Flooding credit markets: loans to SMEs after a natural disaster

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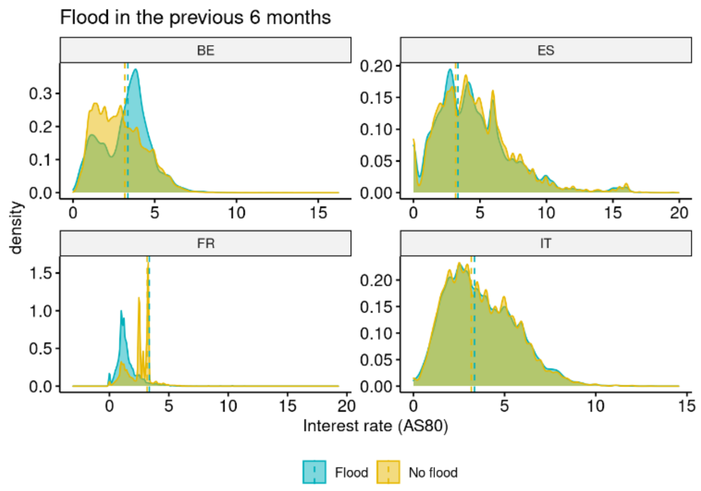
Introduction



Flooding events are correlated with higher interest rates loans for SMEs.

In selected EU countries the interest rate density of loans issued after a flood is shifted to the right of the distribution of the loans issued in normal times. Belgium shows a more pronounced deviation than other member states.

Goals and Contributions:

Using a large dataset of securitized loans, we assess the impact of climate change-related natural hazards, specifically floods, on credit to European small and medium-sized enterprises (SMEs).

Data

- We draw our data on floods from the Risk Data Hub (RDH) repository managed by the Joint Research Centre (JRC) of the European Commission (Faiella et al., 2020).
- We obtain data about lending to SMEs by the European Data Warehouse (EDW), a centralized securitization repository part of the European Central Bank (ECB) loan-level initiative to collect, validate, and distribute standardized data for several European countries. The dataset covers loans originated in NUTS3 regions from January 2008 onwards, and it has monthly frequency.
- We augment the loan-level data set by creating a set of binary variables indicating whether in the previous 6 months there has been at least a flood event in the NUTS3 region where the SME is located.

Country	Number of loans	Avg. interest rate	Avg. balance	Avg. term	Default rate
Belgium	557,710	2.89	114,747	6	1.39
Italy	520,378	3.68	182,942	7	4.03
Spain	898,728	4.60	755,925	6	4.23

Table 1: Descriptive statistics by country at loan origination: number of loans, average interest rate (%), average balance, average loan term (years), default rate (%).

Loan pricing

- First, we study whether the occurrence of a flood has an impact on the interest rate of loan i originated at time t in region j.We obtain the interest rate at origination by considering only loans with a fixed interest rate or, if floating, whose current interest rate has been observed within 6 months from the date of loan origination t.
- To analyze the effect of a flooding event on loan pricing, we run the OLS regression:

$$\mathrm{ir}_{\mathrm{ij,t}} = \alpha + \beta \mathrm{Floods}_{\mathrm{j,t-6}} + \gamma \mathrm{X}_{\mathrm{j,t}} + \mu_{\mathrm{j}} + \tau_{\mathrm{t}} + \varepsilon_{\mathrm{ij,t}},$$

Where $\mathrm{X}_{\mathrm{j,t}}$ is a vector of controls, μ_{j} and τ_{t} are county and time fixed effects.

- We find that SMEs exposed to flooding face a higher cost of credit in the aftermath of the event, all other things being equal.

	(1)	(2)	(3)	(4)	(5)
Interest rate					
Flooding event	0.0798***	0.0729***	0.0652***	0.0409***	0.0367***
	(0.0149)	(0.0146)	(0.0144)	(0.0093)	(0.0087)
ln(maturity)	0.3148***	0.3214***	0.3332***	0.2484***	0.2554***
	(0.0200)	(0.0193)	(0.0187)	(0.0246)	(0.0249)
ln(balance)	-0.3253***	-0.3139***	-0.3167***	0.0154	0.0157
	(0.0169)	(0.0155)	(0.0157)	(0.0134)	(0.0136)
Constant	0.3301***	0.3386***	0.2761***	1.1623***	1.1292***
	(0.0959)	(0.0910)	(0.0895)	(0.1187)	(0.1219)
Observations	1,716,747	1,716,747	1,715,918	1,044,718	1,043,137
R-squared	0.5330	0.5420	0.5517	0.8658	0.8701
Macroeconomic controls	Yes	Yes	Yes	Yes	Yes
Business type FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	No	Yes	No
County FE	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	No	Yes	No
Industry x Time FE	No	No	Yes	No	Yes
Borrower FE	No	No	No	Yes	Yes

Default forecasting

- Second, we apply a penalized logistic regression to evaluate whether information about past floods has additional predictive power with respect to the occurrence of a default.
- If the number of unknown parameters is large relative to the number of observations, then solving the standard likelihood problem might lead to low estimation accuracy or even biased results.

To avoid these problems, we add an elastic-net penalty (Zou et al., 2005) that solves the following minimisation problem:

$$\min_{\beta_0,\boldsymbol{\beta}} \left\{ -\frac{1}{\mathrm{N}} \sum_{\mathrm{i}=1}^{\mathrm{N}} \sum_{\mathrm{t}=1}^{\mathrm{T}} \left[\mathrm{y}_{\mathrm{it}} (\beta_0 + \mathrm{x}_{\mathrm{it}}' \boldsymbol{\beta}) - \mathsf{log}(1 + \mathrm{e}^{\beta_0 + \mathrm{x}_{\mathrm{it}}' \boldsymbol{\beta}}) \right] + \lambda \sum_{\mathrm{k}=1}^{\mathrm{K}} \left[\alpha |\beta_{\mathrm{k}}| + \frac{1}{2}(1-\alpha)\beta_{\mathrm{k}}^2 \right] \right\},$$

where $\lambda \geq 0$ is a regularization parameter and $0 \leq \alpha \leq 1$ is the elastic-net parameter.

- We consider two specifications of the model: one that contains information about past flood events, and another without such variables.
- We evaluate the added value of flood information by comparing some measures of accuracy and fit of the two models.

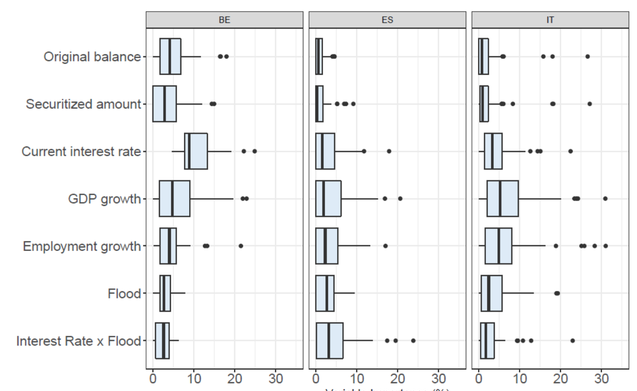


Figure 2: Box plots of the percentage variable importance by country.

Country	AUC	AUC-PR	H-measure	BS
BE	9	18	20	20
ES	16	22	25	20
IT	26	30	32	15

Table 5: Default forecasting metrics: percentage of times the model with flood information performs better than the model without. The column BS report the percentage of time the model with flood information performs significantly better than the nested benchmark.

Extensions and future work

- The effect of a flood on the interest rates on new loans fades away at longer time horizons (12m and especially 24m).
- There is some evidence of larger impact of severe floods. We consider severe floods those that caused economic losses in the NUTS3 region.
- We do not find evidence of a compound effect from multiple floods. This result suggests that there may be some degree of adaptation of economic activity in areas subject to repeated flooding, in line with the literature.
- Work in progress: a diff-in-diff model to explore more in depth the effects of repeated flooding events (i.e. repeated treatments) on local credit market conditions.

Conclusion

- In this paper we use data on securitized loans to assess the impact of floods on credit conditions to European SMEs. We find evidence of climate risk being priced into higher interest rates on new loans. The economic magnitude of the effect is an increase of 2% with respect to the average loan rate.
- When analyzing the probability of default of a loan, we find a significant improvement in the forecasting performance of the model in 15-20% of the cases at the regional level. While they are rare events, the occurrence of floods can improve the accuracy of the forecasts for SME loan default probabilities. This direct effect compounds the indirect effect of a higher interest rate as an important determinant of loan default.
- Taken together, our results suggest that climate-related disasters affect firms also through their cost of funding and their ability to service debt.

References

Faiella, A. T. Antofie, S. Luoni F. Rios Diaz and M. Marin Ferrer, 2020. The risk data hub loss datasets-The risk data hub historical event catalogue, JRC Technical Report JRC116366.
H. Zou and T. Hastie, 2005. Regularization and Variable Selection via the Elastic Net, Journal of the Royal Statistical Society. Series B (Statistical Methodology), 67 (2) 301-320.