Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market

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Clean Air Act and Environmental markets

1970-1990 Clear Air Act: increasing emphasis on compliance flexibility

Market-based policies in other domains

- 30% of global fisheries (Costello et al., 2016)
- $36 billion in ecosystem service payments (Salzman et al., 2018)
- 20% of global GHG emissions (WB, 2019)

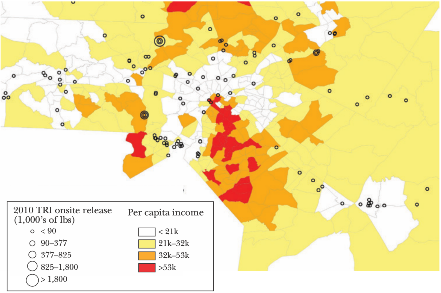
Key feature: market forces determine where pollution occurs

- Lowers overall cost of meeting an environmental objective
- But spatial reallocation of pollution could lead to relatively greater pollution exposure for disadvantaged communities

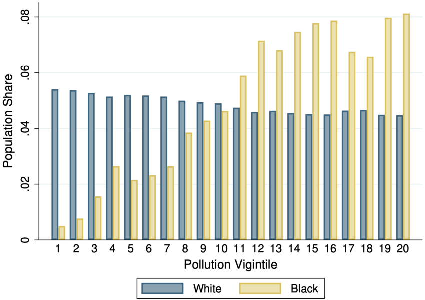
Central tension: the same market forces enabling cost-effectiveness can also alter inequities in pollution exposure

Environmental justice (EJ) concerns

Well-documented that polluted places are also poorer, have more minorities



Banzhaf, Ma, and Timmins (2019)



Currie, Voorheis, and Walker (2020)

Environmental markets and environmental justice

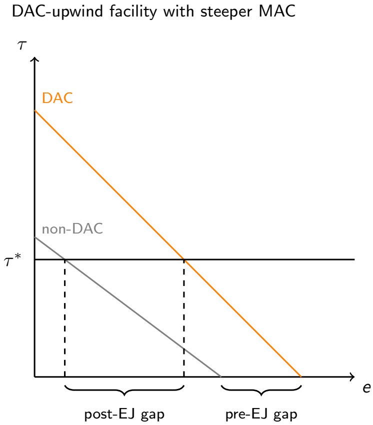
EJ concerns over market-based policies

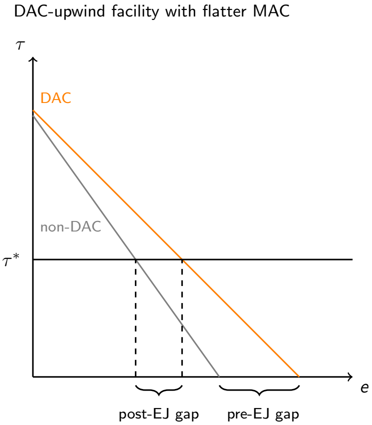
- Renewal of EU-ETS in 2013
- Washington state carbon tax in 2016
- Oregon state climate policy in 2019

California's GHG cap-and-trade (C&T) program

- Baseline: Disadvantaged communities (DAC) exposed to relatively more local air pollution on average (i.e., positive "EJ gap")
- AB 32: establishes world's 2nd largest GHG C&T program, beginning 2013
- EJ concern: GHG C&T would widen the EJ gap
- Played role during program development in 2011 and renewal efforts in 2017

How might GHG C&T affect EJ gap?





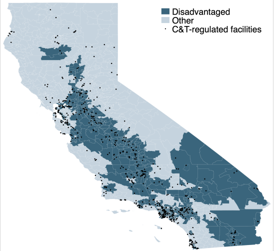
Hard to predict EJ gap effect ex-ante without observing facility-level MAC curves

For climate policy, EJ effect depends on local pollution/GHG co-production

3-step approach: from emissions to exposure

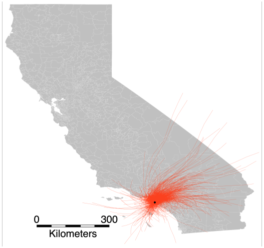
Step 1:

Isolate C&T-driven emissions



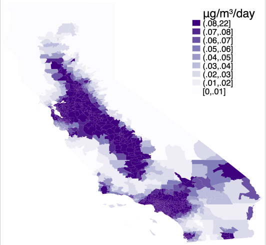
Step 2:

Model transport of emissions to exposure



Step 3:

Estimate change in EJ exposure gap



Step 1: Isolate C&T-driven emissions

Facility j, year t, model $p \in \{CO_2e, PM_{2.5}, PM_{10}, NO_x, SO_x\}$ emissions:

$$asinh(Y^p_{jt}) = \quad \kappa^p_1[C_j \times t] + \kappa^p_2[C_j \times \mathbf{1}(t \geq 2013) \times t] + \phi^p_j + \gamma^p_t + \mu^p_{jt}$$

- κ^p_1, κ^p_2: pre-, post-C&T differential emission trend
- ϕ^p_j, γ^p_t: facility, year fixed effects
- μ^p_{jt}: county-clustered standard errors

Sample restrictions:

- Only C&T: exclude electricity generators (RPS), oil refineries (LCFS)
- Size comparability: exclude facilities with avg. GHG emissions $> 75\%$

Identifying assumption:

Differential pre-C&T emissions trend would have continued if not for C&T

Cap-and-trade effects on emission trends

	Outcome is (asinh) emissions				
	CO_2e	$PM_{2.5}$	PM_{10}	NO_x	SO_x
κ_2^p	-0.297	-0.097	-0.117	-0.104	-0.037
	(0.077)	(0.048)	(0.039)	(0.050)	(0.043)
	[0.000]	[0.053]	[0.005]	[0.042]	[0.393]
Facilities	316	302	302	303	303
Counties	41	40	40	40	40
Observations	2,054	1,968	1,968	1,970	1,965

Robust to: placebo timing, emission size heterogeneity, SUTVA concerns

Step 2: modeling pollution transport

HYSPLIT

- Particle trajectory model
- Incorporates time-varying meteorological conditions and topology
- C&T-driven facility-level emissions every 4 hours between 2008-2017
- $>$ 2 million trajectories, about 4 days of HPC compute time
- Key limitation: no atmospheric chemistry, cannot produce secondary $PM_{2.5}$

Step 3: Cap-and-trade effects on EJ gap trends

For zip code i with disadvantaged status $D_i \in \{0,1\}$

Model pollutant $p \in \{PM_{2.5}, PM_{10}, NO_x, SO_x\}$ exposure in year t:

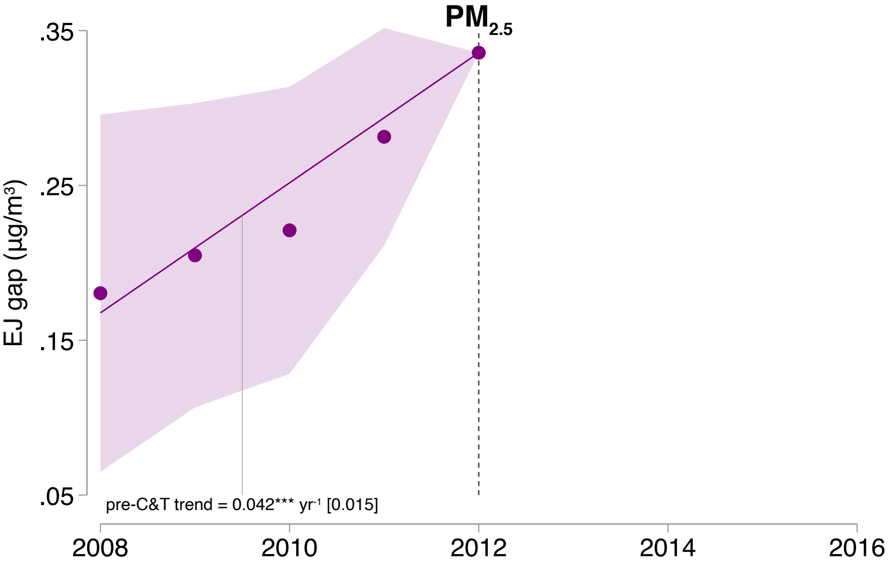
$$E_{it}^p = \beta_1^p[D_i \times t] + \beta_2^p[D_i \times \mathbf{1}(t \geq 2013) \times t] + \psi_i^p + \delta_t^p + \epsilon_{it}^p$$

- ψ_i^p, δ_t^p: zip code, year fixed effects
- ϵ_{it}^p: county-clustered std. errors + bootstrapped std. errors from Step 1
- Obs. weighted by 2008-2012 avg. zip code population

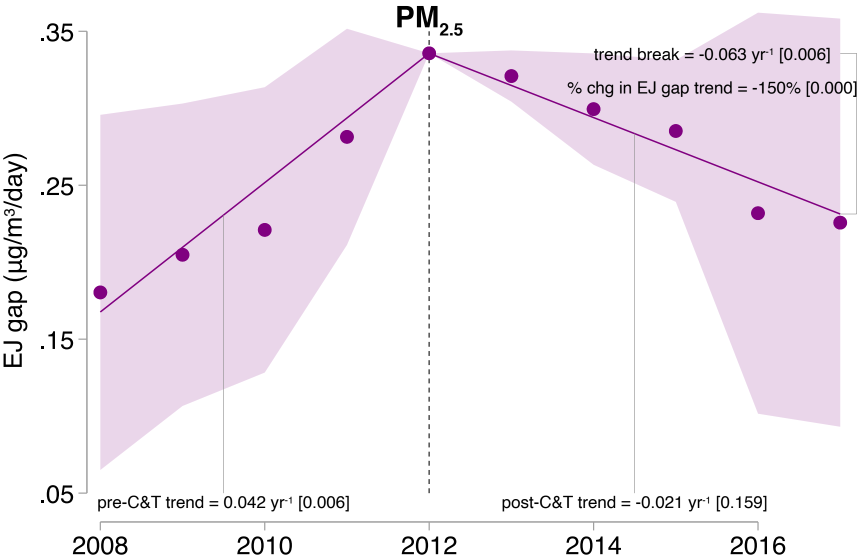
Key statistics

- β_2^p: post-C&T EJ gap trend break
- $\beta_1^p + \beta_2^p$: absolute post-C&T EJ gap trend
- $(\beta_2^p/\beta_1^p) * 100$: pct. change in EJ gap trend

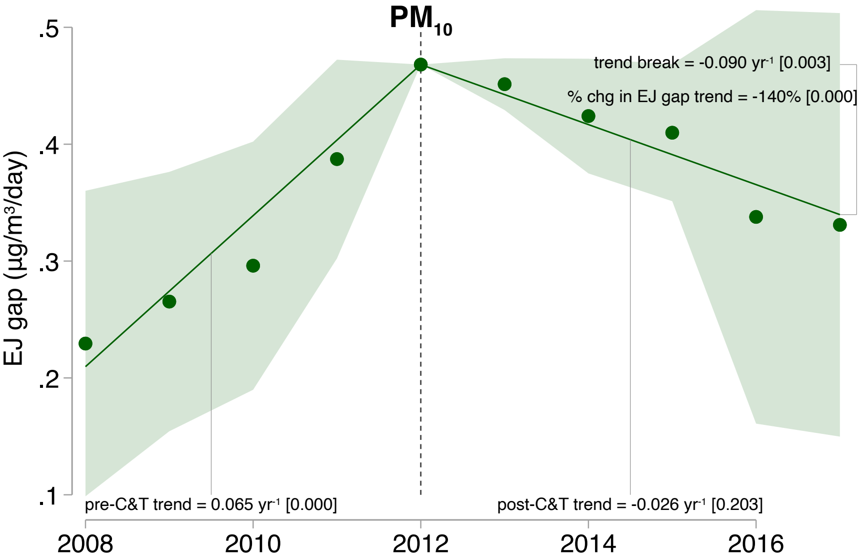
Cap-and-trade effects on EJ gap trends



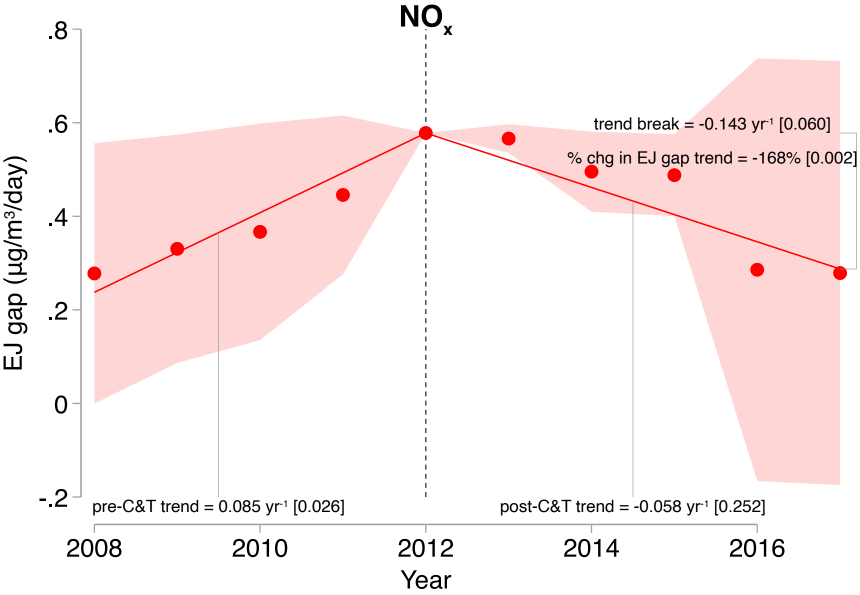
Cap-and-trade effects on EJ gap trends



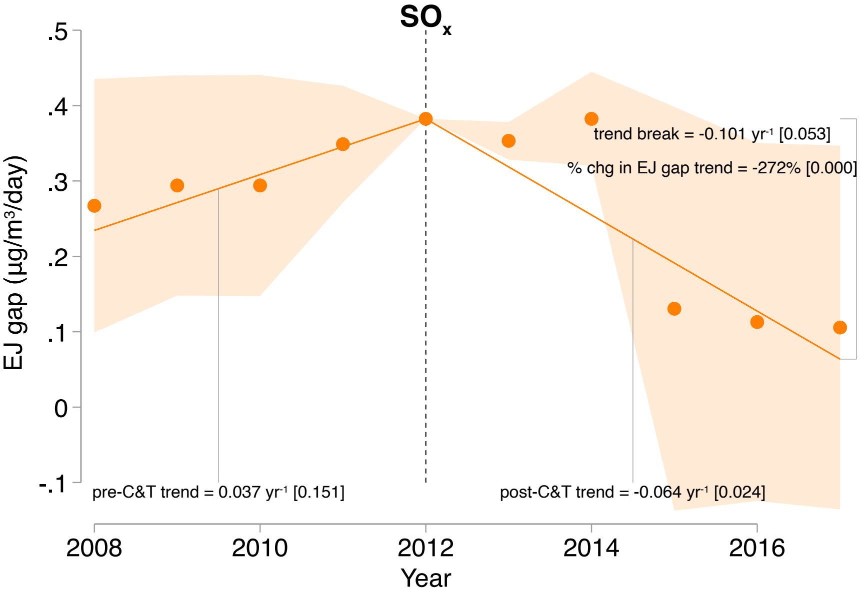
Cap-and-trade effects on EJ gap trends



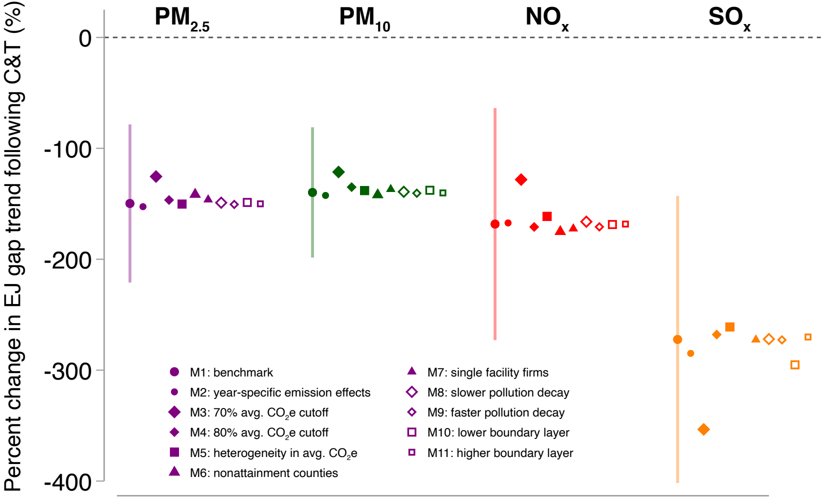
Cap-and-trade effects on EJ gap trends



Cap-and-trade effects on EJ gap trends

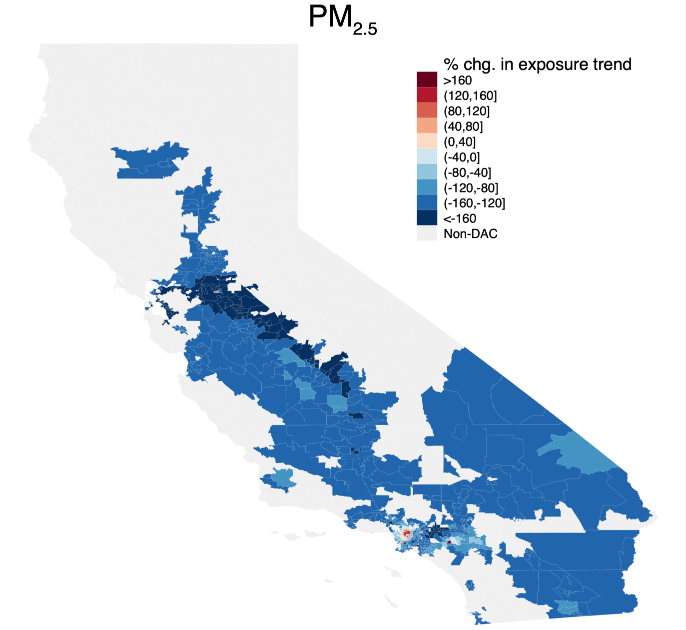


Robustness checks across steps 1-3

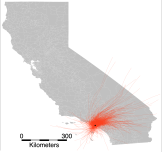


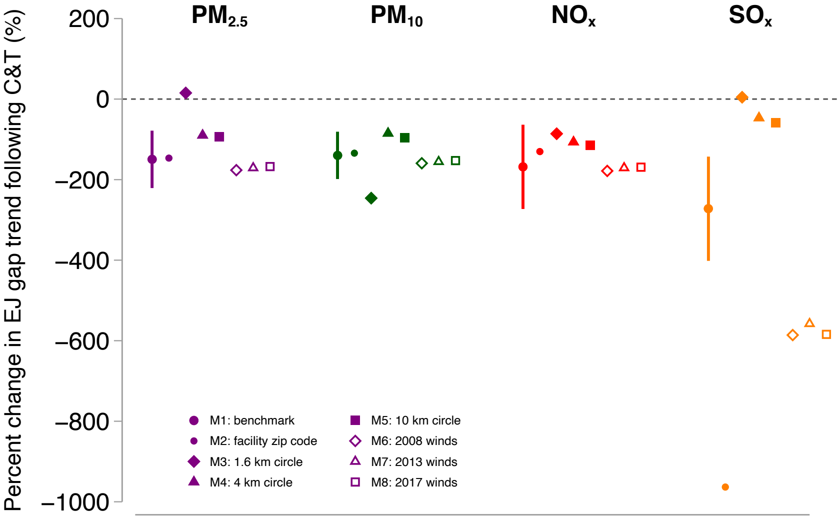
Additional check: InMap for secondary pollutants

Spatial heterogeneity: pct. change in trend break



Pollution modeling matters: transport modeling





Conclusion

California's GHG C&T program slowed (and even narrowed) previously widening EJ gap in $PM_{2.5}$, PM_{10}, NO_x, and SO_x

Caveats

EJ gap still there!

We compare EJ gap trends before/after 2013, not against hypothetical alternative climate policies after 2013

Full distributional analysis requires analyzing health outcomes and cost burden

Environmental markets may not always reduce the EJ gap

C&T not ideal for addressing EJ. Need EJ-specific policies

Thank you

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