

# Wildfire Smoke and Voting Behavior in the United States

Preliminary Results

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# Motivation

- Wildfire smoke is a very widespread *experiential* consequence of climate change in the U.S.
  - Unlike ambient air pollution, smoke events are visible, sudden, and directly attributable to wildfires — making them potentially more *salient* as climate signals
- Does smoke exposure change whether and how people vote?
- Prior work:
  - **Fire proximity** → pro-environment voting in CA, but only among Democrats (Hazlett and Mildenberger, 2020)
  - **Overall air pollution (PM<sub>10</sub>)** → anti-incumbent voting in Germany (Bellani et al., 2024)
  - **Rain on election day** → lower turnout (Gomez et al., 2007)
- **Gap:** No study has linked wildfire-specific smoke PM<sub>2.5</sub> to U.S. election outcomes

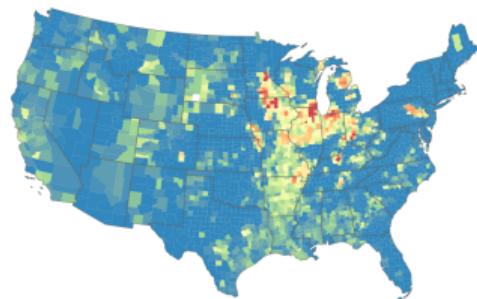
# Data

1. **Wildfire smoke PM<sub>2.5</sub>** — Stanford Echo Lab (Childs et al., 2022)
  - Daily, county-level, 2006–2020
  - ML separation of wildfire smoke from background PM<sub>2.5</sub>
2. **Election returns** — MIT Election Data Lab (MIT Election Data + Science Lab, 2024)
  - Presidential: county-level, 2000–2024
  - House: precinct-level returns aggregated to county, 2016–2020
3. **Analysis samples:**
  - Presidential: 12,429 county × election obs (2008, 2012, 2016, 2020)
  - House: 9,171 county × election obs (2016, 2018, 2020)

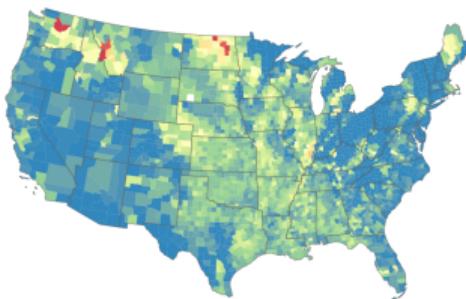
# Smoke Exposure Varies Dramatically Across Elections

**Pre-Election Wildfire Smoke Exposure by County**  
Mean wildfire-attributed PM<sub>2.5</sub> in the 30 days before election day

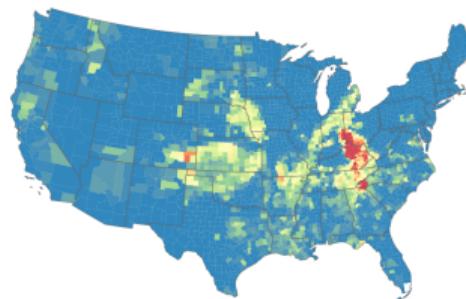
2008



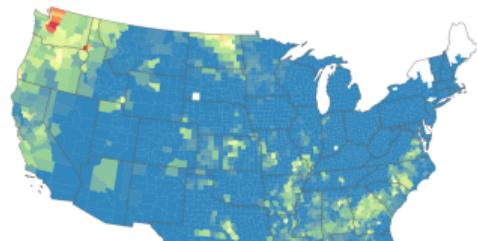
2012



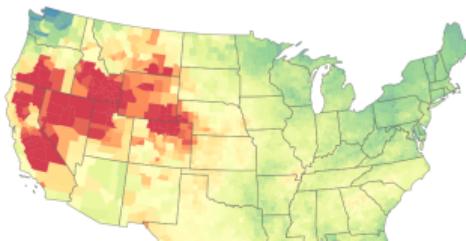
2016



2018



2020



# Empirical Strategy

Two-way fixed effects:

$$Y_{ct} = \alpha_c + \gamma_t + \beta \cdot \text{SmokePM}_{ct} + \varepsilon_{ct}$$

- $\alpha_c$ : County FE — absorb all time-invariant confounders
- $\gamma_t$ : Election year FE — absorb national swings
- SEs clustered by county
- Treatment: mean smoke PM<sub>2.5</sub> in the 60 days before election

**Identifying assumption:** Conditional on county and year FE, variation in smoke exposure is uncorrelated with unobserved determinants of voting. This is plausible because smoke plume direction is determined by wind, not by county politics or demographics.

# Identification: Threats and Estimator Choice

## Potential threats:

- Spatially correlated shocks (e.g., drought affects both fires and local economy)
  - Mitigated: smoke travels hundreds of miles from fire origin
- Secular trends in fire-prone vs. non-fire-prone regions
  - Mitigated: county FE absorb levels; year FE absorb national trends

## TWFE with continuous treatment:

- Callaway et al. (2024) show TWFE with a continuous treatment can produce coefficients with ambiguous causal interpretation due to heterogeneous dose-response weighting
- Our setting mitigates this: treatment is atmospherically assigned (limiting selection into dose); we estimate a linear slope (non-negative ACRT weights)

## Main Results: Presidential Elections

	(1) DEM Vote Share	(2) Incumbent Share	(3) Log Turnout
Smoke PM <sub>2.5</sub> (60d)	0.00087*** (0.00009)	-0.00399*** (0.00044)	0.00242*** (0.00018)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	12,429	12,429	12,429

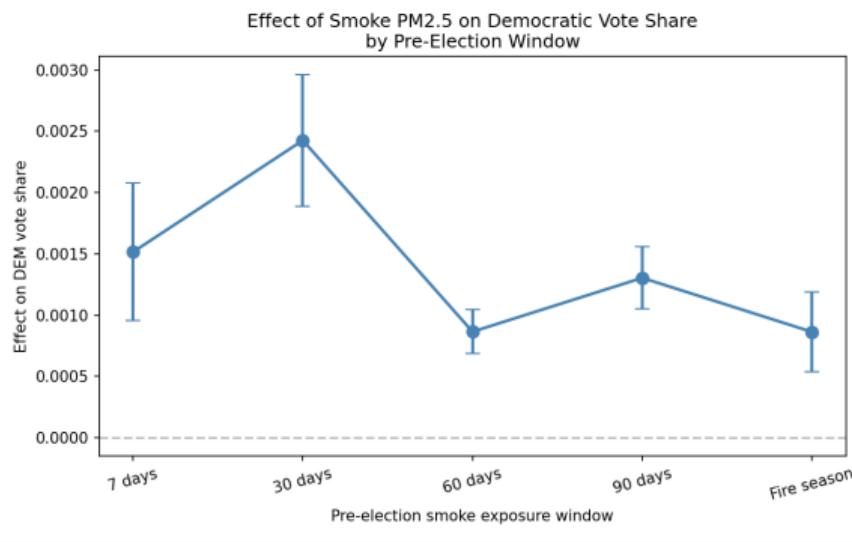
- +10  $\mu\text{g}/\text{m}^3$  smoke  $\rightarrow$  +0.9 pp DEM vote share
- Anti-incumbent effect is  $\sim 4x$  larger than pro-DEM effect
- No evidence of turnout suppression

# Effect Across the Partisan Spectrum

	R-Leaning	Swing	D-Leaning
Smoke PM <sub>2.5</sub> (60d)	0.00066*** (0.00021)	0.00049*** (0.00014)	0.00082*** (0.00013)
N	4,144	4,141	4,143

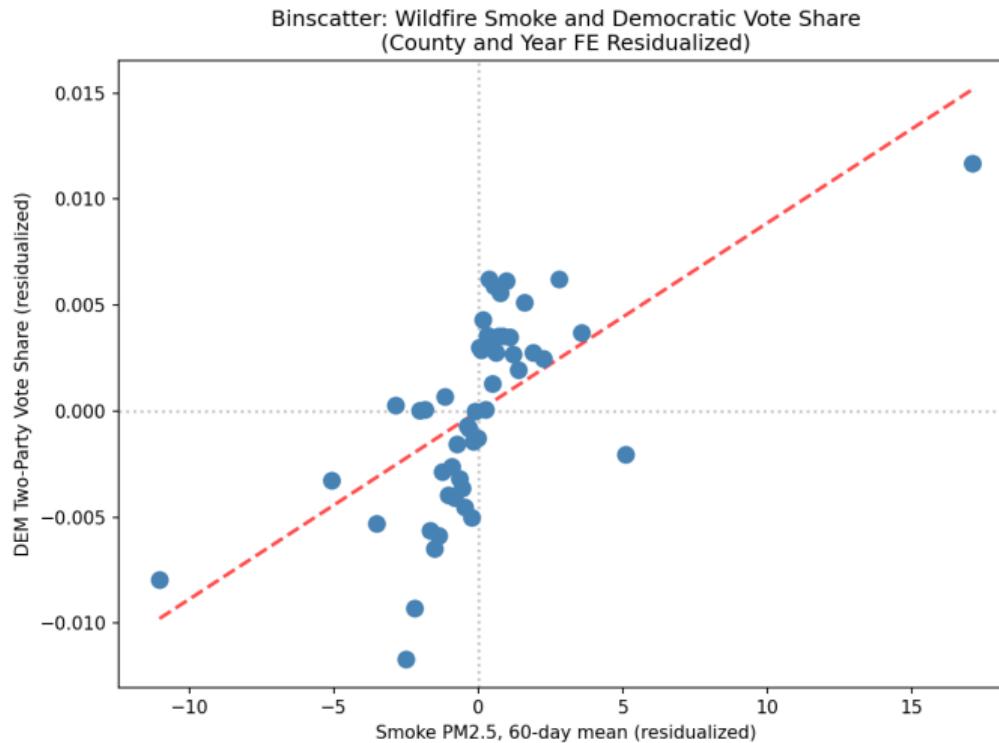
- Effect is **present in all terciles** of prior partisanship
- Somewhat larger in D-leaning counties
- Contrast with Hazlett and Mildenberger (2020): fire proximity affects *only* Democratic areas
- Smoke is a broader, less politically sorted treatment

# Temporal Dynamics



- Effect significant at all windows
- Strongest at 30 days
- Consistent with recency / salience mechanism
- Not just election-day disruption

# Binscatter: Smoke and Democratic Vote Share



County and year FE residualized. 50 equal-sized bins of smoke exposure.

# House Elections: County-Level Analysis

	(1) County House	(2) Presidential
<i>DEM Vote Share</i>	0.00038*** (0.00013)	0.00087*** (0.00009)
<i>Incumbent Share</i>	-0.00153*** (0.00045)	-0.00399*** (0.00044)
Unit	County	County
<i>N</i> (contested)	8,391	12,429
Elections	2016–2020	2008–2020

- County-level House confirms both pro-DEM and anti-incumbent effects
- Magnitudes smaller than presidential, consistent with candidate-driven races
- Same county-level unit avoids crosswalk measurement error

# What Mechanism?

Mechanism	Turnout?	Partisan pattern	Our evidence
<b>Salience</b>	No	Pro-environment	✓ DEM shift
<b>Negative affect</b>	No	Anti-incumbent	✓ Large anti-incumb.
<b>Disruption</b>	Suppression	Differential	✗ No suppression

Evidence is most consistent with **both** salience and negative affect channels operating simultaneously.

# Limitations and Next Steps

## Current limitations:

- Only 4 presidential elections; 3 House elections (smoke data: 2006–2020)
- County-level aggregation; no individual-level variation
- Turnout measure is crude (log total votes without population denominator)

## Planned extensions:

- NOAA HMS smoke plumes for extended coverage through 2024
- State legislative elections
- Wind direction as instrument for smoke exposure
- Conley spatial SEs for inference robust to spatial correlation

# Summary

1. Wildfire smoke **increases Democratic vote share and punishes incumbents**
2. Effects are **nationally representative** and **cross the partisan spectrum**
3. Smoke is **plausibly exogenous** (wind-driven) and affects **far more people** than fire proximity
4. Consistent with both climate salience and negative affect mechanisms

# References

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