

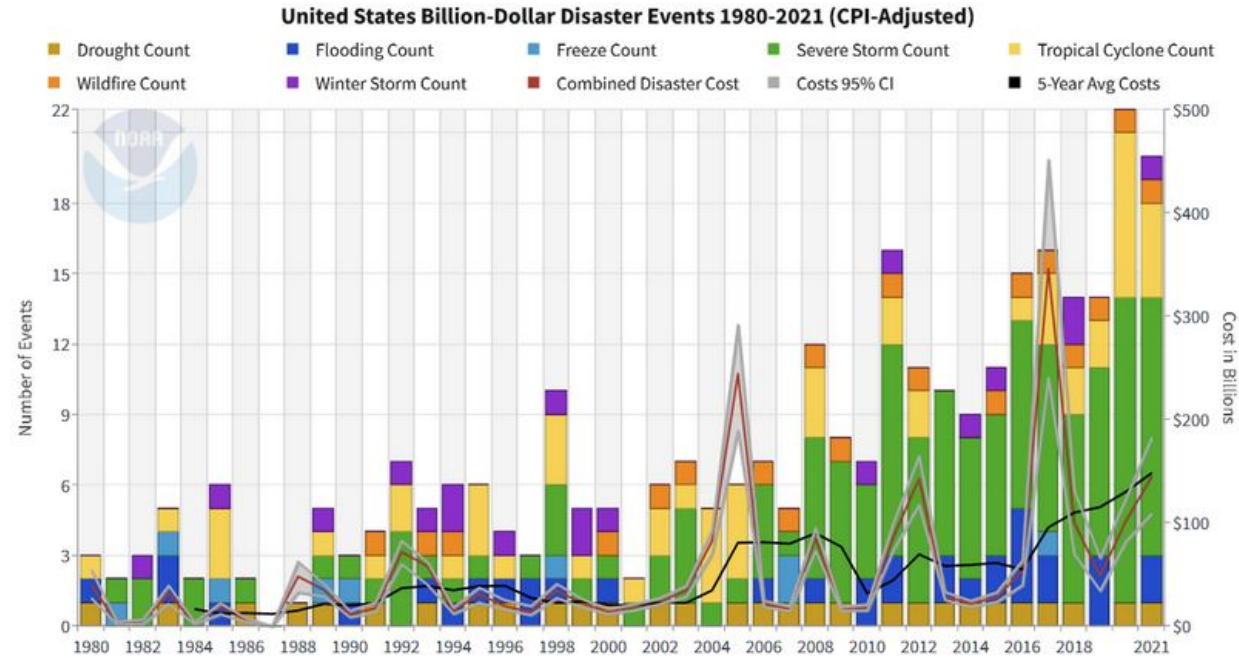
# (Not) Going to school in times of climate change: Natural disasters and student achievement

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# Motivation



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.

Fig. 1: Billion dollar disasters

# 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.

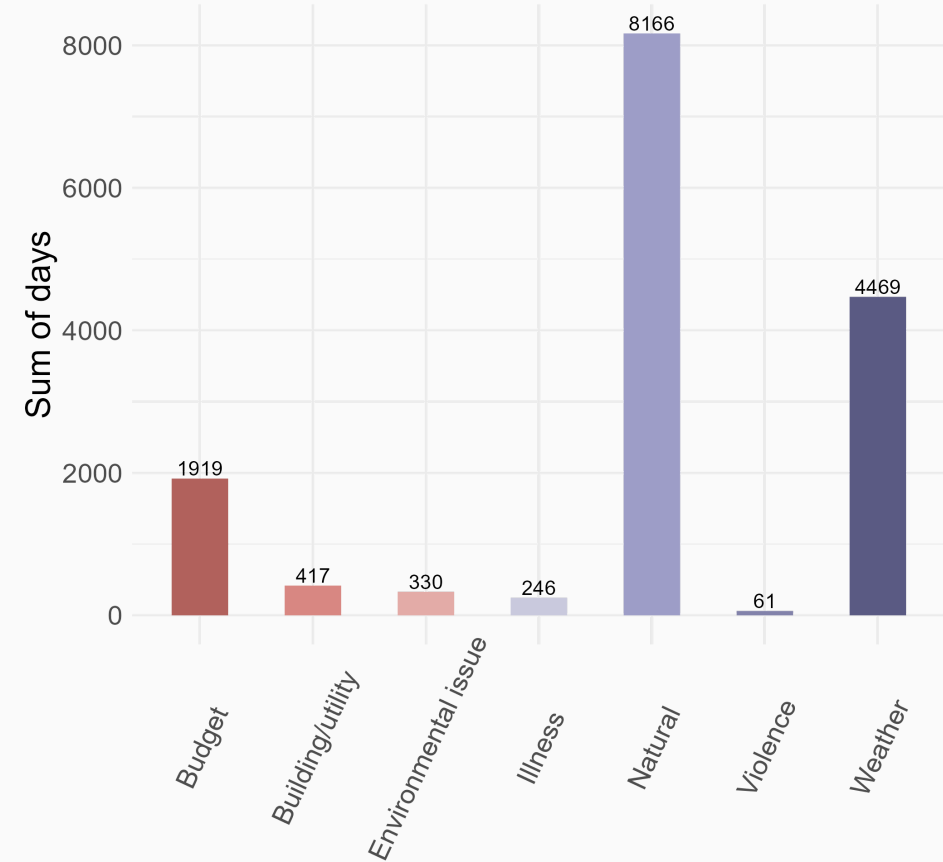
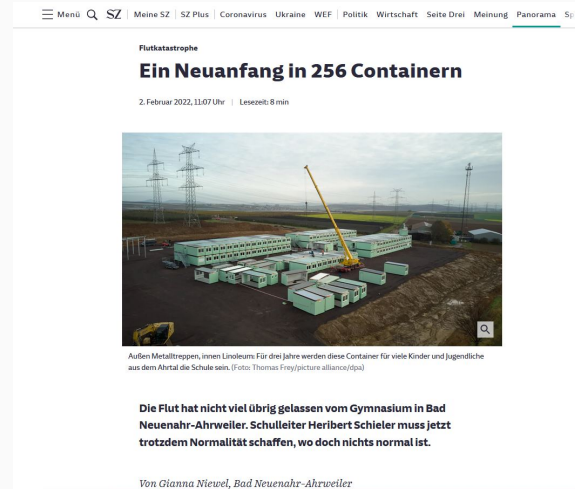


Fig. 2: School closure

# Motivation

- Frequency and costs of natural disasters have increased.
- This can have lasting effects on students' achievement and future earnings.
- Natural disaster can lead to school closures, breakdown of transit system.
- Most studies look at impact of natural disasters on economic growth (eg. Dell, Jones and Olken 2012) but there is less attention on the impact on students.
- Understanding the costs of natural disasters is crucial for pre- and post-disaster investment and policies.



# This Paper

- Main Question: What are the effects of natural disasters on student achievement?
- Data: Combining county level student achievement (SEDA) for 2009-2018 with disaster declarations in the US from the Federal Emergency Management Agency (FEMA) .
- Framework: I estimate the effect of a natural disaster on student achievements in a TWFE framework.

# Contribution to existing literature

## Literature on specific major disasters on schools and students

Sacerdote (2012), Di Pietro (2019), Holmes (2002), Spencer et al. (2016), Shidiqui et al. (2023) find negative short-run effects on students and schools. Evidence on long-run effects are mixed.

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

## 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.

➔ Teacher and students absence suffers from endogeneity issues.

➔ Effect of both absenteeism and infrastructure damages are possible.

# 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 district is at the average expected level of achievement within the United States. One-unit below zero means that students in the district are one grade level behind the average; one-unit above zero means that students in the district are one grade level above the average.

➔ Use county level and focus on grade 3.

# Data: Math scores

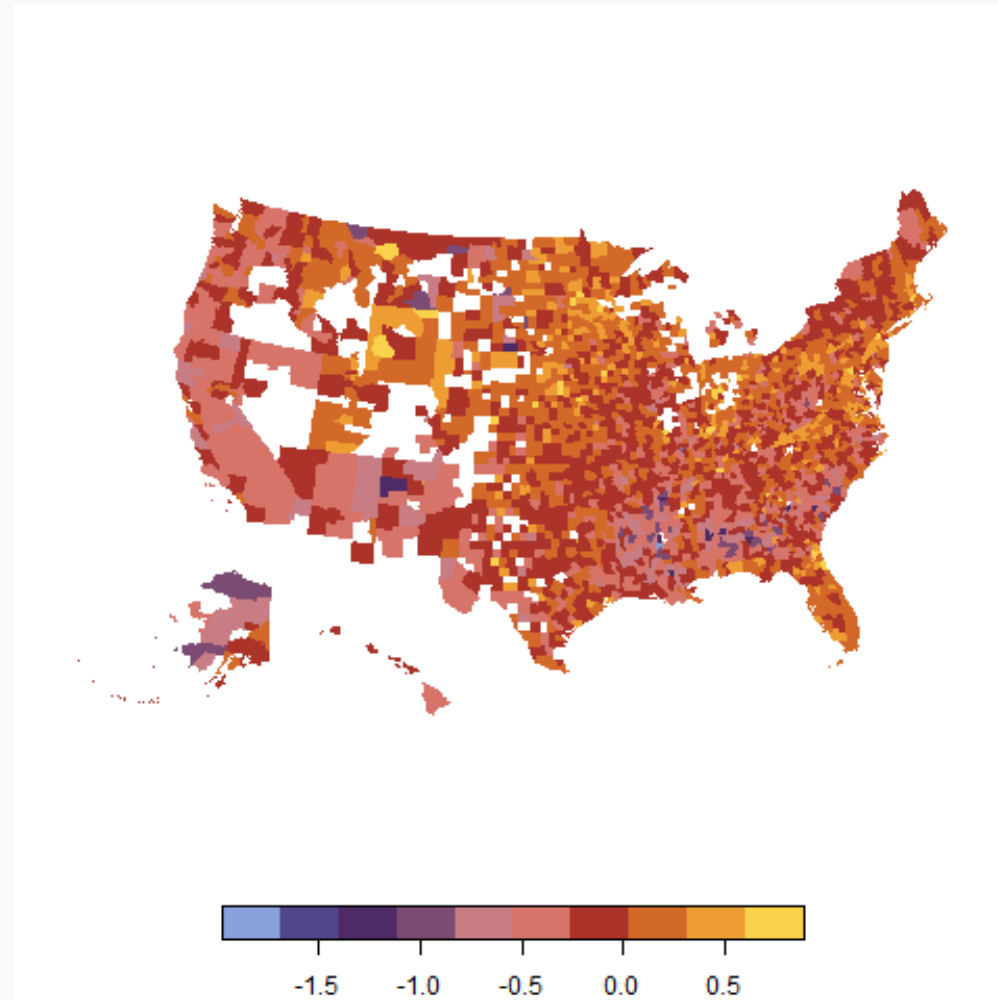


Fig. 3: Average Math Achievement Grade 3 to 5



# Data on Disasters (I): FEMA

- FEMA major disaster declarations 2009-2018 (begins in 1964)
- 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).

# Data on Disasters (II): FEMA

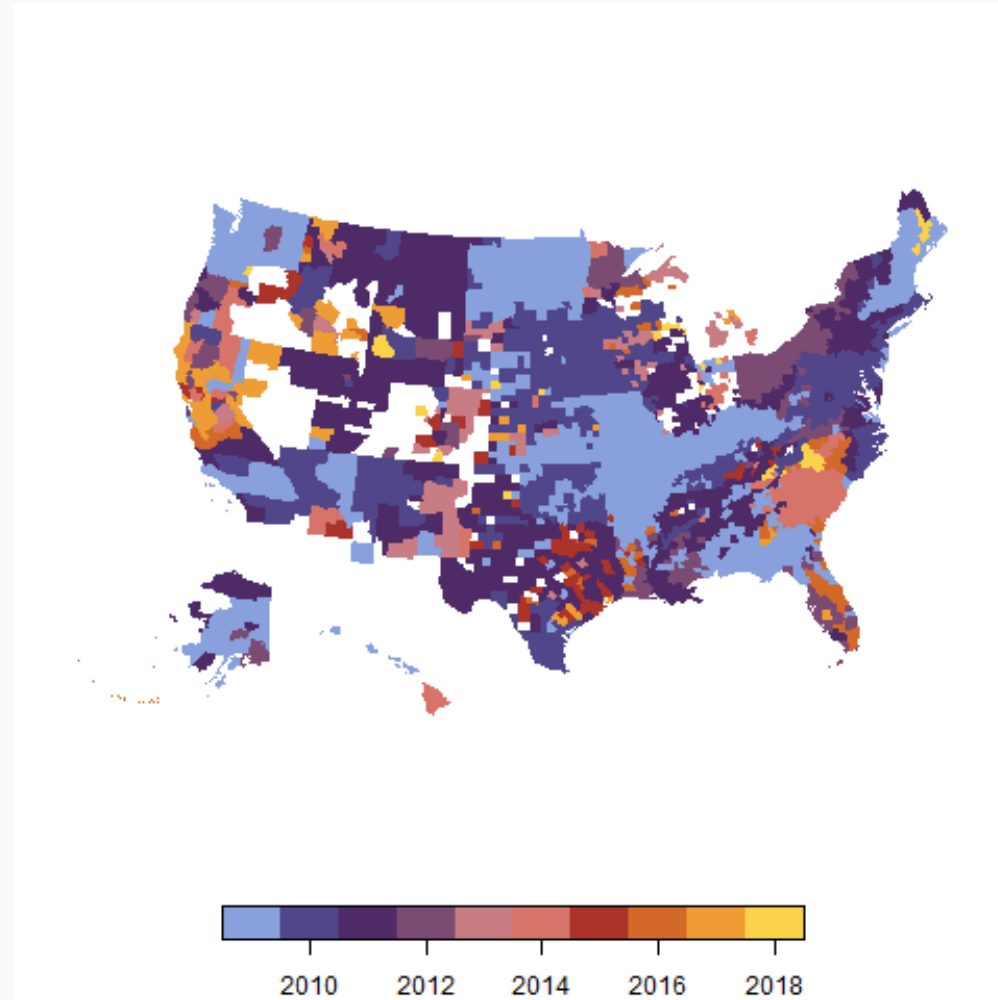


Fig. 4: First year of a natural disaster

# Target Parameter

- 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)

**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

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

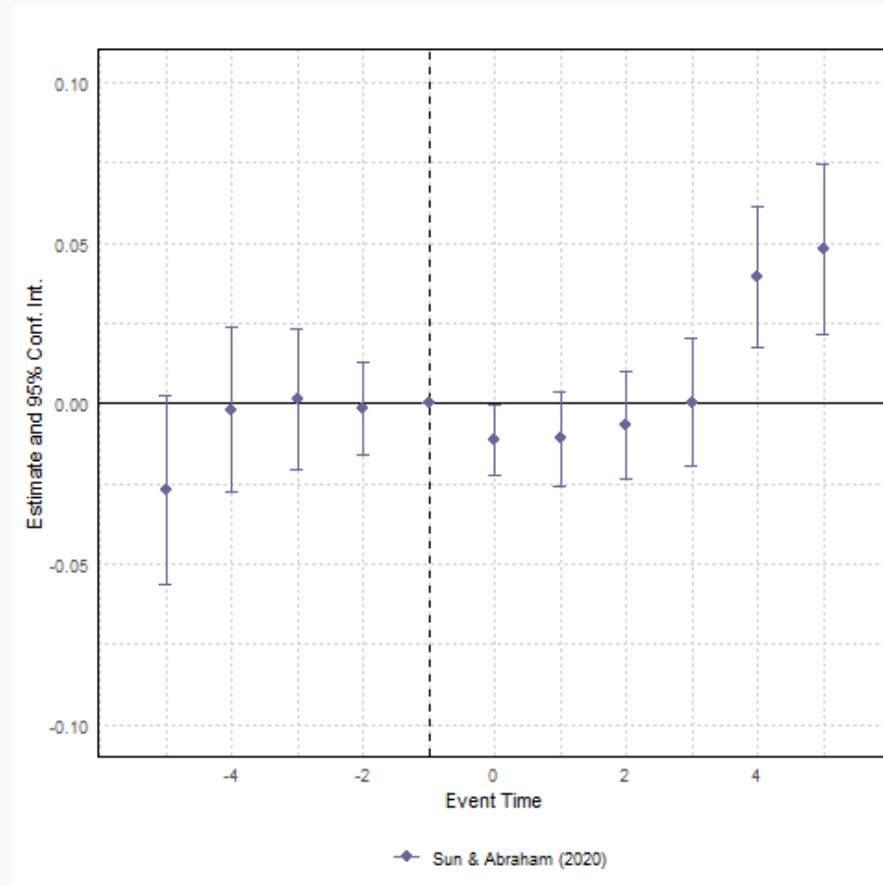


Fig. 5: Math achievement in grade 3

# 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 and severity of a 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.

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

# Results: Larger natural disasters cause more harm

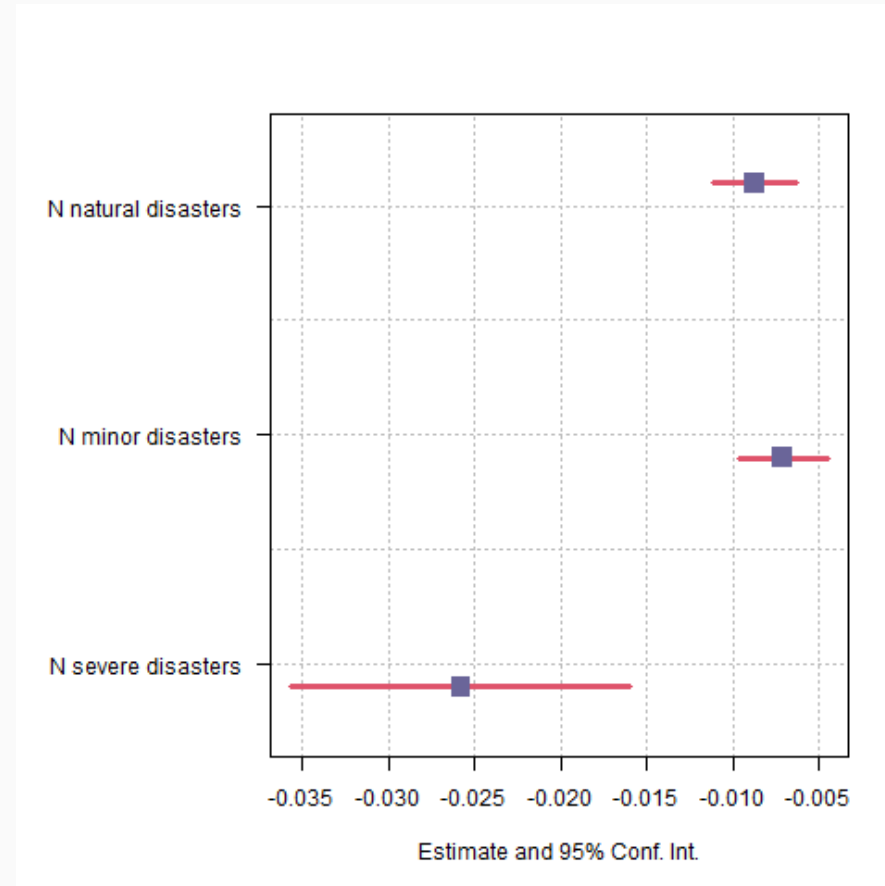


Fig. 6: Number of natural disasters in the past 5 years.

# Robustness and Sensitivity

- Using never treated as control.
- Results look similar with Borusyak, Jaravel, and Spiess (2023).
- Does age matter? Similar effects for kids in grade 4 and 5.
- What about movers? enrollment.



# Conclusion (for now)

- What is the effect of natural disasters on students?
- Setting: US where already now 80% of the prolonged unplanned school closures are due to natural disasters and adverse weather conditions.
- Evidence points to a negative effect of natural disaster on student achievement in the year of the natural disaster.
- More natural disasters cause more harm. This effect is larger for large natural disasters.

Next step:

- Which types of disaster matter?
- Are there effects on achievement gaps?
- Explore the channels.

Get in contact!



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# Descriptive Table

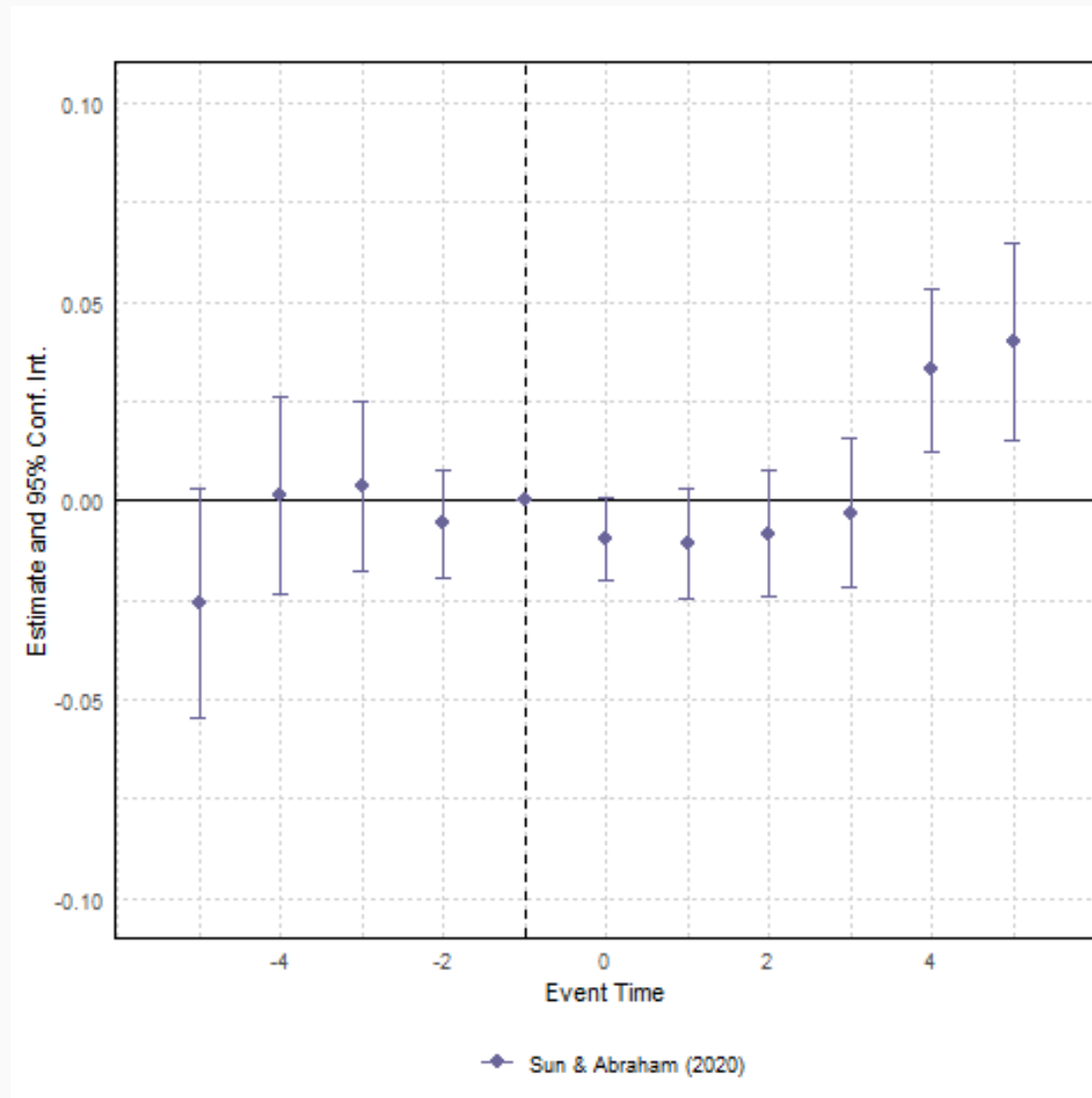
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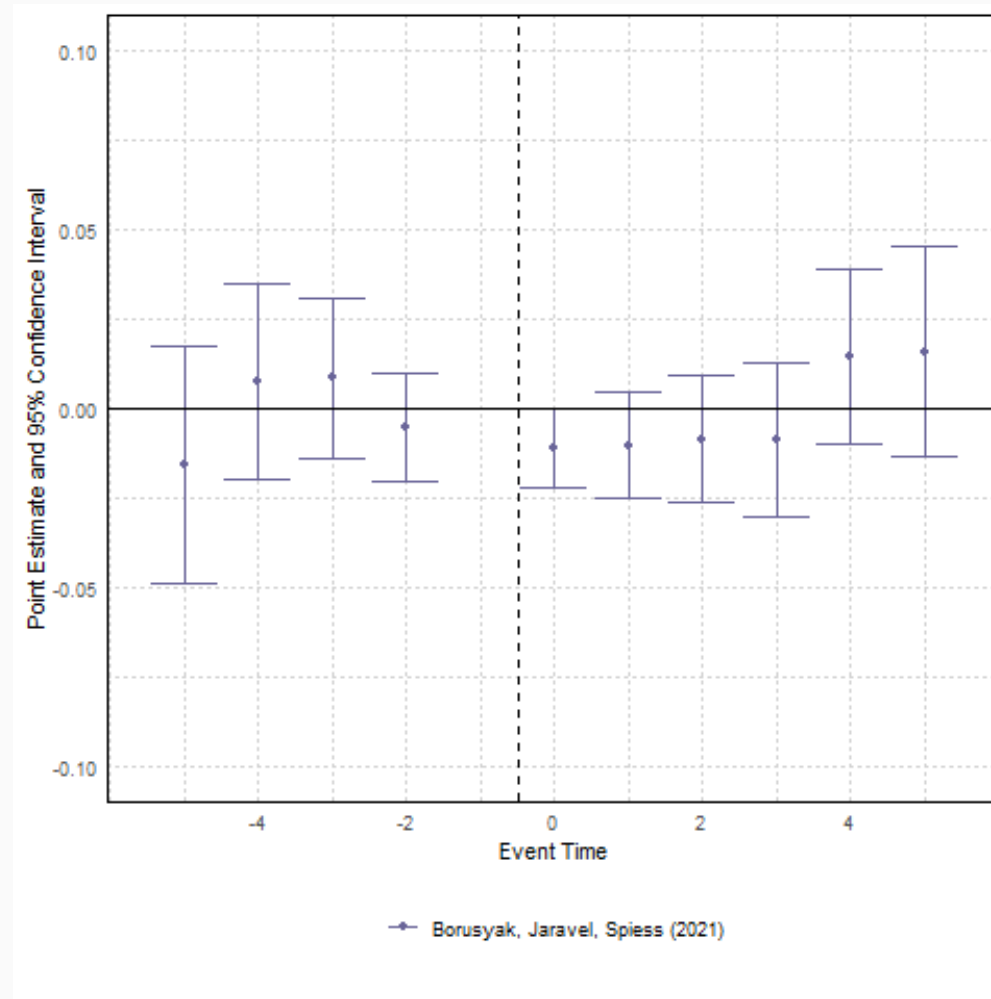
Variable	N	Mean	Std.Dev.	Min	Max
math grade 3	27465	-0.015	0.31	-1.9	1.4
math grade 4	27417	-0.038	0.31	-2.7	1.2
math grade 5	26576	-0.058	0.31	-1.6	1.1
math grade 6	26451	-0.044	0.31	-2.6	1
male-female gap	23773	-0.0056	0.094	-0.55	0.59
non-ECD ECD gap	21308	0.53	0.17	-0.17	1.4
White-Black gap	9264	0.64	0.22	-0.4	1.7
proportion in urban school	27759	0.066	0.18	0	1
proportion in suburban school	27759	0.091	0.21	0	1
proportion in town schools	27759	0.29	0.3	0	1
proportion in rural school	27759	0.56	0.33	0	1
number of students in grade 1	27712	11.68	2.875	2	120822

Showing 1 to 20 of 21 entries

# Sun and Abraham with never treated

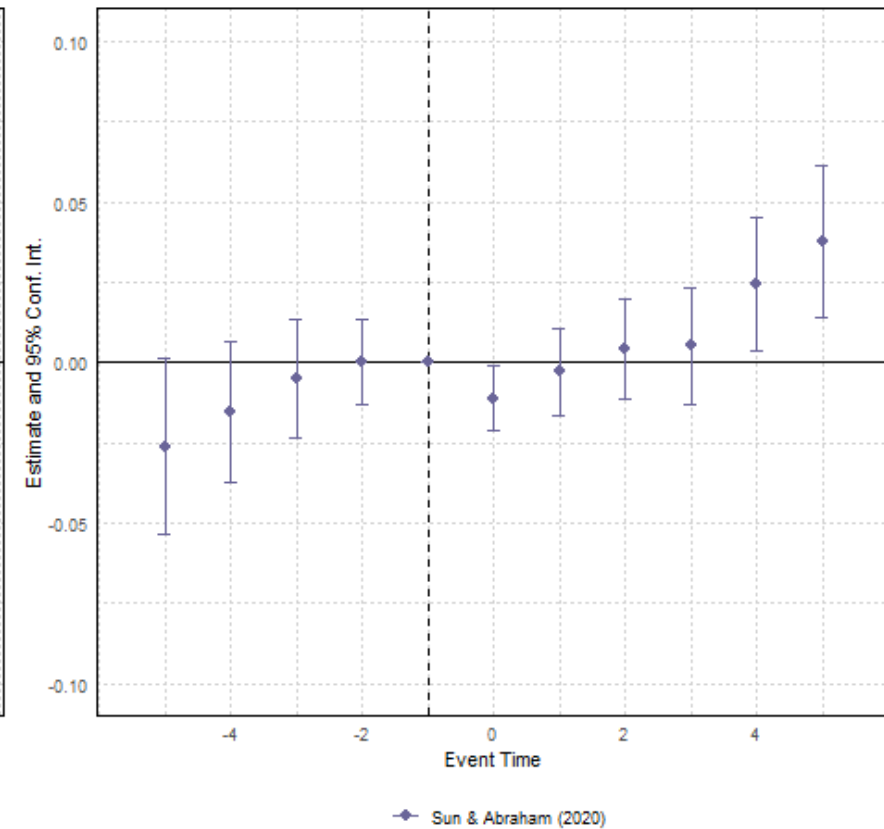
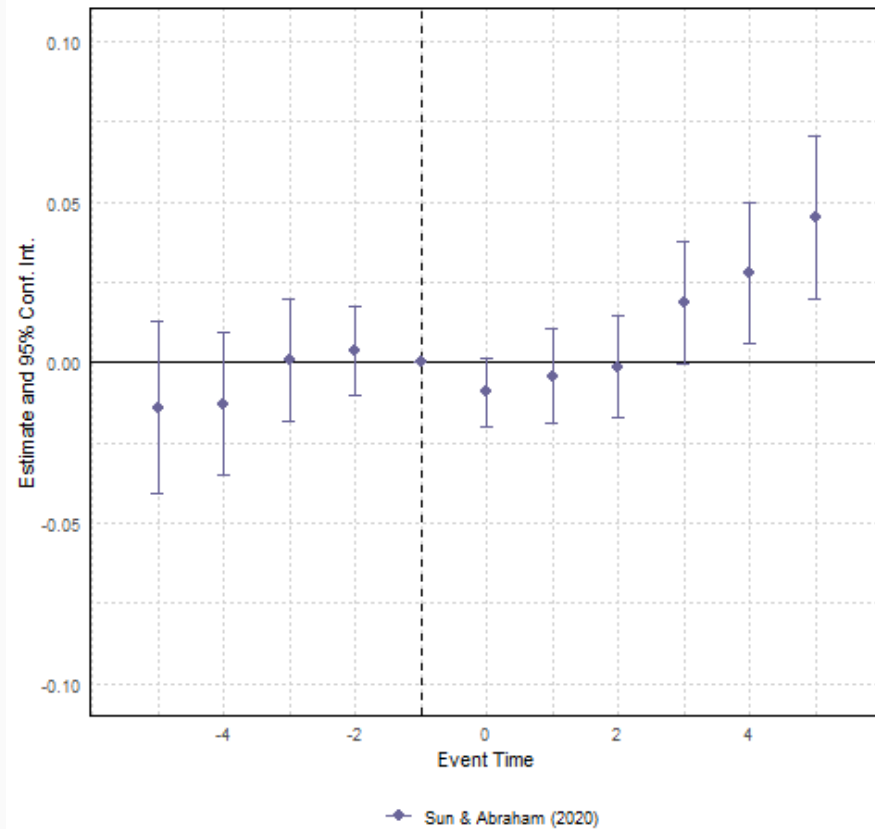


# Imputation method



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

# Results for Grade 4 and 5



Go back

# Enrollment

