The Implications of Carbon Pricing for Environmental Inequality

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April 23, 2023

Preliminaries

- Thank yous and apologies
- Revisions (based on feedback) since 2023-04-20:
  - Copyediting
  - Acknowledgements
  - 5.3 Results — expanded discussion of EI Gap
  - 5.4 Diagnostics & Limitations
- Slides & replication project available

Overview

Research Question

Do carbon pricing policies exacerbate inequalities in air pollution concentrations?

Background Carbon pricing policies are big globally, more common domestically, and popular amongst economists—but little is known about *how* these policies affect the distribution of local air pollution

Method Study the effect of a carbon price on electricity generation in California on air pollution disparities across the Western US

1. Model: Build a model of carbon pricing and environmental inequality
2. Simulation: Use the model and data to estimate environmental inequalities under a range of carbon prices

Overview (contd.)

Results

- Concentration of nitrous oxide emissions increases by in disadvantaged communities, but decreases by in non-disadvantaged communities
- Sulfur dioxide & particulate matter concentration disparities do not meaningfully change
- Effects are driven by differences in coverage under the regulation

Implications

- Exposes potential flaw of ex-post analyses that look exclusively at the regulated geography
- Warrants additional research on combined cap-and-trade + localized pollution control policies

Introduction & Motivation

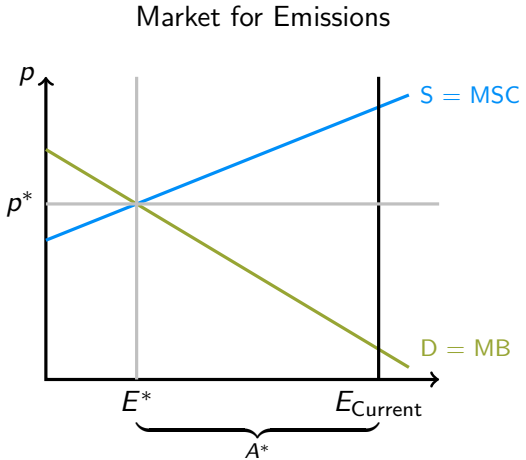
Modeling Carbon Pricing & Environmental Inequality

Empirical Strategy & Data

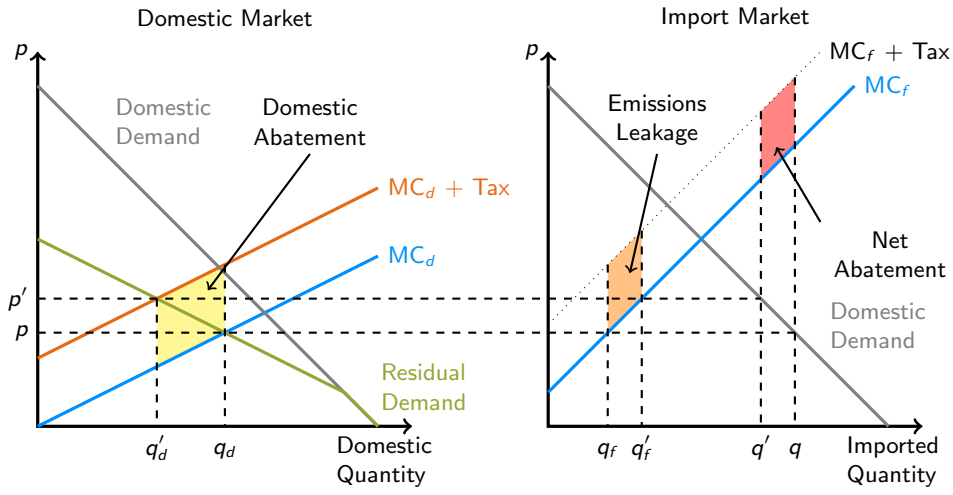
Simulation Results

Takeaways & Discussion

Carbon Pricing



Emissions Leakage



Gobal Air Pollution v. Local Air Pollution

Global Air Pollutants

- Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O)
- Primarily long-run consequences
- Location does not matter

Local Air Pollutants

- Nitrogen oxides (NO_x), Sulfur dioxide (SO_2), Particulate matter (PM2.5)
- Mix of long- and short-run consequences
- Location does matter

Motivation & Ex-Post Research

- CARB Cap-and-Trade FAQ Page
- Descriptive Analysis: Yes, California's cap-and-trade program increased disparities (Cushing et al., 2018; Pastor et al., 2022)
- Causal Analysis: No, California's cap-and-trade program decreased disparities (Hernández-Cortés and Meng, 2023)

Methodological Contributions

- Ex-ante model to anticipate changes in air pollution disparities
- *How* do carbon pricing policies shift local air pollution across jurisdictions?
- Weber (2021) creates a similar model, but does not:
  1. Formally model disparities in air pollution concentrations
  2. Consider leakage and the redistribution outside of California

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Model Overview

Agents N fossil fuel power plants

Environ.
- Geography: R regions, each with its own wholesale market for electricity
- Constraints: Demand, (Capacity,) Transmission
- Markets: Perfectly competitive

Actions
1. Initial investment decision
2. Hourly generation decisions

Behavior Maximize discounted sum of future profits

Equilibrium Minimize total investment and generation costs $\rightarrow$ Generation outcomes $\rightarrow$ Air pollution disparity outcomes

Empirical Strategy: Simulation

- Simulate generation across the Western US power grid (Western Interconnection)
- Focus only on fossil fuel generation: coal, (natural) gas, oil

Empirical Strategy: Policy Scenarios

- Border Carbon Adjustments (BCAs): "Carbon tariff" on electricity California imports from elsewhere
- Nine policy scenarios with a combination of BCAs and carbon prices

Scenario	BCA?	Tax ($/tonne)
A	No	0
B	No	20
C	No	40
D	No	60
E	No	80
F	Yes	20
G	Yes	40
H	Yes	60
I	Yes	80

Empirical Strategy: k-Means Clustering

- Problem: Constrained optimization problems are too large
- Generation Problem
  - Simplify N: k-means cluster power plants into thirty groups
- Investment Problem
  - Simplify T: k-means cluster electricity demand into a "representative day"
  - Simplify N: k-means cluster generation clusters into four clusters

Empirical Strategy: Generation $\rightarrow$ Pollutant Concentrations

Data: Power Plant

- 2019 Emissions & Generation Resource Integrated Database (eGRID) from the EPA
-

Data: Electricity Demand

Data: Disadvantaged Communities

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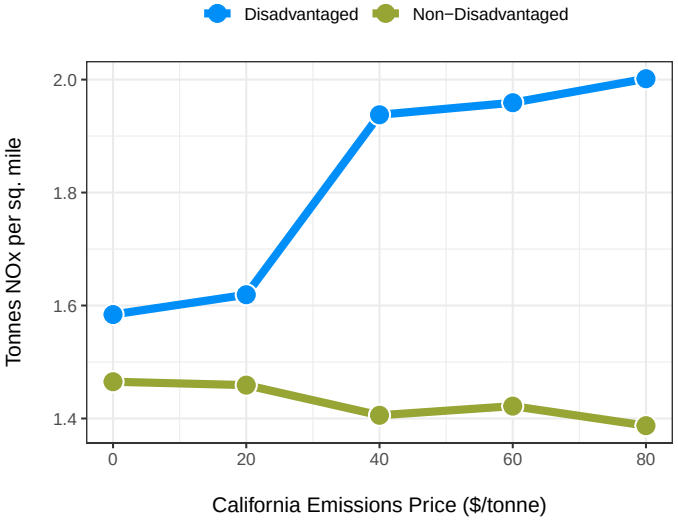
Generation

Greenhouse Gas Emissions

Local Air Pollutant Emissions

The EI Gap


Disadvantaged
Non−Disadvantaged
Tonnes NOx per sq. mile
2.0
1.8
1.6
1.4
0
20
40
60
80
California Emissions Price ($/tonne)

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References I

Cushing, Lara, Dan Blaustein-Rejto, Madeline Wander, Manuel Pastor, James Sadd, Allen Zhu, and Rachel Morello-Frosch. 2018. "Carbon trading, co-pollutants, and environmental equity: Evidence from California's cap-and-trade program (2011–2015)." *PLoS medicine*, 15(7): e1002604.

Hernández-Cortés, Danae, and Kyle Meng. 2023. "Do environmental markets cause environmental injustice? Evidence from California's carbon market." *Journal of Public Economics*, 217: 104786.

Pastor, Manuel, Michael Ash, Lara Cushing, Rachel Morello-Frosch, Edward-Michael Muña, and James Sadd. 2022. "Up in the Air: Revisiting Equity Dimensions of California's Cap-and-Trade System." *USC Dornsife Equity Research Institute*.

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