

# **(Not) Going to school in times of climate change: Natural disasters and student achievement**

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Center Seminar

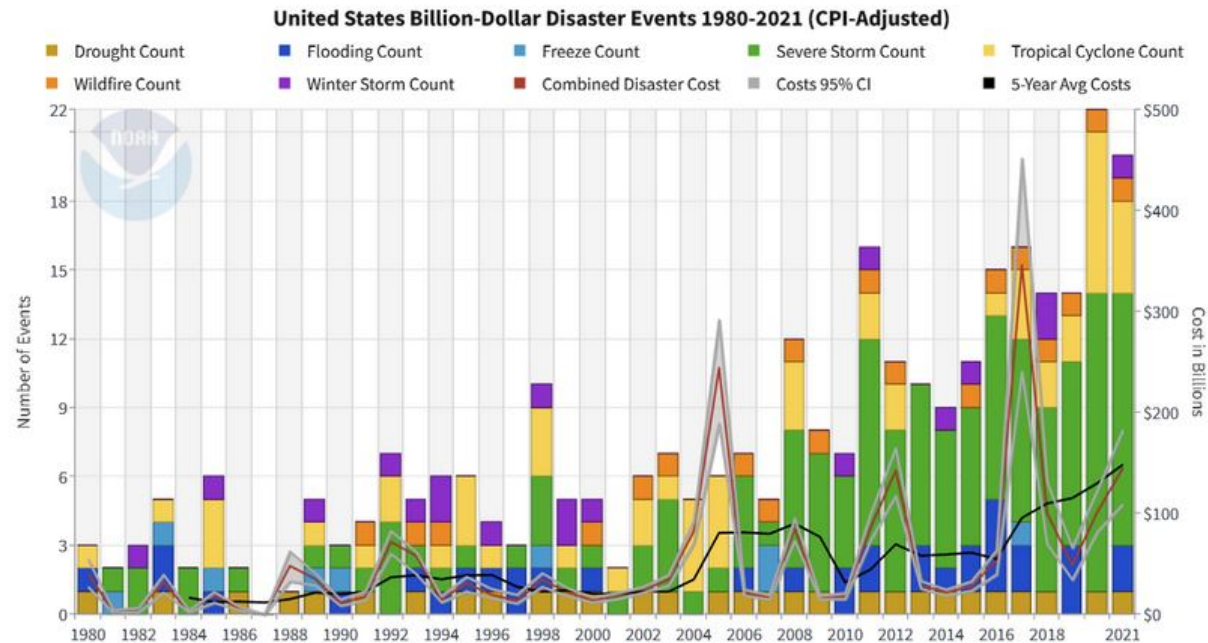
November 30, 2023



Leibniz Institute for Economic Research  
at the University of Munich

# Motivation

Fig. 1: Billion dollar disasters

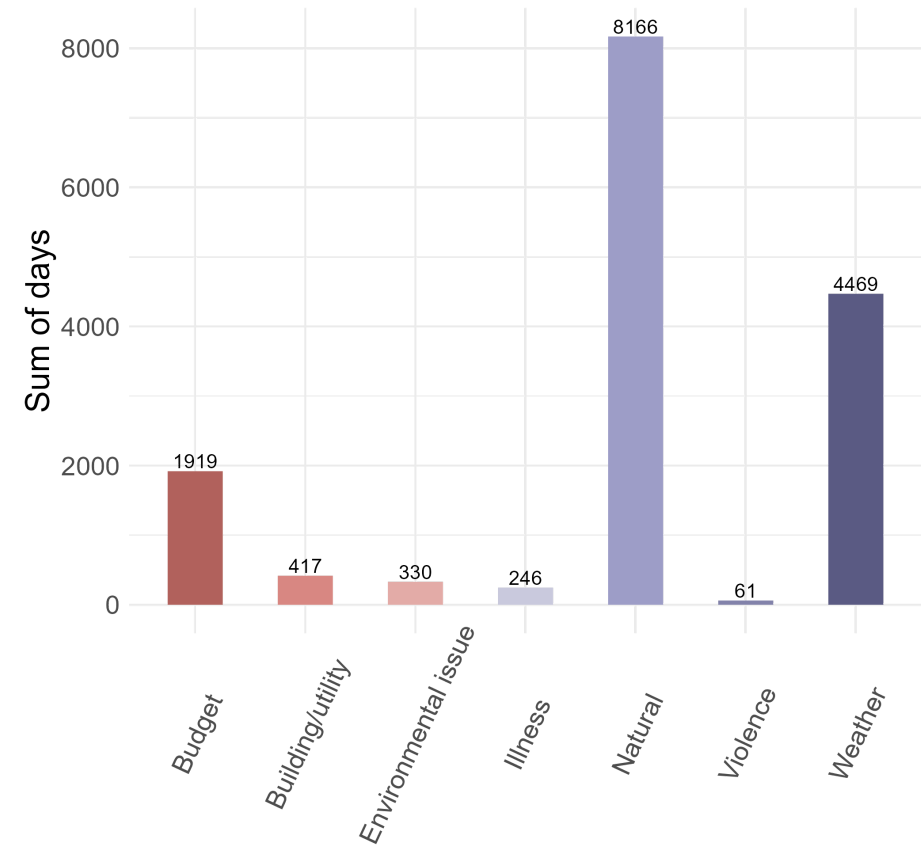


The history of billion-dollar disasters in the United States each year from 1980 to 2021, showing event type (colors), frequency (left-hand vertical axis), and cost (right-hand vertical axis.) The number and cost of weather and climate disasters is rising due to a combination of population growth and development along with the influence of human-caused climate change on some type of extreme events that lead to billion-dollar disasters. NOAA NCEI.

# Motivation

- 22,112 prolonged unplanned school closures in 2011-2019, affecting over 13 million students that resulted in 91.5 million student-days lost (Jahan et al. 2022).
- 18.7% of all schools had at least one prolonged school closure ( $\geq 5$  days).
- Natural disasters (47%), adverse weather conditions (35%) are the most frequent reason.
- Hurricane Harvey led to >3000 schools closed in four states ranging from 1-19 days.

Fig. 2: School closure



# Motivation


- The occurrence and expenses associated with natural disasters have risen (and could continue to do so).
- Natural disaster can lead to school closures, breakdown of transit system, or even destroy school buildings and housing.
- Potentially lasting effects on students' achievement.
- Implications for individual returns and human capital.
- Understanding the costs of natural disasters is crucial for pre- and post-disaster investment and policies.

The New York Times

N.Y. / Region

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### Schools Reopen to Snarls; Transit Headaches Persist



Back to School, for Some: Although most New York public schools reopened on Monday, some were still closed, and their pupils had to move elsewhere temporarily.

By VIVIAN YEE  
Published: November 5, 2012


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Flutkatastrophe

### Ein Neuanfang in 256 Containern

2. Februar 2022, 11:07 Uhr | Lesedzeit: 8 min



Außen Metallregalen, innen Linsolern. Für drei Jahre werden diese Container für viele Kinder und Jugendliche aus dem Ahrtal die Schule sein. (Foto: Thomas Frey/picture alliance/tpa)

**Die Flut hat nicht viel übrig gelassen vom Gymnasium in Bad Neuenahr-Ahrweiler. Schulleiter Heribert Schieler muss jetzt trotzdem Normalität schaffen, wo doch nichts normal ist.**

Von *Gianna Nieuwe*, Bad Neuenahr-Ahrweiler

# This Paper

**Main Question:** What are the effects of natural disasters on student achievement?

## How?

- **Data:** Combining county level student achievement (SEDA) for 2009-2018 with disaster declarations in the US from the Federal Emergency Management Agency (FEMA).
- **Framework:** Exploit variation across US counties and years in TWFE setting
  - ➔ Sun & Abraham DiD event study design with first year of natural disaster
  - 💡 How does the effect evolve over time? Assess common trends.
  - ➔ TWFE with number or severity of natural disasters in the past five years
  - 💡 Are more disasters more detrimental or are counties adapting?
  - 💡 Do larger disasters cause more harm?

# Data on Student Achievement

## Stanford Education Data Archive (SEDA) 2009-2018

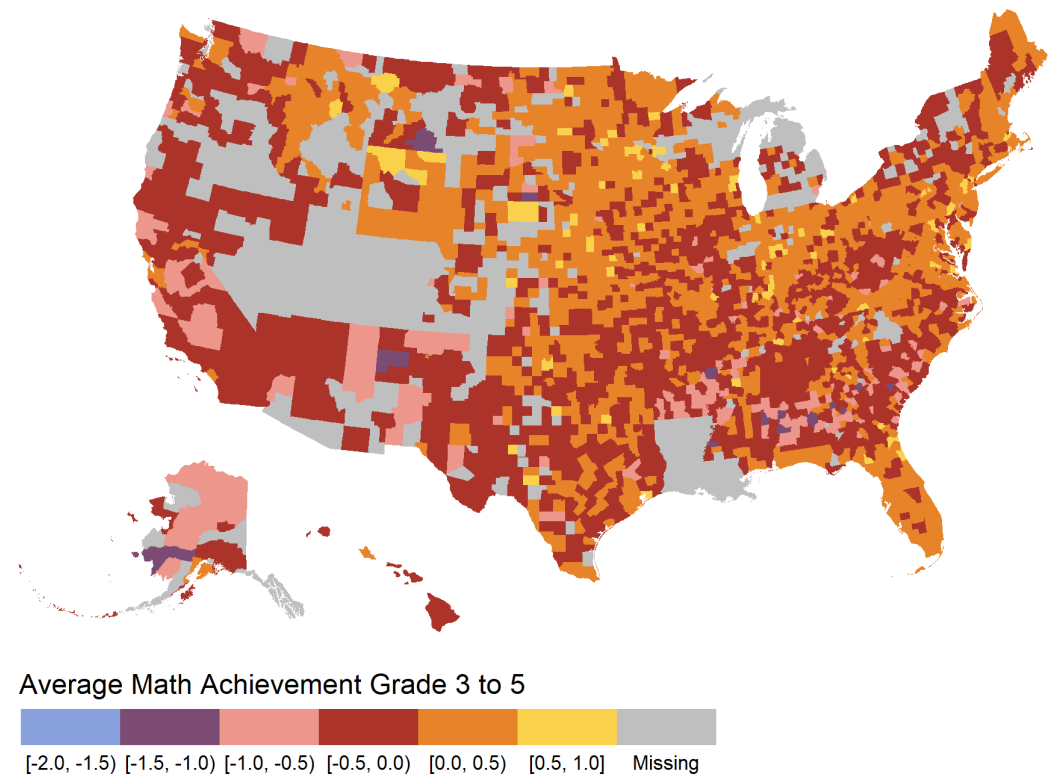
**District and county level average achievement** (for all students and by race/ethnicity and gender), district and county level racial/ethnic and gender achievement gaps, and district level demographic/socioeconomic data.

- **Achievement is centered around zero**, so a score of zero means the county is at the average expected level of achievement within the United States. One-unit below zero means that students in the county are one grade level behind the average; one-unit above zero means that students in the county are one grade level above the average.

➔ Use county level and focus on grade 3.

# Data: Math scores

Fig. 3: Average Math Achievement Grade 3 to 5



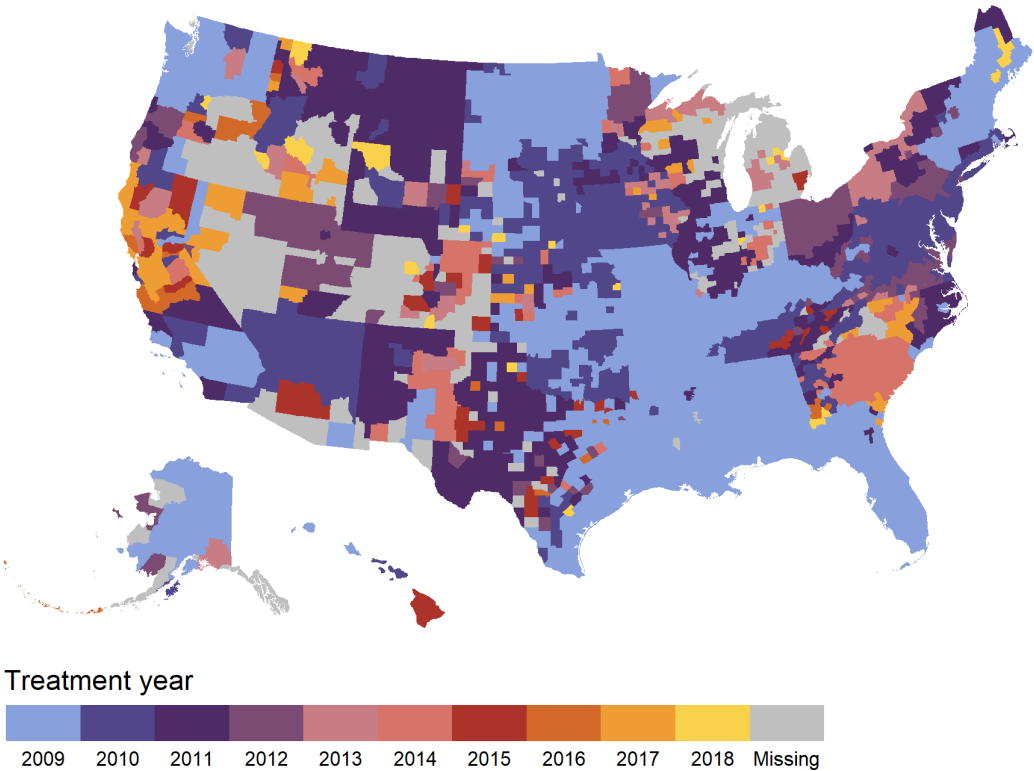
# Data on Disasters (I): FEMA

- OpenFEMA Dataset by the Federal Emergency Management Agency (FEMA) of the Department of Homeland Security
- Major disaster declarations 2009-2018 (begins in 1964)
- A disaster declaration is only made (by the President of the United States) in strongly affected areas that struggle to deal with the consequences → rules out inconsequential natural disasters.
- The disaster declaration includes the date the disaster was declared, the area, the type of incident, denotes which assistance program was declared.
- Storms (73%), Floods (20%), Fire (7%), Drought (2%), Freezing, Earthquake, Landslide, Volcanic activity.
- One disaster can cause multiple disaster events across different counties.
- For large disasters: Information of fatalities from EM-DAT via county and start date.
- Define severe natural disasters as disasters that caused  $\geq 25$  deaths (following Bounsat et al. 2020).



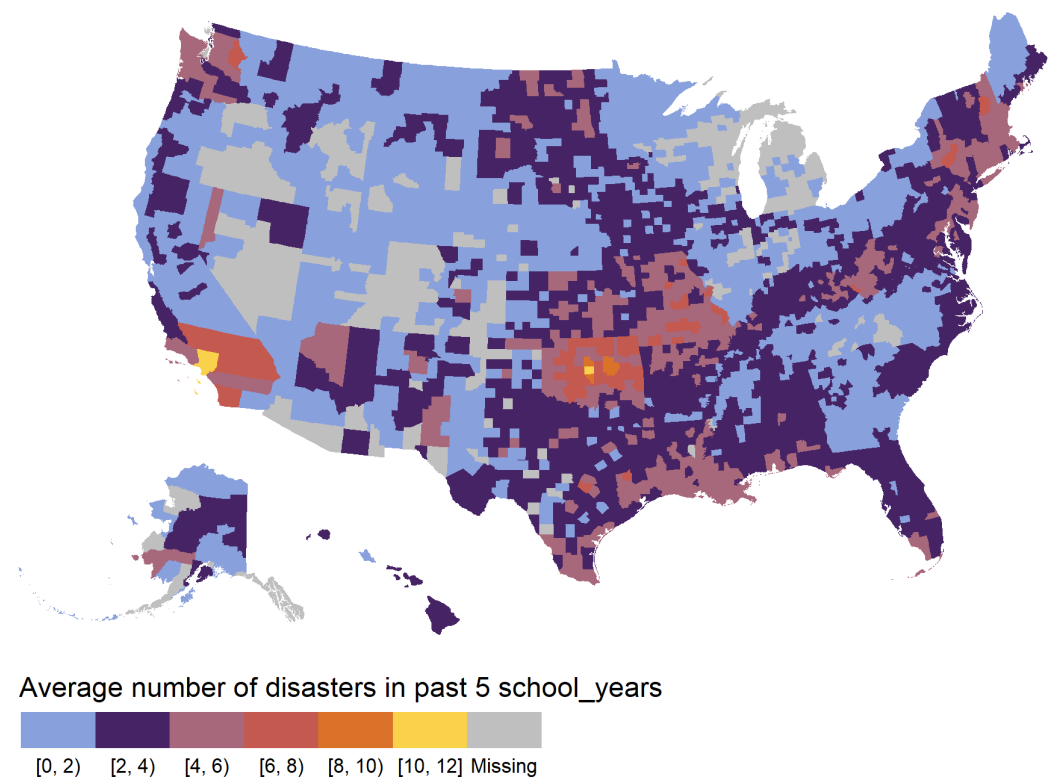
# Treatment year

Fig. 4: First year of natural disaster



# Number of natural disasters

Fig. 5: Number of natural disasters between 2009 and 2018



## Literature on specific major disasters on schools and students

- Sacerdote (2012) for students that were forced to switch school after hurricane Katrina and Rita, there was a sharp decline in test scores in the first year after the hurricanes. Long term effects are mixed.
- Di Pietro (2019): earthquake in Italy reduced students' probability of graduating on-time and slightly increased students' probability of dropping out.

➔ However, most disasters are not as severe as those outliers.

➔ Focus on young kids (grade 3).

## Contribution to existing literature

### Literature on school closures and absenteeism

Covid papers eg. Werner & Woessmann (2023), teacher and student absenteeism eg. Clotfelder, Ladd, and Vigdor (2006), Miller, Murnane, and Willett (2006)

➔ Natural disaster fundamentally different from Covid.

➔ Natural disasters can be seen as an exogenous shock to absence.

➔ Eg. infrastructure damages are possible.

# Model

We're interested in the dynamic effects:

- Problem: Staggered adoption, coefficients on lead and lag indicators in a dynamic specification can be biased with TWFE.
- Solution: reweighting following Sun and Abraham (2021)

## Target parameter

**Cohort average treatment effect on the treated** for a treatment cohort  $e$  and relative time period  $l$

$$CATT_{e,l} = E[Y_{i,e+l} - Y_{i,e+l}^{\infty} | E_i = e]$$

$Y_{i,e+l}^{\infty}$  is the potential outcome of county  $i$  in a world where it is untreated.

Here, a treatment cohort  $e$  are counties that are treated at the same time.  $l$  are periods to  $i$ 's initial natural disaster.

# Dynamic Treatment effect following Sun & Abraham (2021)

Estimate the event study regression using "last treated" as control (C):

$$Y_{i,t} = \alpha_i + \lambda_t + \sum_{e \notin C} \sum_{l \neq -1} CATT_{e,l} (1\{E_i = e\} \cdot D_{i,t}^l) + \epsilon_{i,t}$$

## The interaction weighted estimator

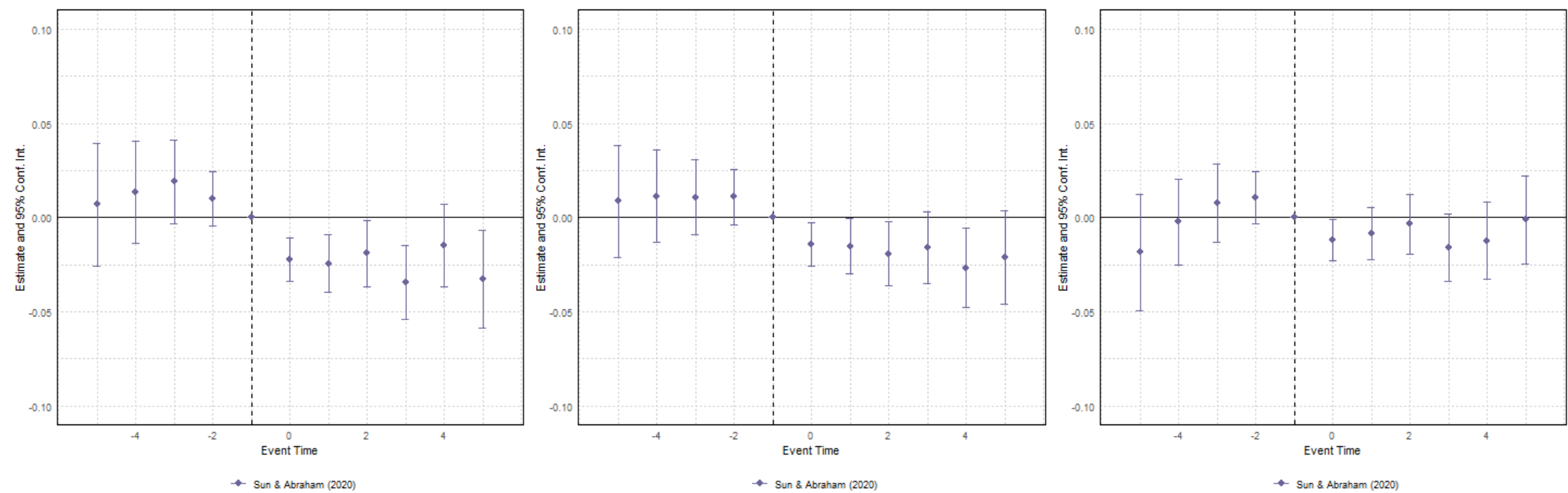
Take the weighted average over all estimates for  $CATT$  multiplied by the sample share of each cohort in the period  $Pr(E = e)$ :

$$\hat{v}_g = \frac{1}{|g|} \sum_{l \in g} \sum_e C\widehat{ATT}_{e,l} \hat{Pr}(E_i = e | E_i \in [-l, T - l])$$

Main assumptions: Parallel trends for all units, Limited anticipation

# Results

Fig. 5: Math achievement in grade 3, 4, and 5



## Alternative specification

Do more disasters cause more harm?

$$Y_{i,t} = \alpha_i + \lambda_t + \beta Disaster_{i,t} + \delta'(\mathbf{X}_i \lambda_t) + \epsilon_{i,t},$$

where  $Disaster_{i,t}$  is the number of natural disasters in the past 5 years in a county and year,  $\alpha_i$  and  $\lambda_t$  are county and year fixed effects,  $\mathbf{X}_i \lambda_t$  includes an interaction between initial county population and a linear time trend.

## Alternative specification

Do larger disasters cause greater harm?

$$Y_{i,t} = \alpha_i + \lambda_t + \delta_1 Minor_{i,t}^{1-5} + \delta_2 Major_{i,t}^{1-5} + \delta'(\mathbf{X}_i \lambda_t) + \epsilon_{i,t},$$

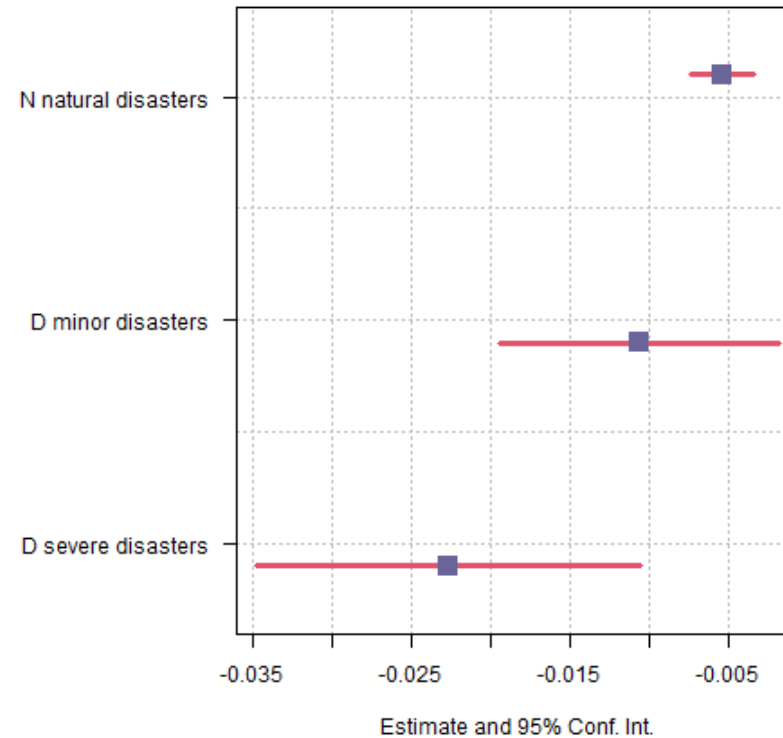
Following the literature,  $Minor_{i,t}$  and  $Major_{i,t}$  are indicators equal to 1 if the county experienced a minor or major disaster in the past five years,  $\alpha_i$  and  $\lambda_t$  are county and year fixed effects,  $\mathbf{X}_i \lambda_t$  includes an interaction between initial county population and a linear time trend. Thus the  $\delta_1$  and  $\delta_2$  parameters provide estimates of the impact of any type of disaster that falls into either of these two categories.

The preferred measure of a "severe" disaster is one that caused 25 or more deaths, following Boustan et al. (2020).



# Results: Number and size of natural disasters

Fig. 6: Number and size of natural disasters in the past 5 years.



Based on cost

# Robustness and Sensitivity

- Sun and Abraham: Using never treated as **control**.
- Results look similar with **Borusyak, Jaravel, and Spiess (2023)**.

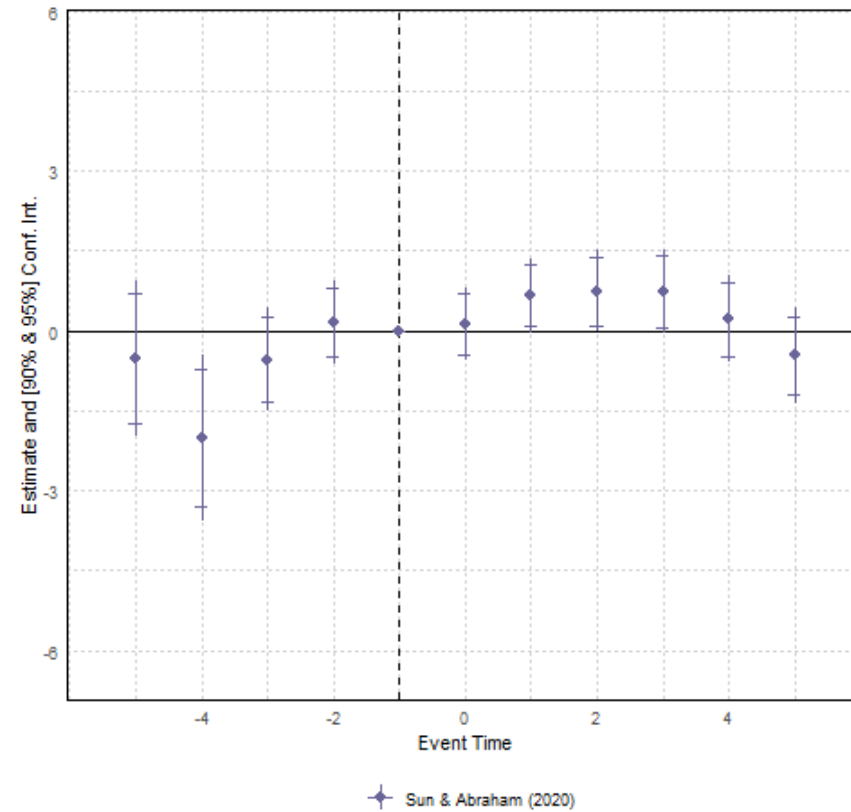
## Mechanism

Human capital loss is detrimental by itself. But can we identify channels for more targeted policies?

- Out-migration?
- Mental health (open)
- Other?

# Mechanism: Effect of net migration

Fig. 8: Results for net migration (Sun and Abraham)



Enrollment

## Conclusion (for now)

- What is the effect of natural disasters on students?
- Setting: Number and costs of natural disasters have been increasing, already now 80% of the unplanned school closures are due to natural disasters and adverse weather conditions.
- Evidence points to a negative effect of natural disaster on student achievement.
- More natural disasters cause more harm. This effect is larger for large natural disasters.
- However, parts of the effect could be explained by out migration.

Next step:

- Individual level data with effects on mental health.

Coffee? ☕



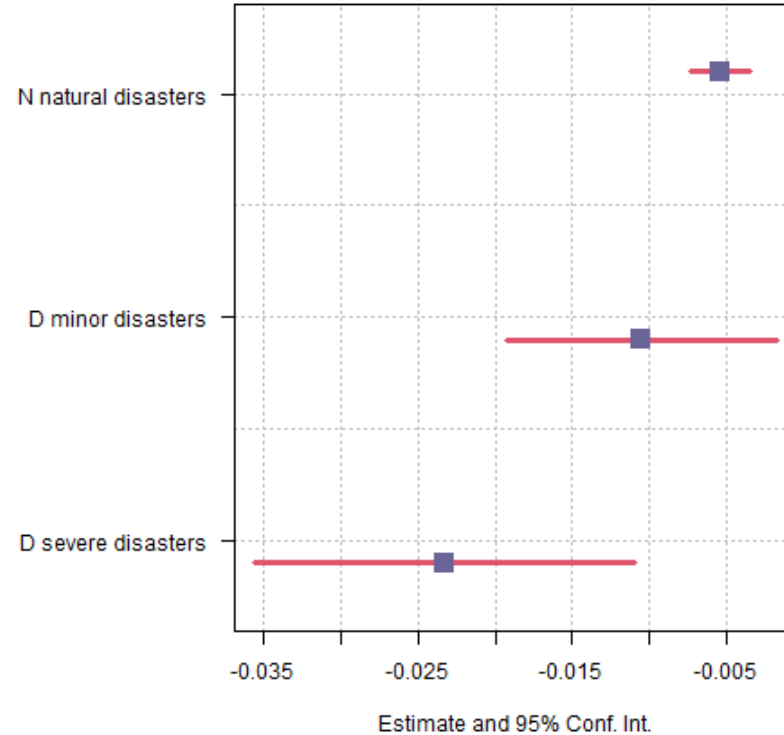
✉ [gust@ifo.de](mailto:gust@ifo.de)

🐦 <https://twitter.com/sarages>

🔗 <https://www.ifo.de/en/gust-s>

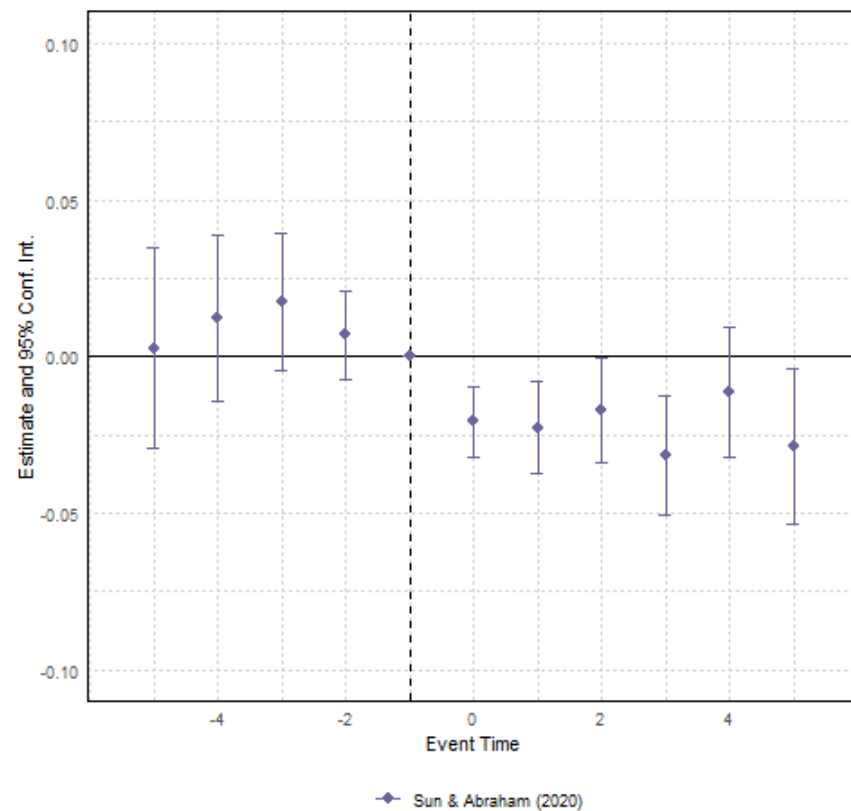
# Descriptive Table

# Alternative Larger natural disasters cause more harm



A "severe" disaster is one that caused more than 1 bn dollar damage (adjusted) [Go back](#)

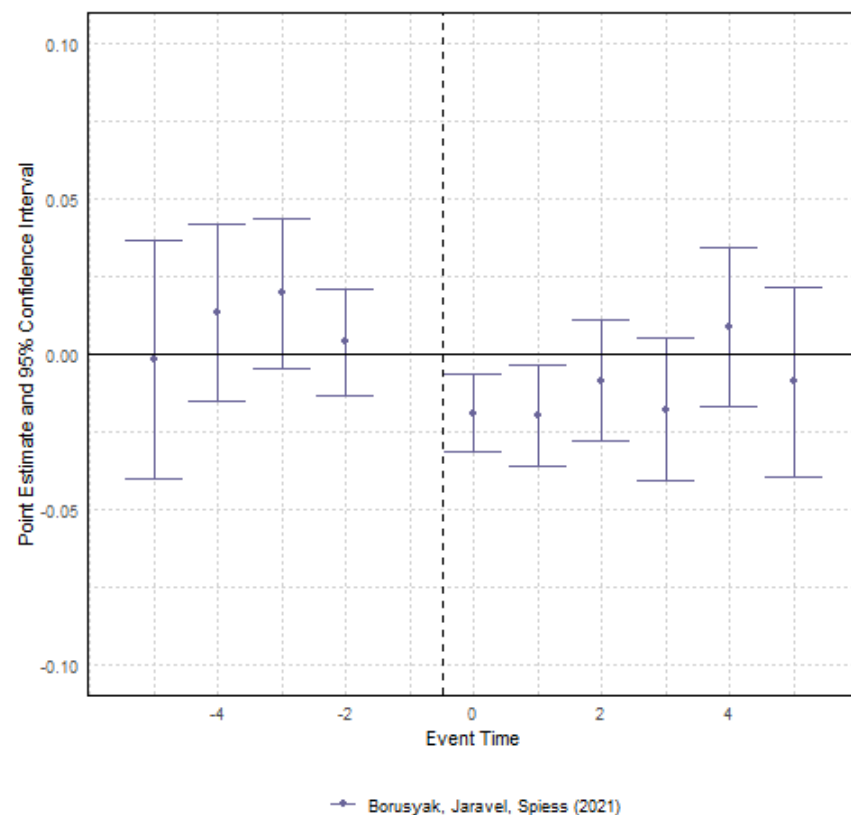
# Sun and Abraham with never treated



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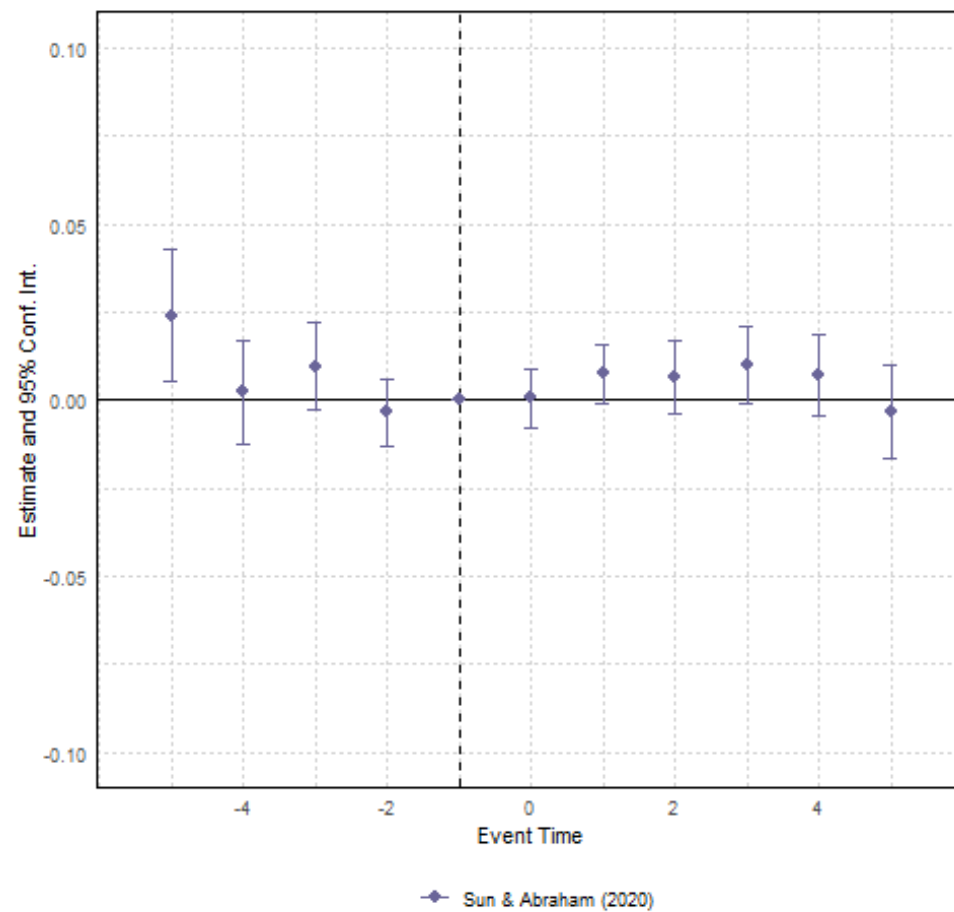
# Imputation method



Intuition: Borusyak et al. 2021 imputes  $Y(0)$  with not-yet treated and never treated units.

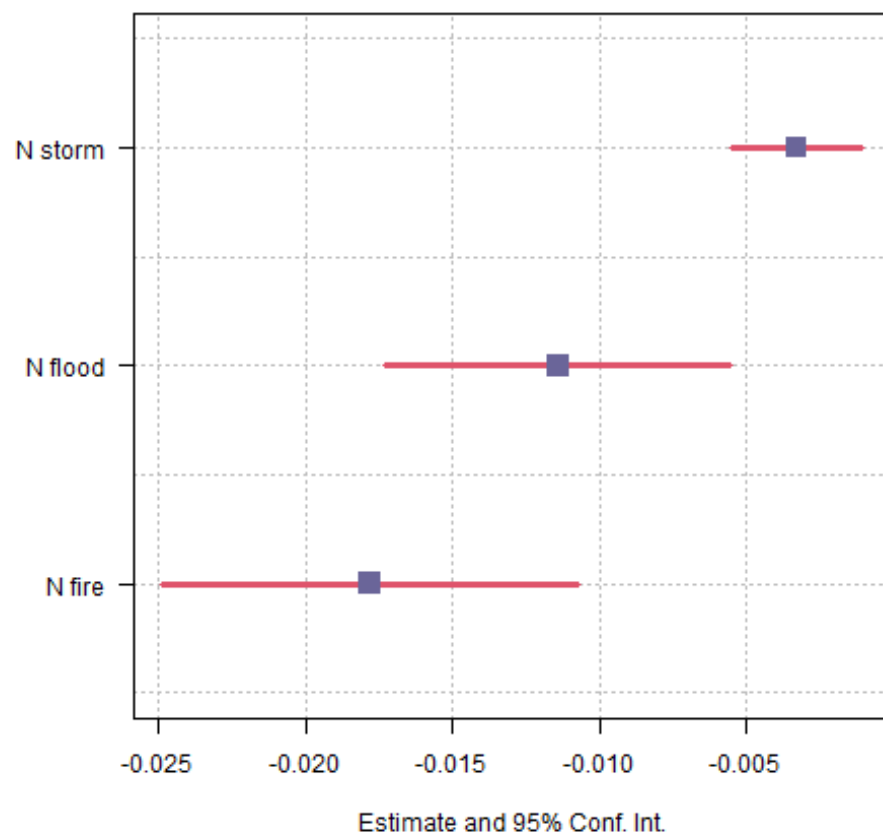
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# Enrollment



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# Disaster types



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# Disaster Count

Fig. 7: Number of natural disasters between 2009 and 2018

