Wildfire Smoke and Voting Behavior in the United States

Preliminary Results

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February 14, 2026

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: <<Break to new slide with this line and a prior work slide>>
  - **Fire proximity** → pro-environment voting in CA, but only among Democrats (Hazlett and Mildenberger, 2020)
  - **Overall air pollution (PM_{10})** → 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 $PM_{2.5}$ to U.S. election outcomes

Data

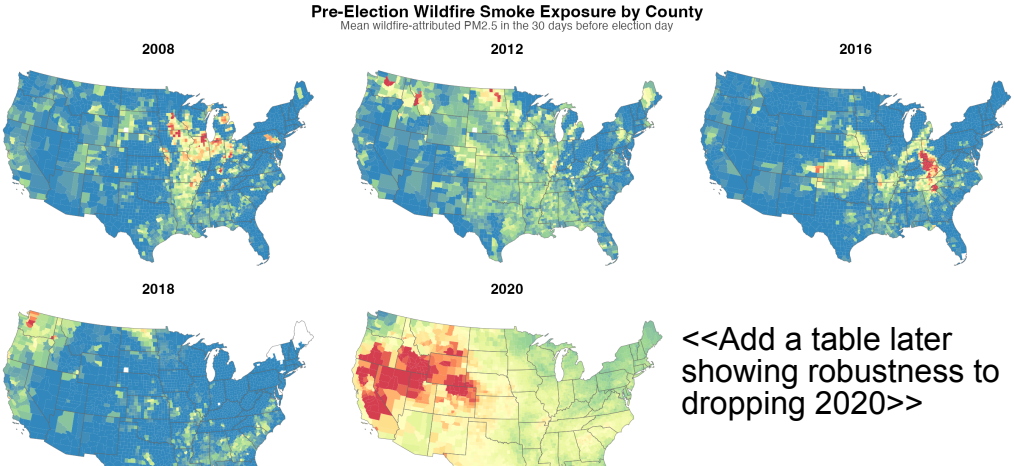
1. **Wildfire smoke $PM_{2.5}$** — Stanford Echo Lab (Childs et al., 2022)
   - Daily, county-level, 2006–2020
   - ML separation of wildfire smoke from background $PM_{2.5}$
2. **Election returns** — MIT Election Data Lab (MIT Election Data + Science Lab, 2024)
   - Presidential: county-level, 2000–2024
   - 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)

<<Explain a bit more ; check for critiques of their method>>

<<Only mention analysis samples>>

Smoke Exposure Varies Dramatically Across Elections

<<Too much whitepace at top of figure means they don't fit>>



<<Add a table later showing robustness to dropping 2020>>

Empirical Strategy

Two-way fixed effects:

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

- α_c: County FE — absorb all time-invariant confounders
- γ_t: Election year FE — absorb national swings
- SEs clustered by county
- Treatment: mean smoke $PM_{2.5}$ 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:

<<this should be it's own slide. Make sure mitigating reasoning is carefully explained in paper>>

- 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 $PM_{2.5}$ (60d)	0.00087***	−0.00399***	0.00242***
	(0.00009)	(0.00044)	(0.00018)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	12,429	12,429	12,429

- **+10 μg/m^3 smoke → +0.9 pp DEM vote share**
- Anti-incumbent effect is ∼4x larger than pro-DEM effect
- No evidence of turnout suppression

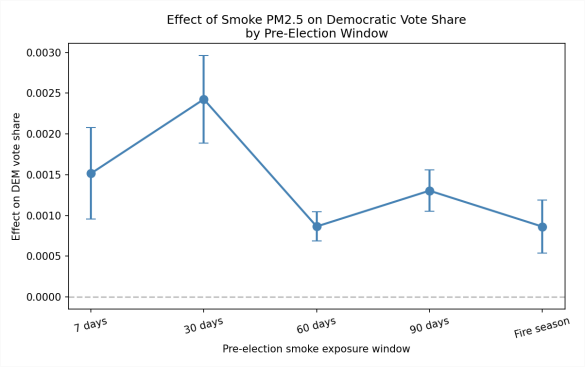
Effect Across the Partisan Spectrum

<<This needs to have an extra header row so the outcome is distinguised from tercile>>

	R-Leaning	Swing	D-Leaning
Smoke $PM_{2.5}$ (60d)	0.00066***	0.00049***	0.00082***
	(0.00021)	(0.00014)	(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

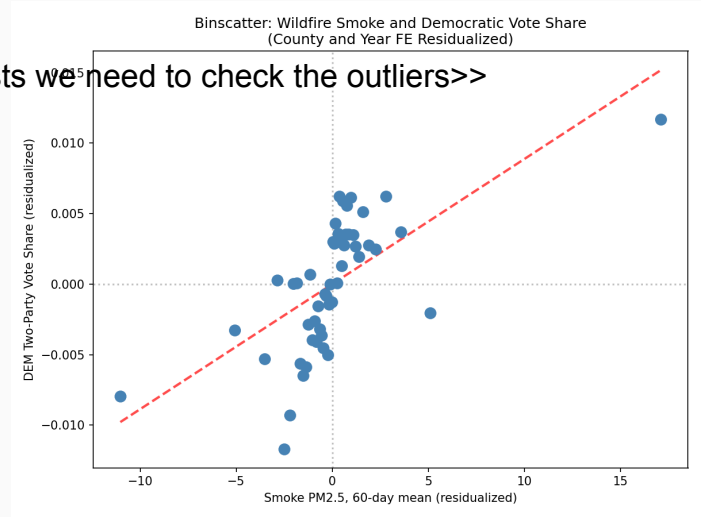
Temporal Dynamics



- 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

<<This suggests we need to check the outliers>>



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

House Elections: County-Level Analysis

<<We need to make this the main results reflect both House and County>>

	(1) County House	(2) Presidential
DEM Vote Share	0.00038***	0.00087***
	(0.00013)	(0.00009)
Incumbent Share	−0.00153***	−0.00399***
	(0.00045)	(0.00044)
Unit	County	County
N (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
Salience	No	Pro-environment	✓ DEM shift
Negative affect	No	Anti-incumbent	✓ Large anti-incumb.
Disruption	Suppression	Differential	× No suppression

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

<<Let's eliminate the mechanism discussion for now>>

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

Bellani, L., Ceolotto, S., Elsner, B., and Pestel, N. (2024). The effect of air pollution on voting behavior. *Proceedings of the National Academy of Sciences*, 121(18):e2309868121.

Callaway, B., Goodman-Bacon, A., and Sant'Anna, P. H. C. (2024). Difference-in-differences with a continuous treatment. *NBER Working Paper*, (32117). arXiv:2107.02637.

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