Gábor Kátay Michela Rancan,

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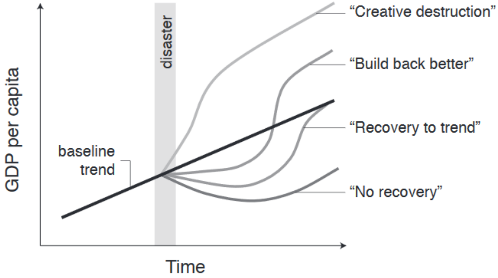
Motivation

- The past three decades are one of the most flood-rich periods over the past 500 years in EU (Blöschl et al., 2020).
- By 2100, in case of inaction against a 3 ℃ increase in temperature (Feyen et al., 2020, JRC PESETA IV report):
  - 3X more people would be exposed to floods each year;
  - Direct losses from river floods would increase by a factor of 6, and coastal flood losses would double.
- Objective: Assessing the dynamic impacts of floods on European manufacturing firms during the 2007-2018 period

Literature

- Creative destruction / build back better? (e.g. Leiter et al., 2009; Coelli and Manasse, 2014; Tran and Wilson, 2020)
- Recovery to trend? (e.g. Strolb, 2011)
- No / partial recovery? (e.g. Hossain, 2020; Indaco et al., 2019)



Source: Hsiang and Jina, 2014, NBER WP.

- Our results: i) Negative and persistent adverse impact on firm-level outcome; ii) No or positive impact on county-level outcome ⇒ These findings reconcile contrasting results in the literature and provide methodological indications to adequately assess the impact of natural hazards.

Data

- Flood data are from the Risk Data Hub loss dataset compiled by the JRC, EC
  - records year of the event and the area affected (NUTS3)
  - includes river floods, flash floods and coastal floods
- Firm-level information from the Orbis historical dataset
  - balance sheets and income statements
  - firms' location (NUTS3 + coordinates or postal codes)
- GeoNames database on geographic coordinates of all postal codes in the relevant countries
- Hazard maps for river and coastal flooding produced by the JRC
- Final sample includes 2.5 mln manufacturing firms from 17 EU countries, 2007-2018.

Treated and control groups

- Firms impacted by a flood are not directly observed (info at NUTS3 level)

1. Geolocalisation: firms (~55%) or postal codes (~40%)
2. Maps of river and coastal flood risks at 100m resolution
   - Flood extent simulated for 1-in-10, ..., 1-in-500-years
   - Estimations based on meteorological, hydrological and topographic data
   - Homogeneous across European countries

- Treated group: All firms located in a risk area according to the 1-in-10-year hazard maps ($\simeq$ 7% of the sample)
- Control group: All firms located at least 10km away from a risk area according to the 1-in-500-year hazard maps

Identification strategy

1. Local projections (LP), Jordà (2005)

- $y_{i,t+h} - y_{i,t-1} = \beta_h D_{it} + \sum_{\tau=0,\tau\neq t}^{h} \theta_\tau D_{i\tau} + \gamma_h X_{i,k<t-1} + \delta_{sch} + \varepsilon_{ith}$
- $y_{i,t+h} - y_{i,t-1}$: cumulative change in the outcome variable (assets, sales, productivity, nb. employees) between $t-1$ and $t+h$
- D_{it}: treatment dummy (flood occurred)
- $\sum_{\tau=0,\tau\neq t}^{h} \theta_\tau D_{i\tau}$: other floods between t_0 and $t+h$
- $X_{i,k<t-1}$: predetermined firm characteristics (2nd and 3rd lag of total assets, nb of employees, tangible and intangible asset ratio, leverage and age) + country's output gap
- δ_{sch}: NUTS3$\times$NACE2 fixed effects

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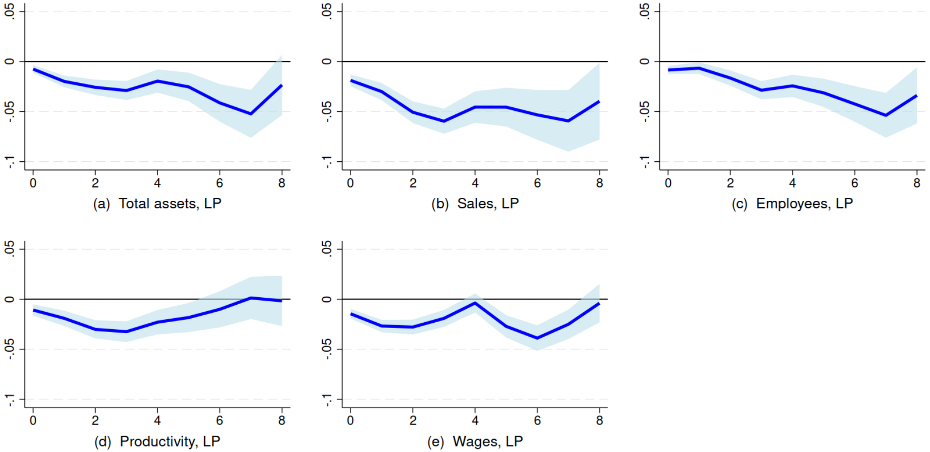
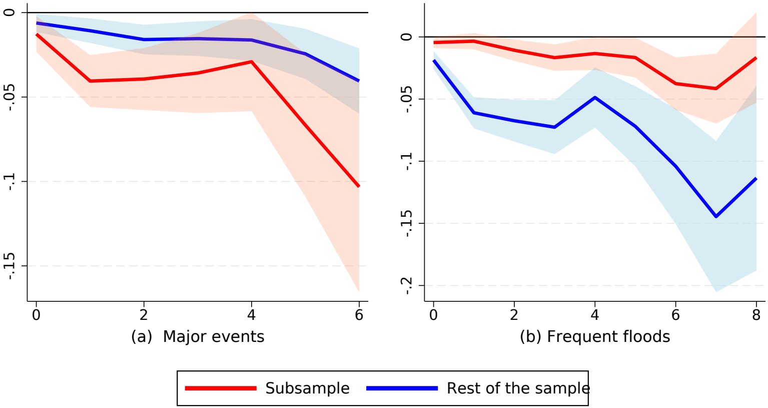
Estimation results



Heterogeneity: floods

- Larger impact of "great flood" and "extraordinary flood" (in Blöschl et al., 2020)
- Smaller impact where floods are more frequent ($\geq$ 3 events) $\rightarrow$ adaptation?



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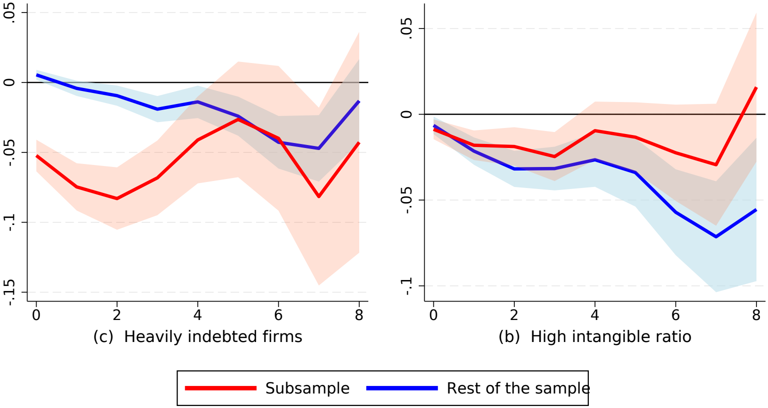
Heterogeneity: firms

- Larger effect if the leverage is above P75
- Lower impact for firms with high level of intangible asset ratio



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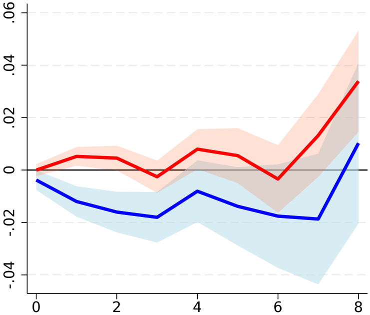
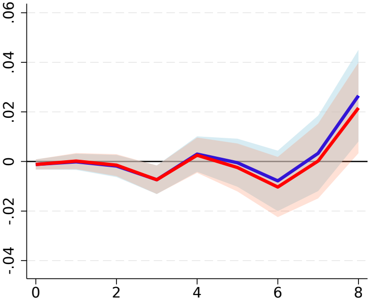
Composition effects and reallocation

- Reallocation from impacted to non-impacted firms in the same county
- The aggregate, county-level effect is null (or positive in the long run)



(a) Impacted and non-impacted firms



(b) All firms in flooded counties

Robustness checks & Extensions

- Augmented inverse propensity weighted (AIPW) and doubly robust AIPW
  - First stage: $\Pr\left(D_{it} = 1 | X_{i,k<t-1}\right) = \Phi\left(\alpha X_{i,k<t-1}\right)$
  - Second stage: same as LP, but obs. are weighted by the inverse of the propensity score, with or without $X_{i,k<t-1}$
- Alternative treated and the control groups
  - the likelihood of being affected depends on the distance between the firms' geographical location and the nearest river or coast.
  - We recursively re-estimate the LP model for $h = 1$ by taking different threshold values for the distance from the nearest river or coast below which the firm is considered as treated.
- Survival analysis: (the extended version of) a Cox proportional hazard model
  - Results show that a firm affected by a flood is less likely to survive (12%)

Thank you

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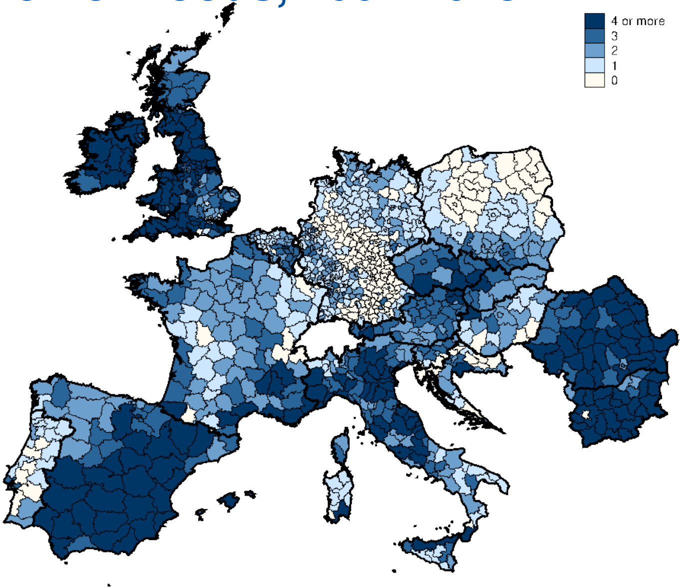
Distribution of floods, 2007-2018



Geographic information for geolocalising firms

	Nb. of obs.	%
Missing geographic info	341,504	3.71
Firm geolocalised	5,048,660	54.89
Postal code geolocalised	3,613,278	39.29
Nearest neighbour postal code	166,926	1.81
3-digit postal codes for the UK and IE	26,365	0.29
Not geolocalised	474	0.01

Frequency of flood events

	1	2	3	4	5	6	7	8	9	Total	%
AT	0	11	21	1	2	0	0	0	0	35	100
BE	16	14	9	2	0	0	0	0	0	41	93
BG	0	3	2	8	11	3	0	0	0	27	96
CZ	0	5	5	3	1	0	0	0	0	14	100
DE	166	73	10	0	0	1	0	0	0	250	66
ES	8	10	13	9	7	4	4	1	1	57	97
FR	19	43	19	6	3	0	0	0	0	90	89
HR	4	6	1	0	1	0	0	0	0	12	57
HU	6	9	1	1	0	0	0	0	0	17	85

Frequency of flood events (cont'd)

	1	2	3	4	5	6	7	8	9	Total	%
IE	0	0	1	2	3	2	0	0	0	8	100
IT	24	22	25	27	9	0	0	0	0	107	97
PL	22	17	4	1	0	0	0	0	0	44	61
PT	14	3	1	0	0	0	0	0	0	18	72
RO	0	1	10	11	9	5	4	1	1	42	100
SI	1	4	4	0	0	0	0	0	0	9	75
SK	0	4	3	1	0	0	0	0	0	8	100
UK	30	23	33	21	20	19	18	4	1	169	98
All	345	266	171	107	68	34	26	6	3	1,026	78

Average nb. of years between events

	2	3	4	5	6	7	8	9	All
AT	4.1	3.1	3.3	2.8					3.2
BE	5.7	4.8	3.3						4.9
BG	6.0	4.2	3.3	2.7	2.2				3.0
CZ	3.6	2.4	2.6	2.8					2.7
DE	4.3	3.2			1.8				3.9
ES	3.5	4.2	3.0	2.5	2.0	1.8	1.6	1.4	2.7
FR	3.0	3.5	1.9	2.2					2.9
HR	2.5	2.0		2.0					2.2
HU	3.2	2.0	2.3						2.9

Average nb. of years between events (cont'd)

	2	3	4	5	6	7	8	9	All
IE		5.0	3.2	2.3	2.0				2.6
IT	3.3	2.8	2.4	2.1					2.5
PL	1.4	3.0	3.0						2.0
PT	5.0	5.0							5.0
RO	2.0	3.5	2.7	2.5	2.0	1.8	1.3	1.4	2.4
SI	5.0	4.5							4.7
SK	4.5	5.2	3.7						4.6
UK	4.9	3.1	2.5	2.4	2.0	1.7	1.5	1.2	2.3
All	3.9	3.4	2.5	2.4	2.0	1.8	1.5	1.3	2.8

Distances from the closest river or coast

	All firms	Firsm in impacted regions
Mean	15.402	15.435
Std.	14.992	14.939
Min.	0.002	0.002
P5	0.677	0.714
P25	3.347	3.423
Med.	10.884	10.906
P75	22.891	23.158
P95	46.015	45.828
Max.	108.254	108.254

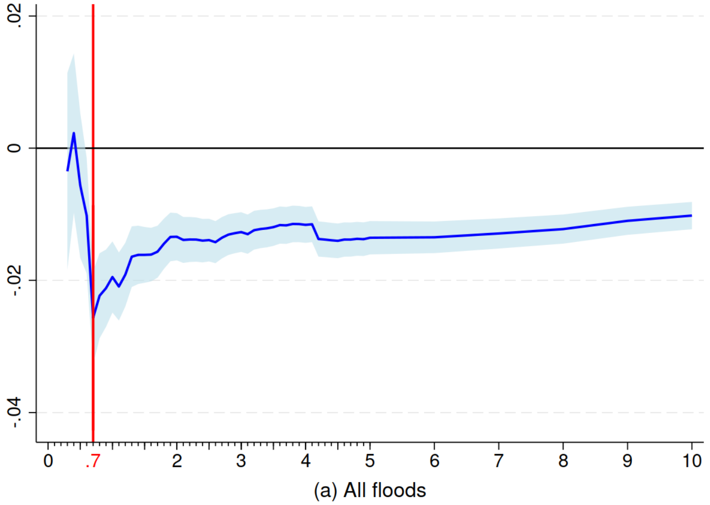
Survival analysis

- We apply (the extended version of) a Cox proportional hazard model (a.k.a. non-proportional hazards model; see Kleinbaum and Klein (2011))
- Results show that a firm affected by a flood is less likely to survive (12%)

Alternative treated and the control groups

- We assume that the likelihood of being affected depends on the distance between the firms' geographical location and the nearest river or coast.
- We use Hydrographic data from the US National Centers for Environmental Information
- We recursively re-estimate the LP model for $h = 1$ by taking different threshold values for the distance from the nearest river or coast below which the firm is considered as treated.

Impact on total assets & distance (km)



AIPW and doubly robust AIPW

2. Augmented inverse propensity score weighting (AIPW)

- First stage: $\Pr\left(D_{it} = 1 | X_{i,k<t-1}\right) = \Phi\left(\alpha X_{i,k<t-1}\right)$
- Second stage: same as LP, but obs. are weighted by the inverse of the propensity score, and without $X_{i,k<t-1}$

3. Doubly robust AIPW
   - Same as AIPW, but with $X_{i,k<t-1}$ included in the second stage