How do Firms Cope with Losses from Extreme Weather Events?

Emanuela Benincasa
UZH and SFI

Frank Betz
EIB

Luca Gattini
EIB

EEA-ESEM Milano
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The views expressed do not necessarily reflect the position of the European Investment Bank.

Climate change: The challenge of extreme weather events

- In a warming climate, weather extremes are becoming more frequent…
  - The 2021 floods affecting Germany and the Benelux countries
  - Canada all-time high temperature of 49.5 degrees in 2021

  …and severe
  - Total of losses of $3.6tn and 2m deaths due to extreme weather events over the period 1970-2019 (WMO, 2021)

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- **Little known** about firms' response to realizations of extreme weather events
  - Investment response?
  - Financing choices?
  - Effects on the asset and the liability side of firms' balance sheets?

This paper

We study how companies cope with monetary losses from extreme weather events

- Evidence that firms increase capital expenditure, invest in green assets, and increase their leverage
  - Firms may seek to replenish their capital stock or invest to guard against future realizations of climate risk

- Exploit the 2019 EBRD-EIB-World Bank Enterprise Survey to study the relation between losses-induced by weather extremes and firms' balance sheets
  - Absorb omitted variables by using **industry-size-country fixed effects**

Main results

Experiencing monetary losses due to extreme weather events is associated with

- ↑ likelihood of capital expenditure by 16.4% (relative to the mean)
- ↑ likelihood of investment in green assets by 17.7% (relative to the mean)

- ↑ likelihood of need for bank loans by 12 pp
  - This is concentrated in the SME segment

- Conditional on needing a loan:
- ↓ likelihood of being discouraged from applying for a loan by 8.7 pp

- ↑ likelihood of being rejected to the loan application by 5.2 pp

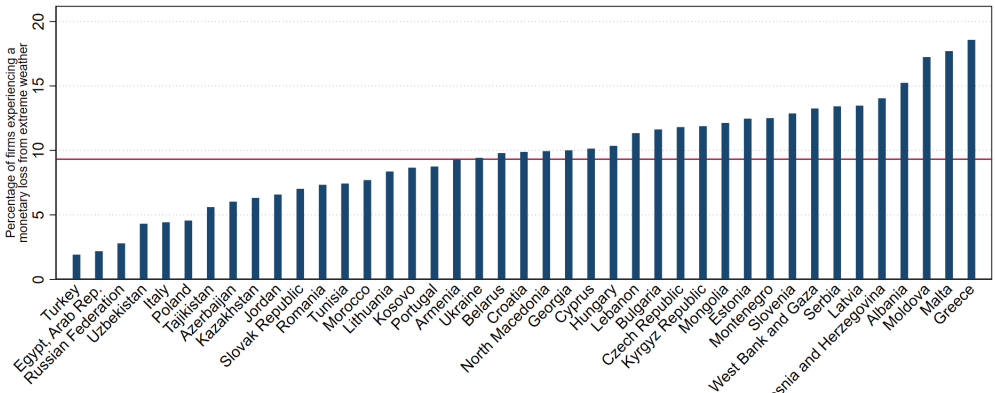
Data & Methodology

Losses due to extreme weather events

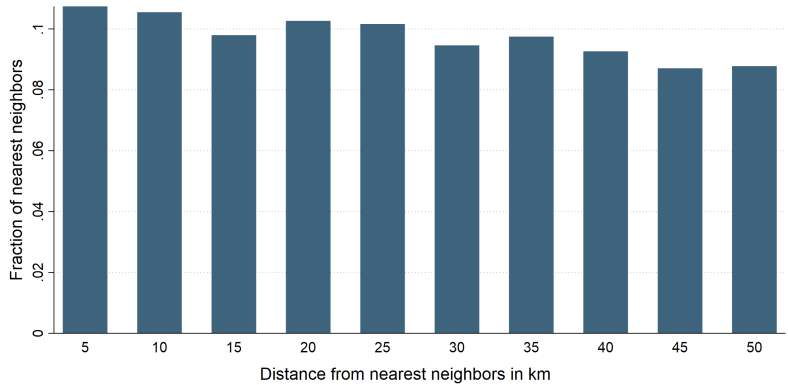
- Cross-sectional firm-level data from the 2019 EIB-EBRD-WB Enterprise Surveys
  - Samples of an economy's formal private sector
  - New Green Economy Module to identify firms that suffered losses due to extreme weather events
  - Explanatory variable of interest is Extreme weather loss: *'Over the last three years, did this establishment experience monetary losses due to extreme weather events (such as storms, floods, droughts, or landslides)?'*
- 24,086 mostly unlisted companies in 41 countries; the majority are in developing and emerging economies

▸ Summary statistics ▸ Extreme weather losses by sector and size

Firms affected by extreme weather events by country



Spatial correlation of losses due to extreme weather events



Methodology

Sample-weighted linear probability model

$$y_{i,s,c} = \beta_0 + \beta_1 \text{Extreme weather loss}_{i,s,c} + \beta_2 \mathbf{X}_{i,s,c} + \underbrace{\gamma_{s,c,k}}_{\text{industry-size-location FE}} + \varepsilon_{i,s,c}$$

- i is the firm, s is the sector, c is the country, k is the firm size category
- Extreme weather loss is an indicator equal to 1 if the firm declares losses due to extreme weather; 0 otherwise
- **X** comprises firm-level covariates to absorb observable firm-level heterogeneity
- Robust standard errors clustered at the (within-country) regional level

Results

Capital expenditure

	(1) Fixed Assets$_t$	(2) Land & buildings	(3) Machinery & equipment	(4) Fixed Assets$_{(t \text{ or } t-1)}$	(5) Log(Inv. amount/size)
Extreme weather loss	0.060***	0.040***	0.051**	0.045***	0.254***
	[0.023]	[0.012]	[0.023]	[0.017]	[0.094]
Obs.	24,086	24,086	24,086	17,097	7,912
Adj. R^2	0.218	0.148	0.215	0.423	0.926
Mean(dep. var.)	0.365	0.110	0.356	0.585	12.424
Firm controls	✓	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓	✓

- Losses due to extreme weather events $\rightarrow$ 16.4% (relative to sample mean) higher probability a firm invests in physical capital

- Mechanism: Firms may seek to replenish their capital stock or firms engage in adaptation investment to guard against future realizations of climate risk

Access to credit

	(1) Need loan	(2) Credit constrained	(3) Discouraged	(4) Rejected
Extreme weather loss	0.120***	-0.034	-0.087**	0.052**
	[0.023]	[0.031]	[0.042]	[0.022]
Obs.	23,567	10,200	10,200	10,200
Adj. R^2	0.155	0.262	0.243	0.157
Mean(dep. var.)	0.425	0.476	0.436	0.039
Firm controls	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓

- Losses due to extreme weather events → 28.2% (relative to sample mean) higher probability to demand bank credit

- Conditional on needing a loan
  - → 8.7pp. lower probability that the firm is discouraged from applying for a loan
  - → 5.2pp. higher probability that the loan application is rejected

- Mechanism: Banks may assess firms as on average less creditworthy

Green investment activity

	(1) Green Measures	(2) Green Measures	(3) Fixed Assets	(4) CO_2 monitoring
Extreme weather loss	0.119***	0.338***	0.171**	0.047***
	[0.021]	[0.074]	[0.082]	[0.010]
log(Years of experience)	-0.002	0.008	0.017	0.000
	[0.012]	[0.012]	[0.011]	[0.003]
Extreme weather loss × log(Years of experience)		-0.078***	-0.039	
		[0.025]	[0.026]	
Obs.	24,086	24,086	24,086	23,844
Adj. R^2	0.217	0.219	0.219	0.144
Firm controls	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓
Mean(dep. var.)	0.641	0.641	0.365	0.063

- Old managers are reluctant to invest in green assets or technology!

- Mechanism: Vintage effects in more modern equipment that has a lower environmental footprint or higher firms' environmental awareness

Additional analysis: Ho do the results vary with firm size?

Panel A: Corporate investments

	(1) Fixed Assets	(2) Land & buildings	(3) Machinery & equipment	(4) Green measures
Extreme weather loss	0.146***	0.106***	0.143***	0.029
	[0.041]	[0.038]	[0.041]	[0.042]
Extreme weather loss × Small-medium sized enterprises	-0.092**	-0.071*	-0.098**	0.097**
	[0.044]	[0.041]	[0.044]	[0.045]
Obs.	24,086	24,086	24,086	24,086
Adj. R^2	0.218	0.149	0.215	0.217
Firm Controls	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓
Mean(dep. var.)	0.365	0.110	0.356	0.641

Panel B: Access to credit

	(1) Need loan	(2) Credit constrained	(3) Discouraged	(4) Rejected
Extreme weather loss	0.036	-0.044	-0.056	0.012
	[0.035]	[0.047]	[0.047]	[0.013]
Extreme weather loss × Small-medium sized enterprises	0.091**	0.011	-0.033	0.043
	[0.038]	[0.052]	[0.062]	[0.028]
Obs.	23,567	10,200	10,200	10,200
Adj. R^2	0.155	0.262	0.243	0.157
Firm Controls	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓
Mean(dep. var.)	0.433	0.493	0.461	0.032

- SMEs show a less pronounced investment response to weather events when compared to larger firms, despite reporting a greater need for credit

Additional analysis: Firm financing choices

	(1) Internal funds	(2) Bank Credit	(3) Non Bank Credit	(4) Trade Credit	(5) Gov. grants	(6) Ex-post internal funds
Panel A. Investment Finance						
Extreme weather loss	-0.109***	0.069**	-0.005	0.065***	0.003	-0.052***
	[0.029]	[0.029]	[0.006]	[0.022]	[0.005]	[0.018]
Obs.	8,285	8,285	8,285	8,285	8,285	8,285
Mean(dep. var.)	0.555	0.300	0.032	0.096	0.026	0.779

	(1) Internal funds	(2) Bank Credit	(3) Non Bank Credit	(4) Trade Credit	(5) Gov. grants	(6) Ex-post internal funds
Panel B1. Working Capital Finance - Sub-sample of firms with fixed investments						
Extreme weather loss	-0.079***	0.060**	0.022*	0.028	0.019**	-0.051***
	[0.027]	[0.029]	[0.013]	[0.027]	[0.009]	[0.014]
Obs.	8,665	8,803	8,803	8,803	8,803	8,665
Mean(dep. var.)	0.504	0.298	0.032	0.230	0.021	0.773
Panel B2. Working Capital Finance - Sub-sample of firms with no fixed investments						
Extreme weather loss	-0.082***	0.079**	0.008	0.027	0.011	-0.062***
	[0.030]	[0.034]	[0.012]	[0.025]	[0.009]	[0.019]
Obs.	14,722	15,283	15,283	15,283	15,283	14,722
Mean(dep. var.)	0.504	0.298	0.032	0.230	0.021	0.773

Informal payments as a liquidity shock

Panel A: Corporate investments

	(1) Fixed assets	(2) Land & buildings	(3) Machinery & equipment	(4) Green measures
Informal payment	0.041	0.033*	0.046	0.011
	[0.035]	[0.017]	[0.034]	[0.036]
Obs.	15,518	15,518	15,518	15,518
Adj. R^2	0.237	0.168	0.239	0.222
Firm Controls	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓
Mean(dep. var.)	0.391	0.106	0.378	0.644

Panel B: Access to credit

	(1) Need loan	(2) Credit constrained	(3) Discouraged	(4) Rejected
Informal payment	0.069**	0.048	-0.014	0.062*
	[0.033]	[0.058]	[0.062]	[0.034]
Obs.	15,168	6,809	6,809	6,809
Adj. R^2	0.164	0.282	0.269	0.186
Firm Controls	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓
Mean(dep. var.)	0.425	0.476	0.436	0.039

- Bribe requests trigger liquidity needs, but is not associated with investment activity

Placebo test: Panel sub-sample

Panel A: Corporate investments

	Fixed Assets		Land & buildings		Machinery & equipment	
	(1)	(2)	(3)	(4)	(5)	(6)
Extreme weather loss	0.117***		0.057***		0.113***	
	[0.025]		[0.020]		[0.025]	
Extreme weather loss$_{2013}$		-0.004		0.007		-0.005
		[0.025]		[0.020]		[0.025]
Obs.	5,210	5,216	5,210	5,216	5,210	5,216
Adj. R^2	0.183	0.130	0.113	0.071	0.180	0.130
Firm Controls	✓	✓	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓	✓	✓
Mean(dep. var.)	0.328	0.420	0.108	0.139	0.318	0.411

Panel B: Access to credit

	Need loan		Credit constrained		Discouraged		Rejected	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Extreme weather loss	0.106***		-0.048		-0.048		0.001	
	[0.027]		[0.037]		[0.037]		[0.016]	
Extreme weather loss$_{2013}$		0.020		-0.043		-0.043		0.006
		[0.027]		[0.034]		[0.034]		[0.016]
Obs.	5,097	5,092	2,393	2,506	2,393	2,503	2,353	2,422
Adj. R^2	0.099	0.063	0.115	0.145	0.115	0.145	-0.018	0.005
Firm Controls	✓	✓	✓	✓	✓	✓	✓	✓
Industry × Size × Country FE	✓	✓	✓	✓	✓	✓	✓	✓
Mean(dep. var.)	0.470	0.489	0.486	0.366	0.486	0.366	0.036	0.044

Conclusions

- A significant share of firms is already suffering losses from extreme weather events
- These firms…
  - are more likely to invest, either to replenish the stock of capital or to guard against future climate risks
  - are more likely to invest in green assets. This may reflect the availability of new technology, but also greater environmental awareness
  - are more likely to desire bank credit. This applies to SMEs in particular
  - are less likely to be discouraged from applying for a bank loan, but more likely to have their loan application rejected
  - have higher ex-post leverage. This may limit the ability of some firms to invest in the future

Appendix

Summary statistics

	Obs.	Mean	Std. Dev.	Min.	Max.
Fixed assets$_t$	24,086	0.365	0.482	0	1
Land and buildings	24,086	0.110	0.313	0	1
Machinery and equipment	24,086	0.356	0.479	0	1
Fixed assets$_{(t \text{ or } t-1)}$	17,097	0.585	0.493	0	1
Log(Inv. amount/size)	7,912	12.424	5.512	4.087	26.719
Green measures	24,086	0.641	0.480	0	1
CO_2 monitoring	23,844	0.063	0.243	0	1
Need loan	23,567	0.433	0.495	0	1
Discouraged	10,200	0.461	0.499	0	1
Rejected	10,200	0.032	0.175	0	1
Credit constrained	10,200	0.493	0.500	0	1
Extreme weather loss	24,086	0.078	0.267	0	1
Audited	24,086	0.406	0.491	0	1
Sole proprietorship	24,086	0.204	0.403	0	1
Publicly listed	24,086	0.063	0.243	0	1
In partnership	24,086	0.089	0.285	0	1
Main market: Local	24,086	0.431	0.495	0	1
Exporter	24,086	0.199	0.399	0	1
log(Age)	24,086	2.750	0.748	0	5.268
Have a website	24,086	0.615	0.487	0	1
Female CEO	24,086	0.158	0.365	0	1
log(Years of experience)	24,086	2.823	0.725	0	4.248
Pay energy levy	24,086	0.207	0.405	0	1
Subject to energy standards	24,086	0.124	0.330	0	1
Manager for climate issues	24,086	0.099	0.299	0	1
Mean Δ sales	24,086	0.654	7.071	-73.389	98.155
Small-medium sized enterprises	24,086	0.805	0.396	0	1
Informal payment	15,518	0.088	0.284	0	1
Management practices	12,646	0.016	0.948	-7.874	1.817

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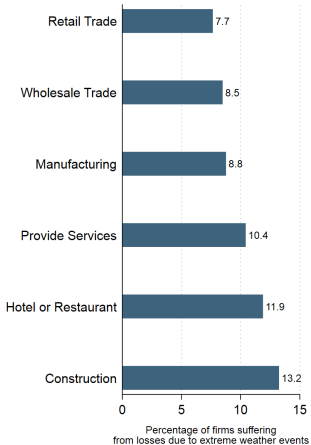
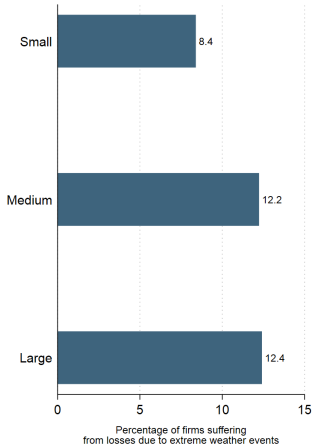
Percentage of firms suffering losses due to extreme weather events by sector and size





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