Should I Stay or Should I Go? The Effects of Floods on Firms' Location Choices

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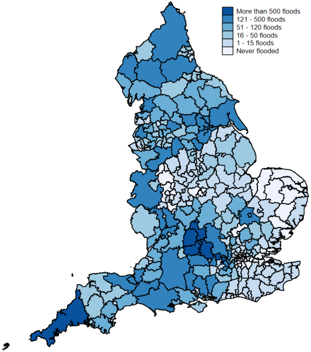
Context

- With the rise in CO_2 concentrations in the atmosphere, the frequency of extreme events has increased.
- The UK has particularly suffered from floods, due to storms or heavy rainfall (Henk, Babet).
- Floods in the UK are ubiquitous and their prevalence has increased.

Number of floods over 1998-2023



Floods affect business premises at their core

- Floods destroy capital and render business premises inaccessible, making it impossible to conduct operations.
- To design adequate policies, we need to understand their effects, particularly on firms' location choices.

This Paper

What is the spatial distribution of firms in the UK and how is it shaped by floods?

- We leverage a unique dataset of UK firms' business premise addresses at the premise $\times$ year level, overlayed with yearly flood maps and data on company ownership structure and characteristics.
- We document the spatial distribution of corporate organisations across the UK.
- We investigate the effect of floods on firms' location choices.
- We examine the interaction with local productivity.
- *In progress:* We look at the interaction with commercial real estate prices

Preliminary Results and Contribution

1. Following a flood, firms are 10 % more likely to relocate.
    - There is heterogeneity across sectors, firm size, productivity.
2. Companies that relocate after a flood internalise the risk of flooding.
3. Local productivity affects firms' location choices but doesn't seem to affect firms' location choice in response to a flooding event.
4. *Preliminary:* Floods have a significant effect on sale price declines, not necessarily on rental price.

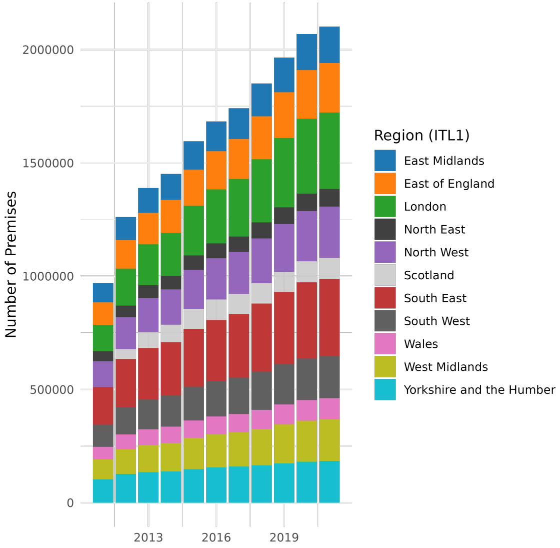
Contribution:

- Few papers have attempted to look at the effects on firm relocation (Balboni et al. Forthcoming). → we provide the first evidence for the UK.
- We add the analysis of commercial real estate prices.

Dataset

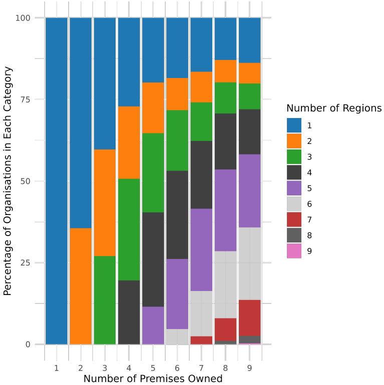
- Floodmaps from the Environment Agency (EA) and Natural Resource Wales.
  GIS Layer at 50m $\times$ 50m resolution from 1946 onwards.
- UK business premises' address information (geo-coordinates) and corporate organisation identifier from Ordnance Survey AddressBase Premium.
- Extent of each business premise from Energy Performance Certificates
  Area in square feet at the UPRN (premise ID) level.
- Corporate balance sheet information at the organisation level from Companies House in the UK (BVD).
- Final dataset: panel at the premise $\times$ year level recording information on business premise characteristic (area, organisation that operates from the business premise and its characteristics), flood information for the years 2011 - 2021.

Stylised Fact 1 - Growing number of business premises over time



Stylised Fact 2 - Organisations with multiple business premises operate from multiple regions

Figure: Number of regions organisations are present in, split by number of premises as of 2020



- Example: among organisations with two premises 70% are operating in one region, 30% in two.

Stylised Fact 3 - The flooded sample of organisations differs from the whole sample

Figure: Flooded Sample

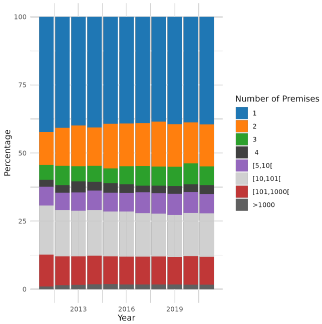
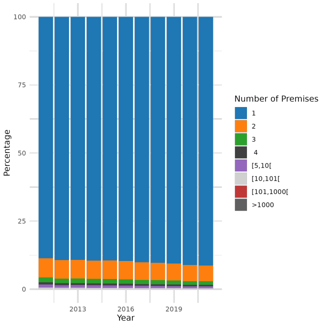


Figure: Whole Sample

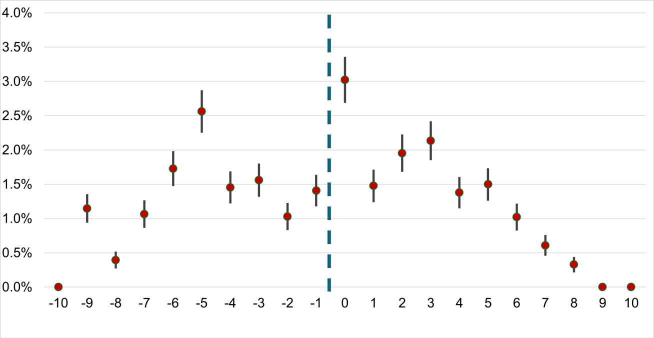


- Partly because having more business premises increases the likelihood of being flooded (by statistical definition).
- Partly as result of larger organisation searching for cheaper land and sorting in more flood-prone areas (Crampton et al. 2025).

Raw Means

- For the flooded sample, we plot the percentage of firms that are moving out, with respect to the time of the flood.
- Excess mass at exactly the time of flood.

Figure: Raw Means: Probability to Move Out as a Function of Time to Flood ($t = 0$)



Identification Strategy - Do organisations move following a flood?

- We want to understand what is the effect of floods on the probability of moving out.

$$\mathbb{P}(Move\ Out_{i,t}|Flood_{i,t} = 1) = \Phi(\beta Flood_{i,t} + \eta_i + \delta_t + \epsilon_{i,t})$$

  - $Flood_{i,t}$ is a dummy for whether the premise i is exposed to flood in year t, η_i and δ_t are the premise and year fixed effects.
  - $Move\ Out_{i,t}$ is a dummy for whether the company moved out of the premise i.

- Specifically, *Move Out* is equal to 1 if this is the last year an organisation is observed at this premise, but the organisation is still in business.

- We test our hypothesis by running our regressions using probit and logit models. *Extension:* Propensity score matching yields similar results.

- Identification assumption: floods are exogenous with respect to move out.

Regression Results

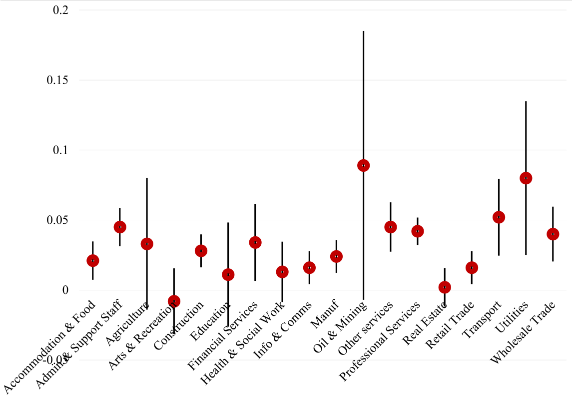
	Dependent variable: Move Out		
	OLS	Logit	Probit
	(1)	(2)	(3)
Flood	0.013^{***}	0.723^{***}	0.290^{***}
	(0.001)	(0.060)	(0.025)
Constant	0.013^{***}	-4.328^{***}	-2.225^{***}
	(0.00003)	(0.002)	(0.001)
Observations	16,877,929	16,877,929	16,877,929
R^2	0.00001		
Adjusted R^2	0.00001		
Log Likelihood		−1,173,274.000	−1,173,274.000
Akaike Inf. Crit.		2,346,552.000	2,346,552.000
Residual Std. Error	0.113		
F Statistic	153.798^{***}		

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Marginal Effects

Decomposition by sector

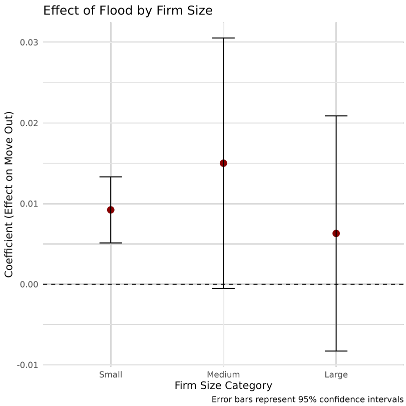
Figure: Effect of flood dummy on probability to move by sector



- Agriculture, Education, Oil and Mining not statistically significant.
- Services, Administration, Info and Communications more likely to move.

Decomposition by size

Figure: Effect of flood dummy on probability to move by size

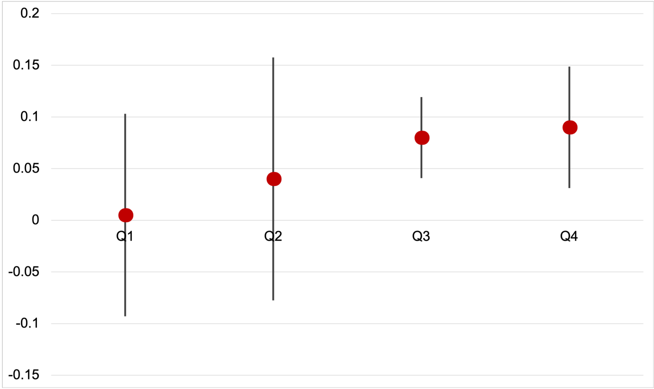


- Results driven by small firms.
- Similar trend for turnover

Decomposition by productivity

- Compute the labour productivity of the parent company.
- Assigns each premise to a productivity quartile.

Figure: Effect of flood dummy on probability to move by productivity quartile

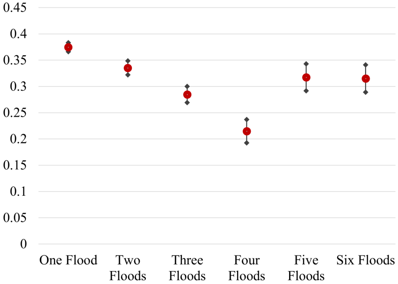


Repeated floods still have an effect on the propensity to move out

- At the organisation j × UPRN i × year t level, assign the total number of floods the organisation has experienced from 2011 until that year.

$$\mathbb{P}(Move\ Out|Flood)_{i,j,t} = \Psi\Big(\sum_{k=1}^{6} \alpha_k \mathbb{1}_{\text{Number of Floods}_{i,j,t}=k} + \eta_{i,j} + \delta_t + \epsilon_{i,t}\Big)$$

Probability to Move Out as a function of the Number of Floods



But some firms continue to stay... Potential channels:

- Stickiness because of financial constraints.
- Adaptation via operational resilience.

Effects on Average Risk

- We observe flood risk exposure for each business premise (identified by UPRN).

- Define the following variables:
  - $\textit{Average Risk}_{j,t}$: average risk across all UPRNs organisation j operates from in year t.
  - $\textit{Average Risk Move In}_{j,t}$: average risk across the new UPRNs organisation j moves into in year t
  - $\Delta\ \textit{Risk}_{j,t} = \textit{Average Risk Move In}_{j,t}$ - $\textit{Average Risk}_{j,t-1}$
  - $\textit{Flood}_{j,t}$: total number of floods the organisation has been exposed to that year (sum across the UPRNs the organisation has been operating from)

- Run the following regression

$$\Delta \textit{Risk}_{j,t} = \kappa \textit{Flood}_{j,t-1} + \mu_j + \nu_t + \epsilon_{j,t}$$

Effects on Average Risk - Results

Table: Effect of Floods on Average Flood Exposure

	Dependent variable:	
	$\Delta Risk$	
	(1)	(2)
$Flood_{t-1}$	-0.068^{***}	-0.039^{***}
	(0.014)	(0.014)
Constant	0.007^{***}	
	(0.002)	
FE	NO	YES
Observations	129,046	129,046
R^2	0.0003	0.677
Adjusted R^2	0.0002	0.139
Residual Std. Error	0.599 (df = 129044)	0.556 (df = 48448)
F Statistic	32.681^{***} (df = 1; 129044)	
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$	

Do Local Characteristics Matter?

- How does the probability to move out depend on local productivity?
- At the regional level (ITL3) $\times$ year level, use ONS measures of labour productivity and compute the number of firms per square meter.
- Compute the z-score of each region for each of these variables, i.e. the deviation from the average number of business premises, rescaled by the standard deviation. A higher z-score would mean that a region is more productive.
- Run the following regression:

$$\mathbb{P}(\text{Move Out}_{i,r,t}) = \Phi(\alpha + \beta Flood_{i,t} + \gamma ZScore_{q_{r,t}} + \delta Flood_{i,t} \times ZScore_{q_{r,t}} + \eta_i + \delta_t + \epsilon_{i,t})$$

- Coefficients of interest: β, γ, δ
- Control for year and premise fixed effects

Agglomeration Effects On Move Outs

	Dependent variable:	
	Move Out	
	(1)	(2)
Flood	0.013^{***}	0.014^{***}
	(0.001)	(0.002)
Z-Score$_{ONS}$	-0.001^{***}	-0.001^{***}
	(0.00003)	(0.00003)
Flood $\times$ Z-Score$_{ONS}$		0.004
		(0.005)
Constant	0.013^{***}	0.013^{***}
	(0.00003)	(0.00003)
Observations	16,653,776	16,653,776
R^2	0.00004	0.00004
Adjusted R^2	0.00004	0.00004
Residual Std. Error	0.113 (df = 16653773)	0.113 (df = 16653772)
F Statistic	316.189^{***} (df = 2; 16653773)	210.996^{***} (df = 3; 16653772)
Note:		*p<0.1; **p<0.05; ***p<0 .01

Other definitions

Agglomeration Effects On Move Ins

	Dependent variable:	
	Move In	
	(1)	(2)
Flood	-0.019^{***}	-0.023^{***}
	(0.003)	(0.005)
Z-Score$_{ONS}$	0.004^{***}	0.004^{***}
	(0.0001)	(0.0001)
Flood $\times$ Z-Score$_{ONS}$		-0.009
		(0.013)
Constant	0.090^{***}	0.090^{***}
	(0.0001)	(0.0001)
Observations	16,653,776	16,653,776
R^2	0.0002	0.0002
Adjusted R^2	0.0002	0.0002
Residual Std. Error	0.285 (df = 16653773)	0.285 (df = 16653772)
F Statistic	$1{,}397.734^{***}$ (df = 2; 16653773)	931.984^{***} (df = 3; 16653772)
Note:		*p<0.1; **p<0.05; ***p<0.01

Other definitions

Investigating the link with commercial real estate prices - *(Preliminary!)*

- CoStar: Rent, sale prices per square feet for commercial real estate between 2005 and now.
- Instrument floods by the percentage of each postcode district that has been flooded each year
- For now: hedonic regression with postcode and year fixed effects

Postcode districts

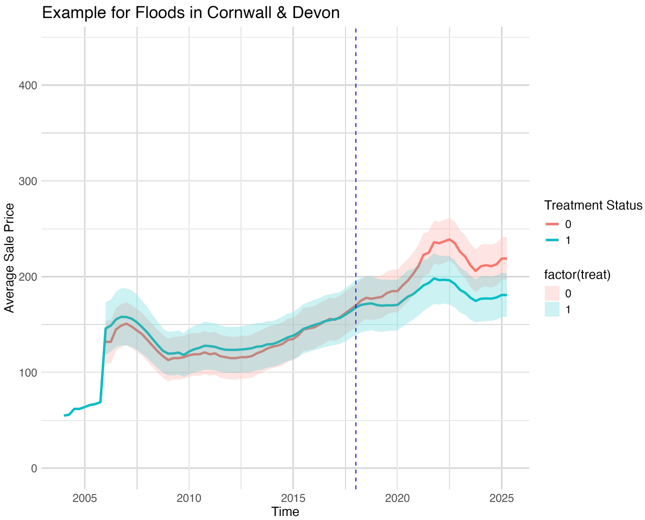
Commercial Real Estate: Results *(Preliminary)*

$$ln(Price)_{p,t} = \beta_{p,t} Share\ Flooded_{p,t} + \rho_p + \eta_t + \epsilon_{p,t}$$

- Where p is the postcode district, t is the year
- Price is the price per square feet recorded across all transactions that took place per year in that postcode district.

	Dependent variable:			
	ln(Sale Price)		ln(Rent Price)	
	(1)	(2)	(3)	(4)
Share Flooded	-0.0486^{***}	-0.052^{**}	-0.291^{***}	0.056
	(0.010)	(0.021)	(0.084)	(0.038)
Constant	4.870^{***}		2.405^{***}	
	(0.002)		(0.002)	
Observations	119,800	119,800	119,800	119,800
Year FE	NO	YES	NO	YES
Postcode FE	NO	YES	NO	YES
R^2	0.0002	0.964	0.0001	0.811
Adjusted R^2	0.0002	0.963	0.0001	0.808
Residual Std. Error	0.663 (df = 119798)	0.128 (df = 117933)	0.640 (df = 117145)	0.280 (df = 115405)
F Statistic	22.673^{***} (df = 1; 119798)		11.949^{***} (df = 1; 117145)	
Note:				*p<0.1; **p<0.05; ***p<0.01

Example for floods in Devon & Cornwall



Conclusion and Policy Implications

- Following a flood, premises are more 10% more likely to move out.
- Strong sectoral effects driven by firms in more mobile sectors.
- Flooded companies internalise the flooding risk when making subsequent location decisions.
- Local productivity significantly drives firms' location choices.
- But local productivity doesn't manage to retain firms in response to flooding.
- Floods seem to negatively impact commercial real estate sale price, not necessarily rent.

What does this mean for policy?

- Floods will shape the corporate landscape in the UK and potentially elsewhere.
- Some immobile sectors and large firms will not move: adaptation policies are essential.
- Firms internalise the risk of flooding when they have been flooded: how to convey information effectively?
- General equilibrium effects: impacts on regional productivity, inequality, employment.

Next steps?

- Refine the analysis on CRE prices.
- How do CRE prices affect firms' decisions?
- Model on regional productivity.
- Think about insurance? Keen to have your thoughts.
  Data on premia / insurance penetration at the sub-regional level?

Thank you! ☺

Comments and suggestions welcome:

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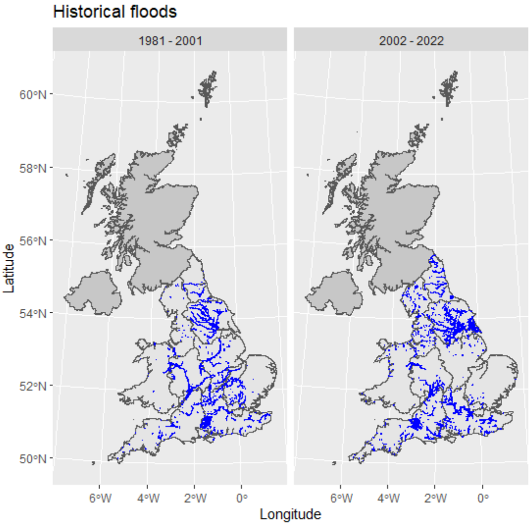
Prevalence of Floods



Back to Context

Marginal Effects, Probit Move Out

Table: Marginal Effects

	Dependent variable: Move Out					
	AME	SE	z	p	Lower Bound	Upper Bound
Probit	0.097	0.008	11.58	0	0.0812	0.1143
Logit	0.093	0.008	12.13	0	0.0928	0.0931

Note: *p<0.1; **p<0.05; ***p<0.01

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Move Out Interaction with Agglomeration Effects

	Dependent variable:	
	Move Out	
	(1)	(2)
Flood	0.013^{***}	0.015^{***}
	(0.001)	(0.002)
Z-Score$_{Density}$	-0.001^{***}	-0.001^{***}
	(0.00003)	(0.00003)
Flood $\times$Z-Score$_{Density}$		0.006^{*}
		(0.003)
Constant	0.013^{***}	0.013^{***}
	(0.00003)	(0.00003)
Observations	16,653,776	16,653,776
R^2	0.0001	0.0001
Adjusted R^2	0.0001	0.0001
Residual Std. Error	0.113 (df = 16653773)	0.113 (df = 16653772)
F Statistic	547.760^{***} (df = 2; 16653773)	366.251^{***} (df = 3; 16653772)
Note:		*p<0.1; **p<0.05; ***p<0.01

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Agglomeration Effects On Move Ins - Density

	Dependent variable:	
	Move In	
	(1)	(2)
Flood	-0.019^{***}	-0.018^{***}
	(0.003)	(0.004)
Z-Score$_{\textit{Business Density}}$	0.004^{***}	0.004^{***}
	(0.0001)	(0.0001)
Flood $\times$ Z-Score$_{\textit{Business Density}}$		0.004
		(0.009)
Constant	0.089^{***}	0.089^{***}
	(0.0001)	(0.0001)
Observations	16,653,776	16,653,776
R^2	0.0002	0.0002
Adjusted R^2	0.0002	0.0002
Residual Std. Error	0.285 (df = 16653773)	0.285 (df = 16653772)
F Statistic	$1{,}857.695^{***}$ (df = 2; 16653773)	$1{,}238.554^{***}$ (df = 3; 16653772)
Note:		$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

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