Staying Afloat: The Impact of Flooding on UK Firms

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Abstract

This paper investigates the current exposure of UK corporates to flood risk and the past impact of flooding events on corporate outcomes. Through the use of a novel dataset combining business premise information with flood maps and corporate financial records, we find that exposure to flood risk in the UK is highly concentrated in specific regions and sectors, with a search for cheap land driving risk exposure for large businesses. We also find that flooding is associated with a negative impact on revenue, employment and total assets across all firm sizes, and an increase in the probability of business termination for small and medium firms.

Introduction

Flooding is the largest source of physical risk from climate change in the UK.

- Flooding costs the UK £2.2bn each year (£0.8bn defences, £1.4bn damages)[1,2].
- UK most exposed to flooding from rivers and sea and surface water flooding.
  - There are over 3m UK properties at risk from surface water flooding alone[3].
- Substantial land development over flood plains over the last three decades in the UK. In most sectors, more than 5% of business premises between 2008 and 2018 were built in high/medium flood risk areas[4].
- Climate change increases the frequency and intensity of precipitation in the UK[5]
  - BoE CBES/NGFS NAA scenario estimates £0.8bn average annual losses on banks' liabilities in 30 years associated to floods in the UK.

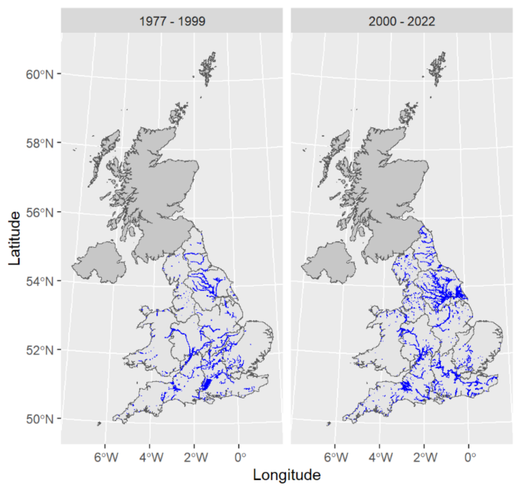

Figure 1. Historical flooding in England and Wales

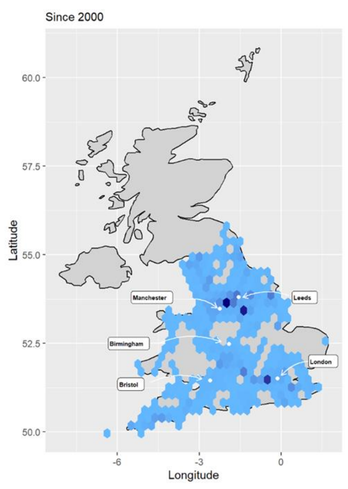

Figure 2. Heatmap of flooded organizations

Data

We built a novel dataset merging business premise address information with flood maps and corporate financial records for all businesses in England and Wales. Business premise address information including coordinates, usage destination and extension is sourced from Ordnance Survey and Energy Performance Certificates. FAME (BvD) provides annual corporate balance sheet information. Flood risk and past extent maps are obtained from DEFRA and NRW.

How are UK corporates currently exposed to flood risk?

The exposure to flood risk and incidence of past flooding is highly heterogenous across regions in the UK.

- 1% of UK firms and 2% of business premise floor area has been flooded over the last 20 years. The incidence increases to 6% for Yorkshire and Humber region.
- 9% of UK corporate business premises are located in a flood plain

Results from **univariate logistic regressions** suggest that being a core business premise is associated with 2x higher odds of operating from High-Medium flood risk area (HMFR) and 2.4x higher odds of having been flooded in last 20y. Being a tradeable firm is associated to 1.5x higher odds of HMFR and past flooding. Large business premise areas, operating in the industry sector (utilities in particular), high productivity, high employment and large size are all factors significantly increasing the odds of HMFR and past flooding.

But results from **multivariate logistic regressions** suggest that for non-residential premises, when region and sector-specific flood risk exposures are controlled for, only the size of the premise has a significant impact on the odds of HMFR and past flooding - the larger it is, the higher the odds. **The results may suggest that the need for a large business premise is associated with 'search for cheap land' -** likely to be non-arable flood-prone land in the UK - **thus increasing the exposure to flood risk. Higher capitalisation (total assets) of the firm mitigates this.**

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Table 1. Multivariate logistic regression results

Marginal Impact on Odds Ratio $\left(\frac{P}{(1-P)}\right)$

		Flooded Over Last 20 Years			Located in High/Medium Flood Risk Area		
		All	*Non-Residential*	*Residential*	*All*	*Non-Residential*	*Residential*
Total Assets		1.042 ***	0.975 ^	1.035	1.034 ***	0.976 ***	1.014
Core BP		3.302 ***	0.872		2.985 ***	0.926	
Total Assets * Core BP		0.940 ***	1.007		0.948 ***	1.006	
Tradeable		1.102	1.231	0.000	1.101	1.222	0.604
BP Size	Medium	1.168	1.190	0.909	1.158 **	1.157 **	1.062
	Large	1.550 ***	1.494 ***	0.496 *	1.352 ***	1.284 ***	0.787
	V. Large	2.050 ***	1.938 ***	1.580	1.496 ***	1.400 ***	1.601
Fixed Effects							
SIC Sector		✓	✓	✓	✓	✓	✓
ITL 2 Region		✓	✓	✓	✓	✓	✓

*** p<0.01, ** p<0.05, * p<0.1, ^ p<0.15

What is the impact of floods on UK corporate activity?

Micro Estimates

- Generalised DID model

$$Y_{it} = \theta_t + \eta_i + \beta \cdot D_i \cdot Post_t + \varepsilon_{it}$$

$Y_{it} \rightarrow$ outcome variable for firm *i* in natural logarithm
$Post_t \rightarrow$ event study dummies for the three years following the flooding event
$D_i \rightarrow$ flood intensity for firm *i* (% total corporate business premise area flooded)

- Cox-H Survival model

$$s_{it} = s_{st} \cdot \exp(\boldsymbol{\beta}' \boldsymbol{X}_{it}) + \varepsilon_{it}$$

$s_{it} = 1 - \pi_{it} \rightarrow$ survival probability for firm *i*
$s_{st} \rightarrow$ baseline survival probability for sector *s* (stratification variable)
$\boldsymbol{X}_{it} \rightarrow$ flood-shock covariates for firm *i*

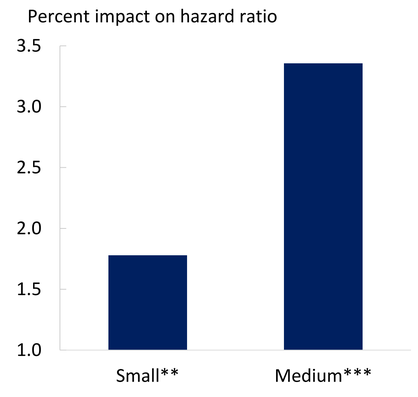

Figure 3. Average impact of flood on business termination hazard ratio in shock year

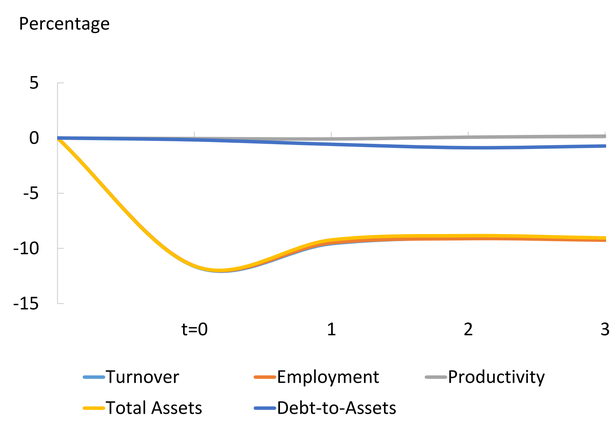

Figure 4. Average impact of flood on corporate outcomes

We find that **small and medium firms are significantly more likely to terminate their business operations following a flood**, whilst large firms aren't. Among those continuing their operations, flooding to a business premise is associated to a **significant reduction in the firm's turnover, employment and total assets on the year of the flooding, followed by a recovery in the subsequent years.** The impact on firm outcomes appears to be larger for large firms (more than 3x larger than small firms surviving) and firms operating in services and natural-resource related sectors (2.5x larger than firms operating in manufacturing).

Aggregate Impact

From a bottom-up approach we derive the aggregate impact of flooding on the UK economy. Over the last 10 years, on average 0.05% of annual corporate turnover was lost due to flooding, with a peak of 0.28% in 2015. This estimate only considers the direct losses estimated by the DID model without accounting for aggregate productivity implications from the firms' exit nor second order effects.

Conclusions

Overall, flooding represents a current risk to UK firms' performance and even more in the future as a result of climate change. Today, nearly 1 in 10 UK business premises is located in a floodplain. Exposure to flooding risk is particularly concentrated in specific regions and sectors due to their structural characteristics, such as water utilities firms or the elevated presence of watercourses at regional level. But a 'search for cheap land', on the back of business needs associated with a larger premise, also appears to be a potential risk factor. When estimating the direct impact of flooding at firm-level we find a negative impact on revenue, employment and total assets across all firm sizes, and an increase in the probability of business termination for small and medium firms. At aggregate level this is consistent with an average loss of 0.05% in annual GVA over the last 10 years.

1. HM Government(2023). Foresight Future Flooding.
2. Energy & Climate Intelligence Unit (2022). Flood risk and the UK.
3. HM Government (2022). UK Climate Change Risk Assessment 2022.
4. Mathews S, Roezer V, Surminski S (2021). The risk of corporate lock-in to future physical climate risks: the case of flood risk in England and Wales.
5. Met Office (2022). State of the UK Climate 2022