Weathering the Storm
Sectoral Economic and Inflationary Effects of Floods and the Role of Adaptation

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RESEARCH QUESTION

What is the impact of **flood events** on **GDP** and **inflation**? Can **investments in adaptation** mitigate the impact?

1. MOTIVATION & CONTRIBUTION

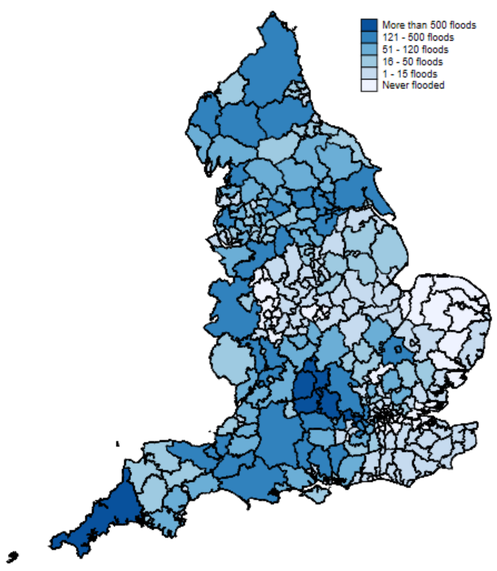
Floods are the **most costly** natural disaster in Europe.

- **Aggregate results** often hard to make sense of.
- **Adaptation**: most readily available tool, no evidence of its effectiveness

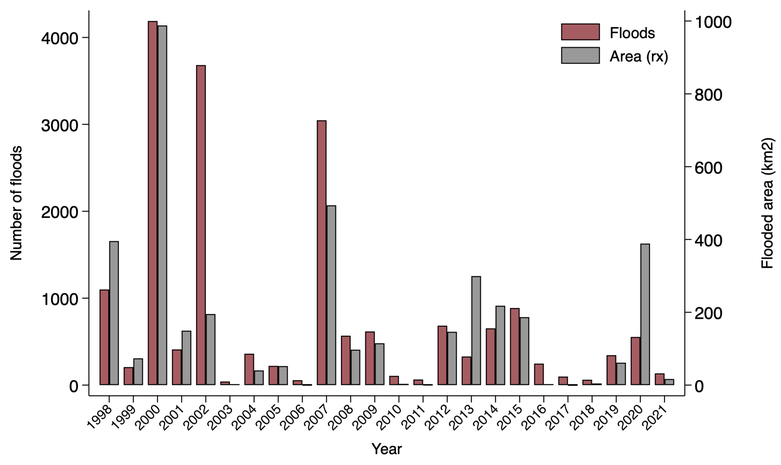
1. **Sector level analysis**: heterogeneity explains aggregate dynamics and speaks to the supply vs. demand debate
2. **Data**: all recorded flood events and data on flood defences
3. **Methodology**: tackle endogeneity through LP-IV

2. DATA & SETTING

- Panel of **309 counties in England** (ITL3), **1998-2021**.
- GIS layer of **flood events** from UK Environmental Agency
- **Rainfall** data from ERA5
- Local governments' budget data on **flood defences expenditure** → adaptation investments
- GVA and inflation for **43** different **sectors** of activity from ONS



- Final sample consists of **18,735 floods**
- Each county is flooded on average **2.32 times/year**
- Average flood extends for **0.21 squared kilometres**



6. MECHANISMS

we explore the drivers behind the sectoral results by studying investments, the real estate market, and sector linkages.

- **Investments** do not drive drop in GDP, only a temporary decline in manufacturing
- Evidence of a **wealth effect** through **real estate market transactions**: number and value of transactions ↓
- The shock **propagates** through input-output linkages, impact is stronger at the top and bottom of the **production network**

3. METHODOLOGY

Endogeneity concerns related to **adaptation capital**:

- ↑ in adaptation capital can ↓ flood events and ↑ output
- Richer areas have more policy space to build up adaptation capital that ↓ flood events

→ **precipitation z-score as an instrument for floods**:

$$P^z_{i,t} = \frac{P_{i,t} - P_i}{\sigma^P_i}$$

Fitted values of first stage used in IV local projection regression *à la* Jordà (2015):

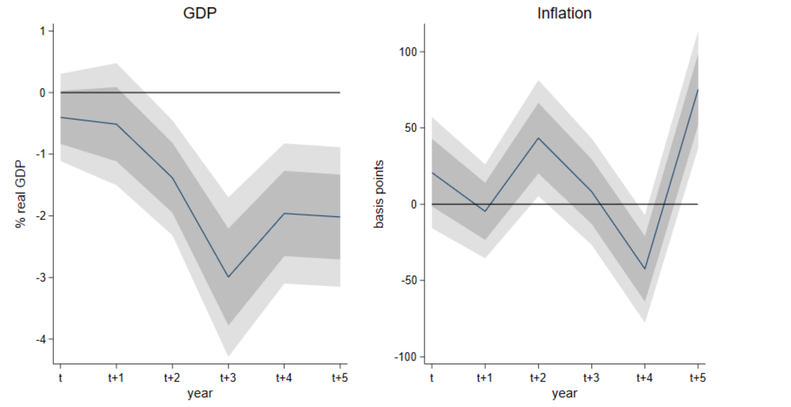
$$y_{i,t+h} = \alpha_i + \beta^h \hat{f}_{i,t} + \gamma X_{i,t} + \Theta y_{i,t-1} + \lambda_t + \varepsilon_{i,t+h}$$

- $f_{i,t}$**: n. of floods in county** i **in year** t
- β_h: cumulative impact of a 1 std ↑ in n. of floods
- Controlling for lags and population
- $\varepsilon_{i,t+h}$ clustered at ITL3 level

4. AGGREGATE ANALYSIS

Aggregate analysis confirms results in the literature:

- **GDP ↓ persistently** after 2 years by up to 3%. Remains 2% lower 5 years after the shock → why is the impact **delayed**?
- **Inflation** shows an **erratic behaviour** → is it a **supply** or a **demand** shock? Does it matter for **monetary policy**?



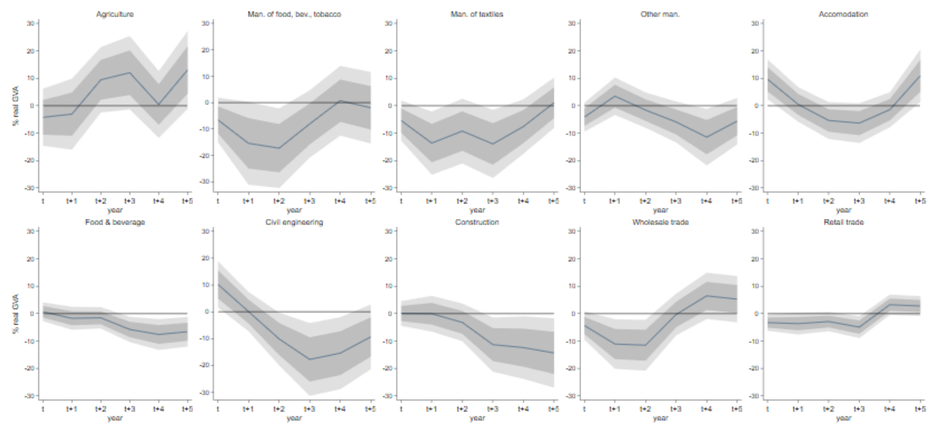
5. MAIN RESULTS: SECTOR ANALYSIS

1. GDP at sector level:

- **Manufacturing of textiles**, **wholesale trade** and **retail trade**: output ↓ **immediately**
- **Construction** and **food and beverage** services: output ↓ **persistently after 3 years**
- **Civil engineering** and **accommodation**: immediate ↑ in output due to **increase in demand**

Implications:

1. **Averaging out sectors explains aggregate dynamics**
2. **Policy: one-size-fit-all interventions might not be effective**

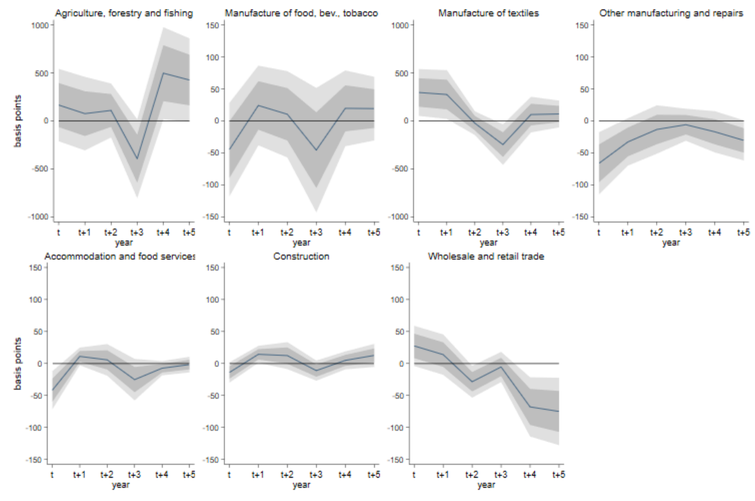


2. Inflation at sector level:

- Deviations in output **not always** go hand in hand with **variations in prices**
- **Other manufacturing** and **accommodation and food services**: π ↓ **temporarily upon impact**
- **Wholesale and retail trade**: π ↓ persistently → **demand side** type of shock
- **Manufacture of textiles**: π ↑ on impact → **supply side** type of shock

Implications:

1. **Floods can act as both demand and supply side shocks**
2. **Monetary policy: core inflation** (wholesale and retail trade) **can be affected, not just headline**



7. ADAPTATION

1. Extensive margin:

- Proxy adaptation capital as cumulated expenditure in flood defences:

$$k^{adapt.}_{i,t} = exp^{adapt.}_{i,t} + \delta k^{adapt.}_{i,t-1}$$

- A flood prone county ($prone_i = 1$) is subject to more floods than the national average

⇒ **Adaptation capital strongly reduces the number of floods in flood prone areas**

Dep: n. of floods	(1) t	(2) t+1	(3) t+2	(4) t+3	(5) t+4	(6) t+5
$exp_{i,t}$	-0.231	-0.791	-1.952	-3.879	-11.19**	-9.467
	(-0.14)	(-0.41)	(-0.79)	(-1.02)	(-2.50)	(-1.61)
$exp_{i,t} \times prone_i$	-8.187	-43.26	-74.51****	-1.762	-6.449	-12.14
	(-0.20)	(-1.30)	(-4.03)	(-0.04)	(-0.14)	(-0.39)
$k^{adapt.}_{i,t}$	-0.127	0.0195	-0.415	-0.877	0.0938	0.855
	(-0.26)	(0.04)	(-0.72)	(-1.15)	(0.09)	(0.93)
$k^{adapt.}_{i,t} \times prone_i$	-23.56*	-33.29**	-20.17***	-21.03**	-45.02**	-40.85***
	(-1.78)	(-2.48)	(-3.04)	(-2.31)	(-2.45)	(-2.94)
Obs.	4,326	4,326	4,017	3,708	3,399	3,090
ITL3 FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

2. Intensive margin:

- Does adaptation help once the flood happens?
- We estimate a state-dependent LP where the state is defined by adaptation expenditure:

$$I_{i,t-1} = 1 \quad if \quad exp_{i,t-1} > \overline{exp}$$

⇒ **Adaptation is not as effective at reducing damage once the flood happens**