# (Air) Pollution and Welfare

Matthew Gordon

Fall 2023

Paris School of Economics

# (Air) Pollution and Welfare

Outline for Today

- Meta-Skills: Combining Theory and Empirics
- Air Pollution
    - Coase Theorem: Payments for Ecosystem Services
    - Estimating Damages
        - Hedonic Approach
        - Bottom up: Health Effects and Defensive Behaviors
    - Estimating Abatement Costs
    - Distributional Considerations - Environmental Justice

# Meta-Skills

What do I want you to get out of this class

- Approaches that can be applied to many questions.
  - How to model behavior
  - How to test a model
  - How to interpret a result

# Combining Theory and Empirics

# Taxonomy of Empirical Economics[1]

All empirical work in economics is either structural or descriptive.

[1] Borrowed shamelessly from Phil Haile's slides:
https://www.dropbox.com/s/8kwtwn30dyac18s/intro.pdf?dl=0

# Taxonomy of Empirical Economics[1]

All empirical work in economics is either structural or descriptive.

Descriptive work:

- Establishes facts about the data - e.g PM 2.5 levels are higher in India than the US, and have been declining over time

[1] Borrowed shamelessly from Phil Haile's slides: https://www.dropbox.com/s/8kwtwn30dyac18s/intro.pdf?dl=0

# Taxonomy of Empirical Economics[1]

All empirical work in economics is either structural or descriptive.

Descriptive work:

- Establishes facts about the data - e.g PM 2.5 levels are higher in India than the US, and have been declining over time

Structural work:

- Poses a model of the relationships between variables or the data-generating process
- Allows us to estimate 'counterfactuals' - what would happen if...

[1] Borrowed shamelessly from Phil Haile's slides: https://www.dropbox.com/s/8kwtwn30dyac18s/intro.pdf?dl=0

# What about Reduced Form?

A reduced form relationship is obtained by writing each endogenous variable as a function of *only* exogenous variables.

- e.g. solve for equilibrium quantities (price, quantities) in terms of exogenous parameters (technology, budget constraints, preferences)

We don't always need to explicitly solve the model. We just need to know what goes on which side of the equation and what restrictions our model implies.

# What about Reduced Form?

A reduced form relationship is obtained by writing each endogenous variable as a function of *only* exogenous variables.

- e.g. solve for equilibrium quantities (price, quantities) in terms of exogenous parameters (technology, budget constraints, preferences)

We don't always need to explicitly solve the model. We just need to know what goes on which side of the equation and what restrictions our model implies.

But there is still a model! (Even if it's implicit)

# Pop Quiz

Are these claims descriptive or structural?

- Shutting down the coal plant caused pollution to fall.

# Pop Quiz

Are these claims descriptive or structural?

- Shutting down the coal plant caused pollution to fall.
- An RCT showed that an information campaign increased clean cookstove adoption.

# Internal vs External Validity

Internal Validity - Are the conclusions valid within the context of the study?

- Are the instruments really exogenous?
- Was there non-random attrition or measurement error?

External Validity - Would these results hold in other contexts?

- What would happen if we ran the same RCT in a different time/place?

# Why does this matter?

Making a 'policy recommendation' requires understanding a counterfactual

- This means we are in structural world.
- It also requires a normative framework - in econ usually (but not always) maximizing welfare (in $).

So as we read the papers, I want you to keep in mind:

- What is the model here (even if it's implicit)
- What are threats to internal validity
- What are threats to external validity
- What is the normative framework?

# Air Pollution

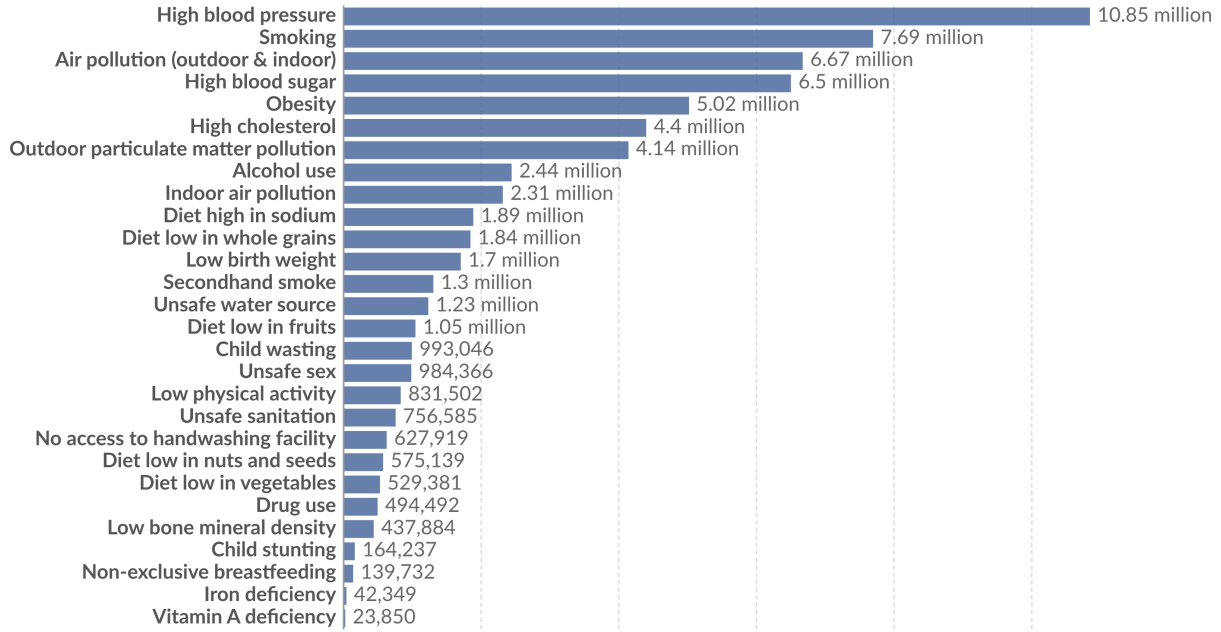
# Stylized Facts

## Air Pollution is a big problem

### Deaths by risk factor, World, 2019

Our World in Data

The estimated annual number of deaths attributed to each risk factor[1]. Estimates come with wide uncertainties, especially for countries with poor vital registration[2].




**Data source:** IHME, Global Burden of Disease (2019) OurWorldInData.org/causes-of-death | CC BY

**Note:** Risk factors are not mutually exclusive: people may be exposed to multiple risk factors, and the number of deaths caused by each risk factor is calculated separately.

**1. Risk factor**: A risk factor is a condition or behavior that increases the likelihood of developing a given disease or injury, or an outcome such as death. The impact of a risk factor is estimated in different ways. For example, a common approach is to estimate the number of deaths that would occur if the risk factor was absent. Risk factors are not mutually exclusive: people can be exposed to multiple risk factors, which contribute to their disease or death. Because of this, the number of deaths caused by each risk factor is typically estimated separately. Read more about risk factors and their impact in our article: How do researchers estimate the death toll caused by each risk factor, whether it's smoking, obesity or air pollution?

**2. Civil and Vital Registration System**: A Civil and Vital Registration System (CVRS) is an administrative system in a country that manages information on births, marriages, deaths and divorces. It generates and stores 'vital records' and legal documents such as birth certificates and death certificates. You can read more about how deaths are registered around the world in our article: How are causes of death registered around the world?

# Stylized Facts

But a solvable problem

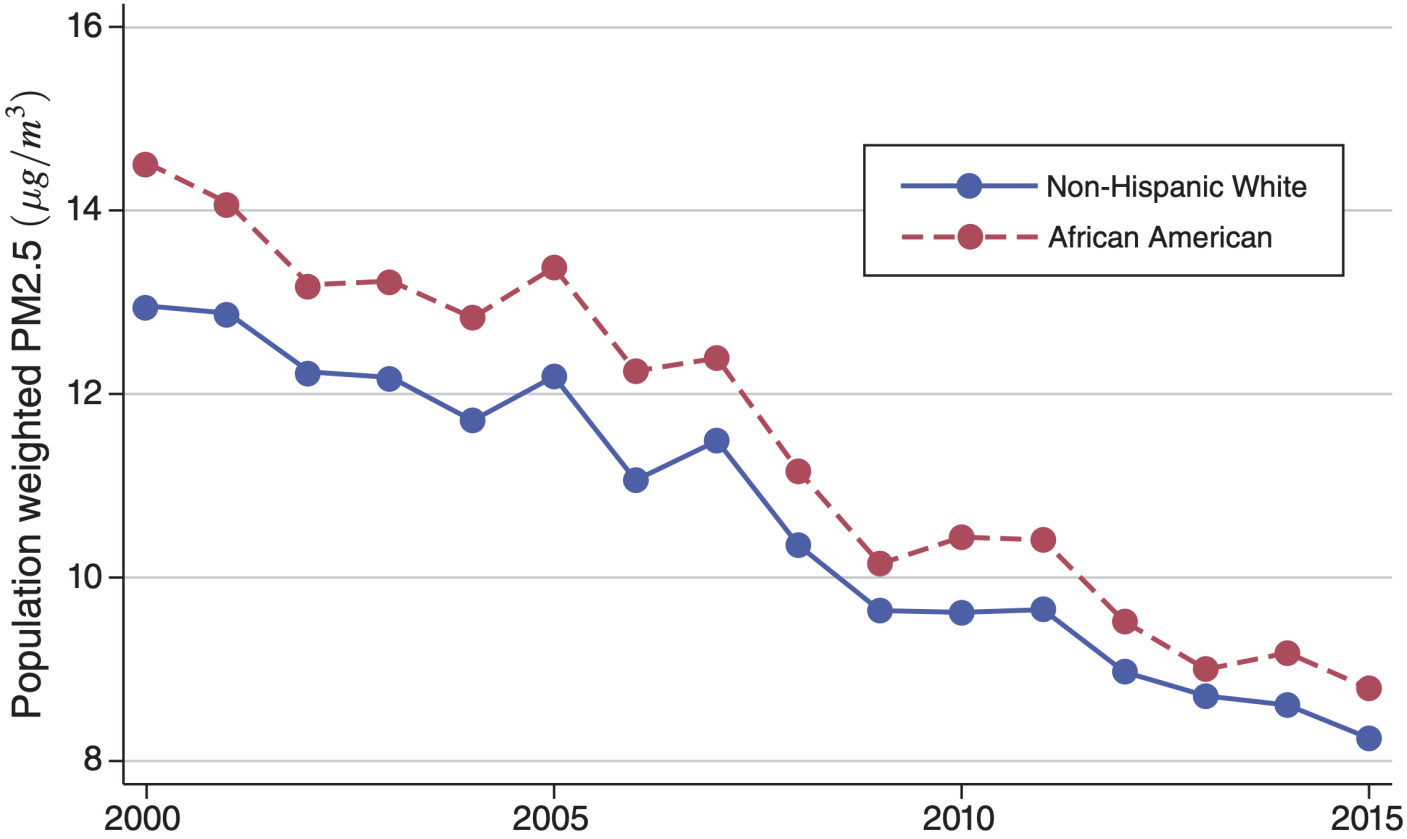



FIGURE 1. TRENDS IN POLLUTION EXPOSURE BY RACE

Currie, Voorheis and Walker, 2023

# Stylized Facts

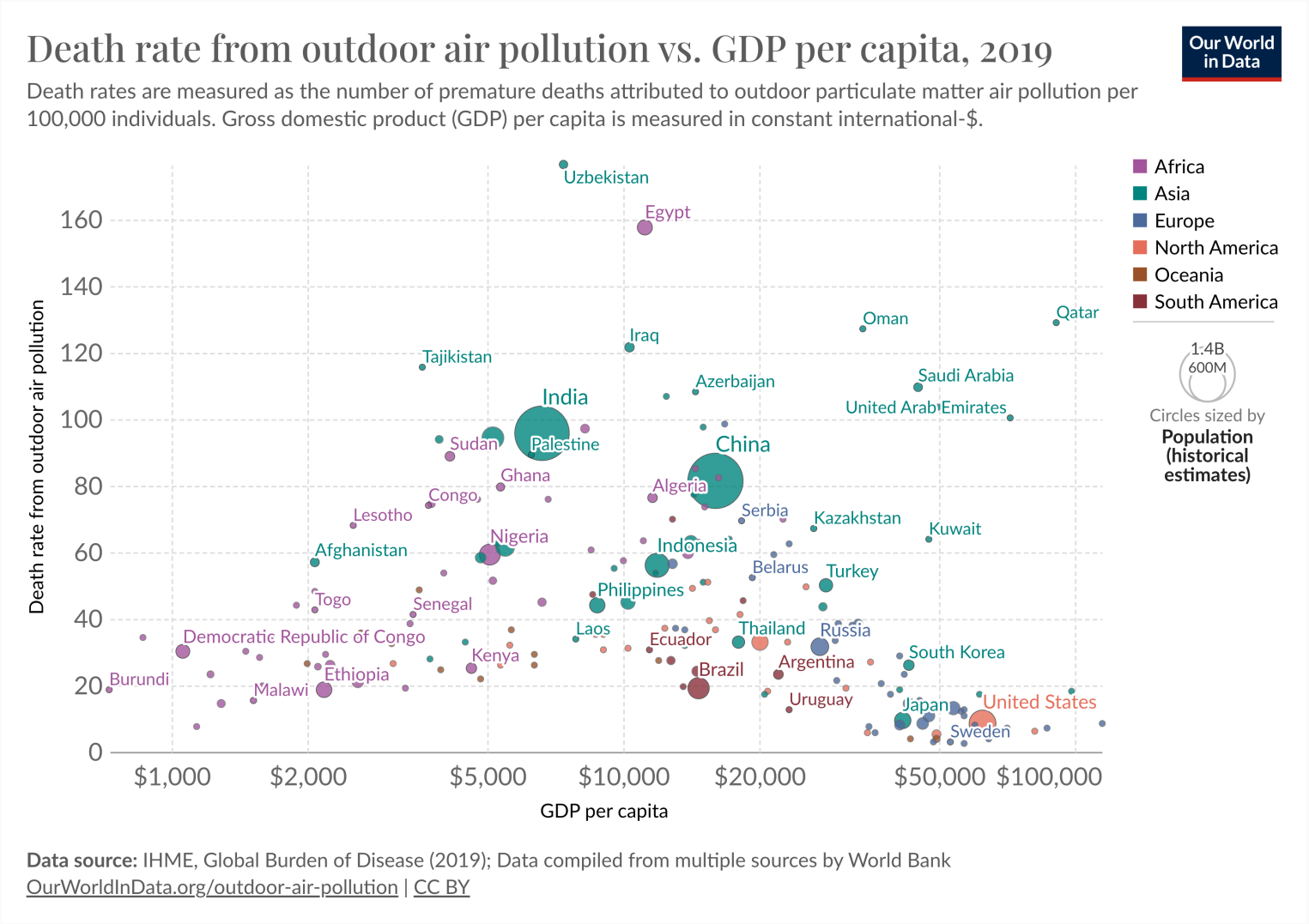
New Delhi today

# Stylized Facts

Pittsburgh in the 1940s

# Descriptive or Structural?

## U-shaped relationship with income

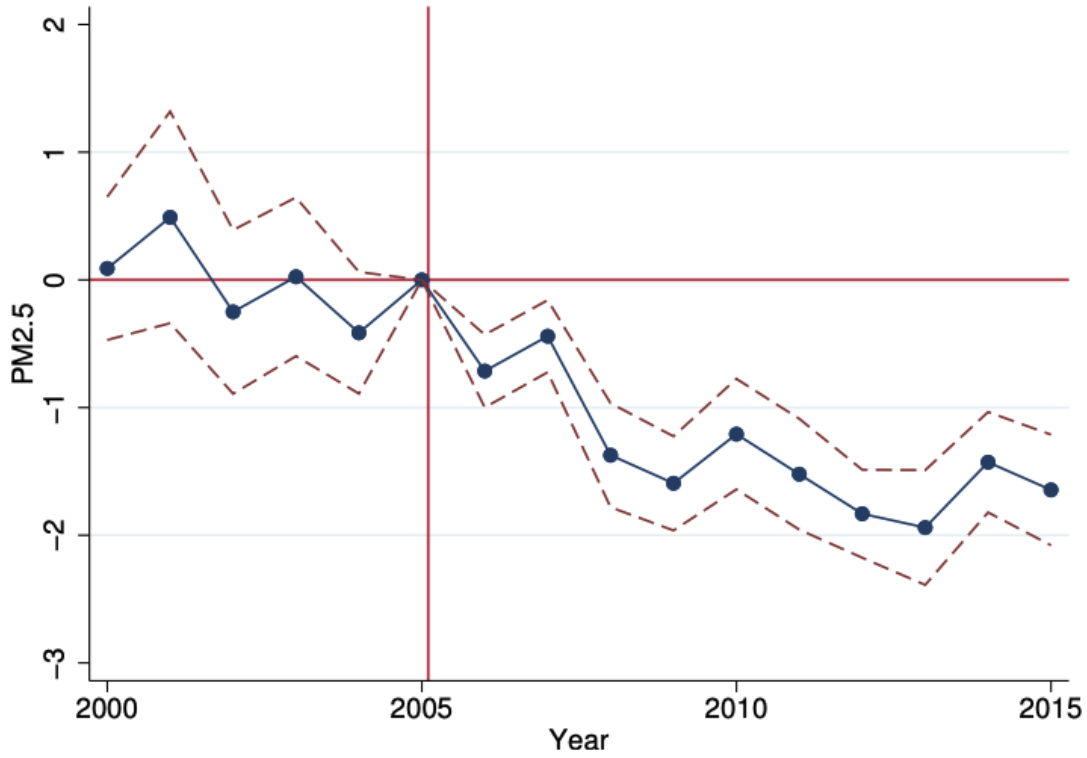



**Data source:** IHME, Global Burden of Disease (2019); Data compiled from multiple sources by World Bank
OurWorldInData.org/outdoor-air-pollution | CC BY

# Descriptive or Structural?

Why did pollution decline in rich countries?

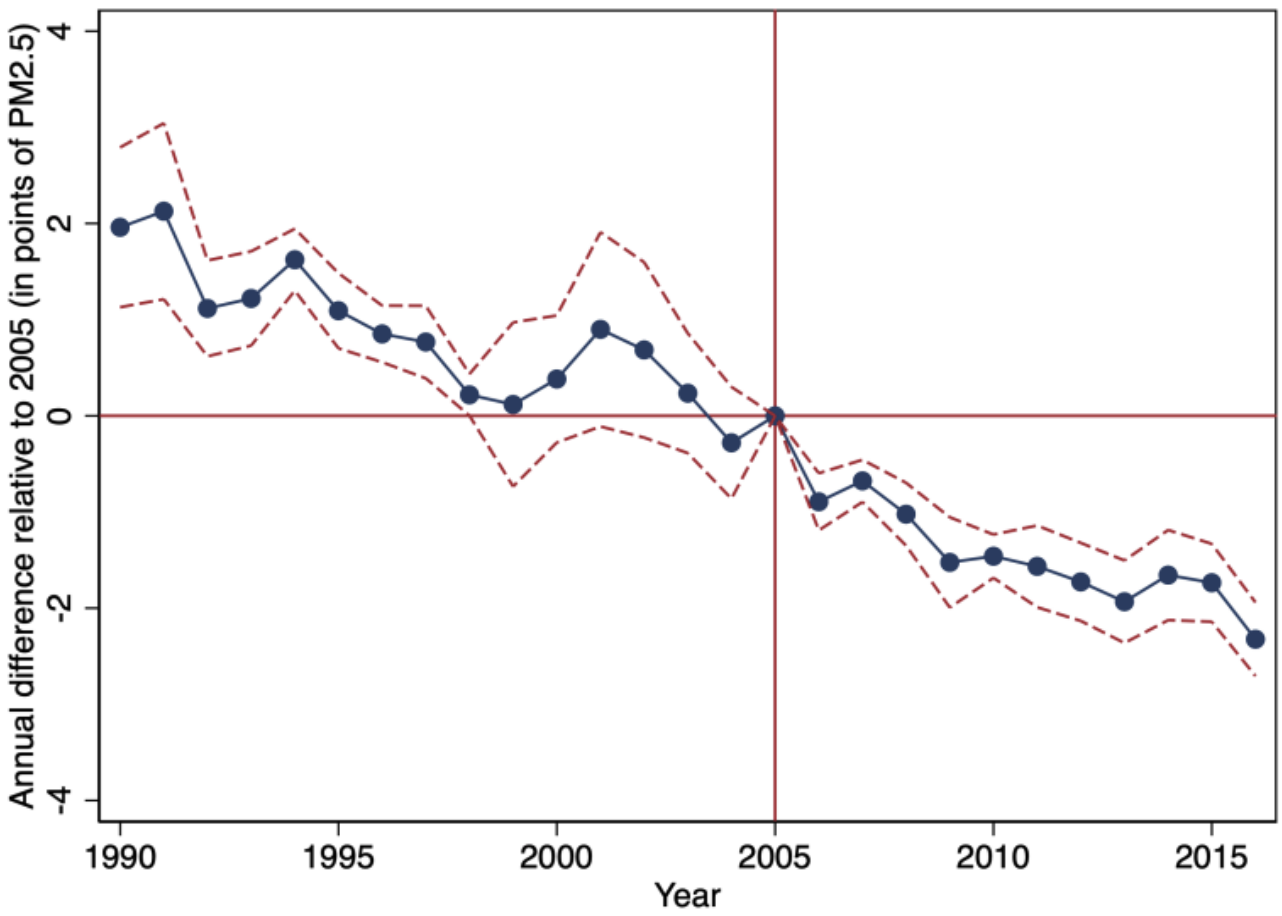
Figure 6: The Effect of the PM2.5 NAAQS on Newly Regulated Commuting Zones




Currie, Voorheis and Walker (2023)

# Descriptive or Structural?

Why did pollution decline in rich countries - revisited




(b) Event study (annual nonattainment-attainment differences in $PM_{2.5}$)

# Coase Theorem: The Promise of Decentralization

# What should we do about it?

Should we do anything?

- Coase Theorem says that if property rights are well-defined, transaction costs low, then the efficient outcome can be achieved by decentralized bargaining.

Does the existence of air pollution show that the Coase Theorem fails?

# Coase in Action: Payments for Ecosystem Services

Jack, Jayachandran, Kala, and Pande: Money (Not) to Burn: Payments for Ecosystem Services to Reduce Crop Residue Burning

- Farmers in Punjab burn crop stubble at end of planting season.
    - Why? Cheaper than renting machinery, labor
- Sends massive plume of smoke over densely populated areas.
- Why not pay them not to burn?

# Money (Not) to Burn

Table 1: Contract Compliance and Not Burning

| | | | CRM techniques | |
|---|---|---|---|---|
| | Complied with Contract | Not Burned | Baler | Seeder |
| | (1) | (2) | (3) | (4) |
| Standard PES | 0.085 | 0.020 | -0.010 | -0.020 |
| | (0.015)*** | (0.030) | (0.037) | (0.023) |
| Upfront PES | 0.183 | 0.077 | 0.096 | 0.013 |
| | (0.020)*** | (0.032)** | (0.039)** | (0.026) |
| $p$-val: Standard PES = Upfront PES | 0.000 | 0.071 | 0.014 | 0.157 |
| Control mean | 0.000 | 0.091 | 0.199 | 0.102 |
| Standard PES mean | 0.084 | 0.098 | 0.171 | 0.087 |
| Upfront PES mean | 0.185 | 0.161 | 0.295 | 0.112 |
| N | 1668 | 1664 | 1387 | 1387 |

# Money (Not) to Burn

Table 3: Cost-Effectiveness

| | Amount Paid per Acre (1) | Not Burned (2) | Cost per Unburned Acre (3) |
|---|---|---|---|
| Standard PES | 105.6 | 0.020 | 5156.5 |
| | (21.7)*** | (0.030) | (7156.0) |
| Upfront PES | 310.5 | 0.077 | 4051.3 |
| | (15.4)*** | (0.032)** | (1595.0)** |
| $p$-val: Standard PES = Upfront PES | 0.000 | 0.071 | 0.864 |
| N | 1667 | 1664 | |

Rough back of the envelope suggests $\approx$ \$4,400 per life saved.

- 86,000 premature deaths from crop burning, 53.5% from Kharif burning in Punjab, 4 million acres = .01 death/acre

# Can we scale up Coase?

Challenges:

- Farmers liquidity constrained
- Coordination problem/transaction costs
- Verifications/additionality
    - Aspelund and Russo - Additionality and Asymmetric Information in Environmental Markets: Evidence from Conservation Auctions

# A Normative Framework:

Regulate Air Pollution such that:

$$\min_{A} \sum_{i} \omega_i (C_i(A) + D_i(A)) \tag{1}$$

Conjecture: Marginal damages are much greater than marginal abatement costs.

- How would we know?
- For a normal good, we could measure the benefits of a change in supply by looking at market prices - these measure consumers' marginal willingness to pay
- The fundamental problem of environmental economics: there is no market for clean air
- This puts us in the world of non-market valuation

# Estimating Damages: Hedonics

# The Hedonic Method: Housing Values

Measuring willingness to pay for clean air: individuals get utility from a house: $U(q_1, ..., q_n, A, u_i)$.

In equilibirium:

$$P_i = P(q_1, ...., q_n, A_i, u_i) \tag{2}$$

$$\tag{3}$$

Set up a regression:

$$\log P_i = \beta_1 q_{1i} + ... + \beta_n q_{ni} + \beta_A A_i + u_i \tag{4}$$

Then $\frac{d \log P_i}{dA} = \beta_A$ gives willingness to pay for changes in A.

# The Hedonic Method: Housing Values

Measuring willingness to pay for clean air: individuals get utility from a house: $U(q_1, ..., q_n, A, u_i)$.

In equilibirium:

$$P_i = P(q_1, ...., q_n, A_i, u_i) \tag{2}$$

$$\tag{3}$$

Set up a regression:

$$\log P_i = \beta_1 q_{1i} + ... + \beta_n q_{ni} + \beta_A A_i + u_i \tag{4}$$

Then $\frac{d \log P_i}{dA} = \beta_A$ gives willingness to pay for changes in A.

- Question: Why logs?

# The Hedonic Method: Reduced Form

Why doesn't this work?

- $u_i$ could be correlated with $A$ and $P_i$
- $q$s are endogenous, could have been chosen as a result of $A$.
- We need a *reduced form*!

Chay and Greenstone (JPE) 2003: Look at changes in home prices resulting from 'exogenous' changes in air pollution (the Clean Air Act).

- Model restrictions: CAA changed $A$ but not $q$s or $u$s.

# From Model to Estimation

$$\log P_{it} = \theta A_{it} + q_{it}\beta + \mu_i + u_{it} \tag{5}$$

$$A_{it} = q_{it}\Pi + \gamma_i + \nu_{it} \tag{6}$$

First differencing gets rid of time invariant unobservables:

$$\log P_{i1} - \log P_{i2} = \theta(A_{i1} - A_{i2}) + (q_{i1} - q_{i2})\beta + u_{i1} - u_{i2} \tag{7}$$

$$A_{i1} - A_{i2} = (q_{i1} - q_{i2})\Pi + \nu_{i1} - \nu_{i2} \tag{8}$$

Now identification assumption is $E(\nu_{i1} - \nu_{i2})(u_{i1} - u_{i2}) = 0$.

$$A_{i1} - A_{i2} = Z_{it}\Gamma + (q_{i1} - q_{i2})\Pi + \nu_{i1} - \nu_{i2} \tag{9}$$

$$Z_{it} = \mathbf{1}_{\{A_{i1}>75\}} + A_{i1} \tag{10}$$

Plug in $Z_{it}\widehat{\Gamma} + (q_{i1} - q_{i2})\widehat{\Pi}$ for $A_{i1} - A_{i2}$.

Now assumption is $E(Z_{it}(u_{i1} - u_{i2})) = 0$.

# The Hedonic Method: Results

People are willing to pay for better AQ (about 2% per 1$\mu$g).

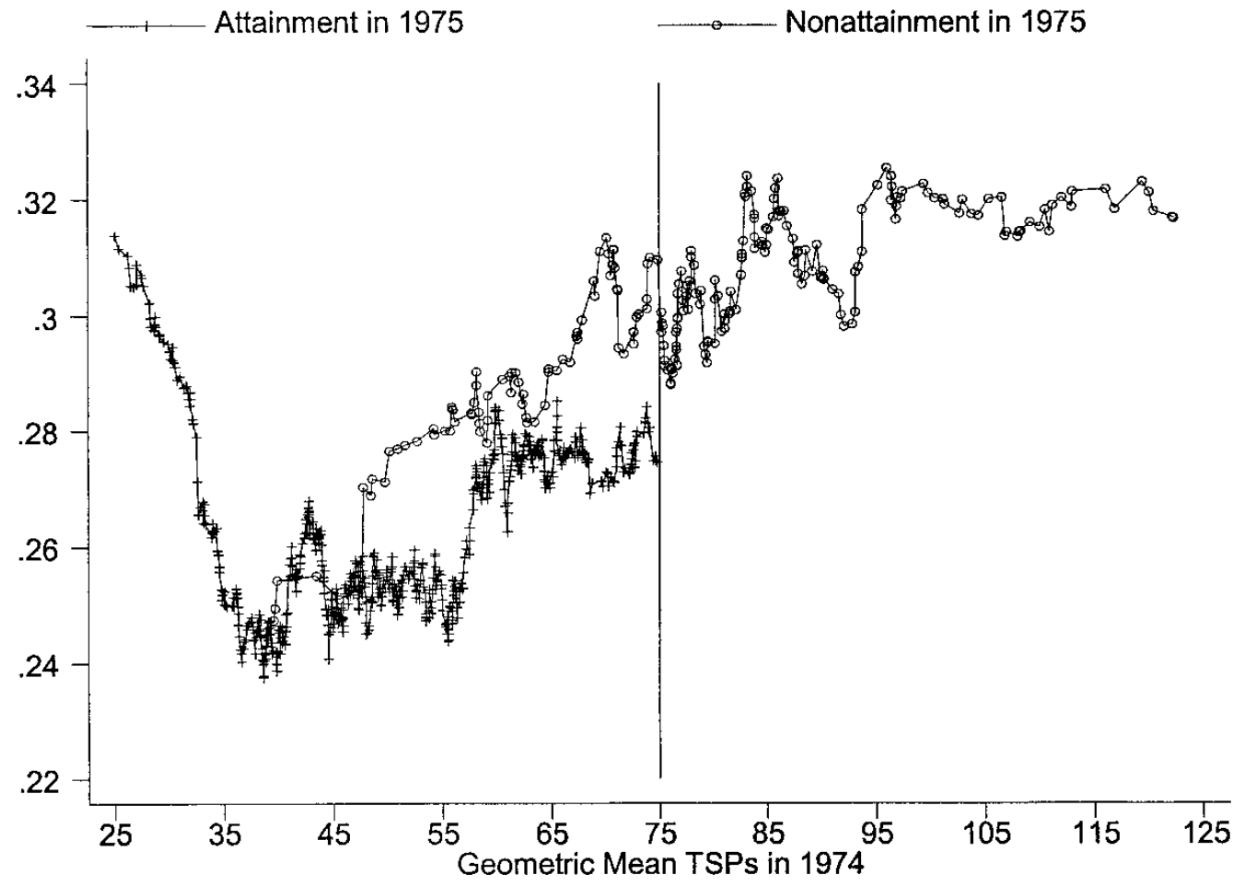



FIG. 5.—1970–80 change in log housing values by 1975 nonattainment status and the geometric mean of TSPs in 1974.

# Does this capture everything?

Why might some damages not capitalize into housing prices?

# Does this capture everything?

Why might some damages not capitalize into housing prices?

How should we think about external validity?

- Free mobility between houses
  - See Christensen and Timmins (2022). Sorting or Steering: The Effects of Housing Discrimination on Neighborhood Choice
- Perfect information
- Well functioning capital markets

But maybe not a bad first approximation. Other uses of hedonics:

- Muehlenbachs, Spiller and Timmins (AER, 2015) - Fracking
- Keiser and Shapiro (QJE 2018) - Clean Water Act
- Taylor and Druckenmiller (AER 2022) - Wetlands and Flooding

# Estimating Damages: Bottom Up

# Bottom up damage estimation

Health Costs

- Can we regress health status on ambient air pollution?
- What is our (implicit) structural model?
- How can derive a reduced form relationship?

# Wind Direction as an IV

## The Mortality and Medical Costs of Air Pollution: Evidence from Changes in Wind Direction

Tatyana Deryugina

Garth Heutel

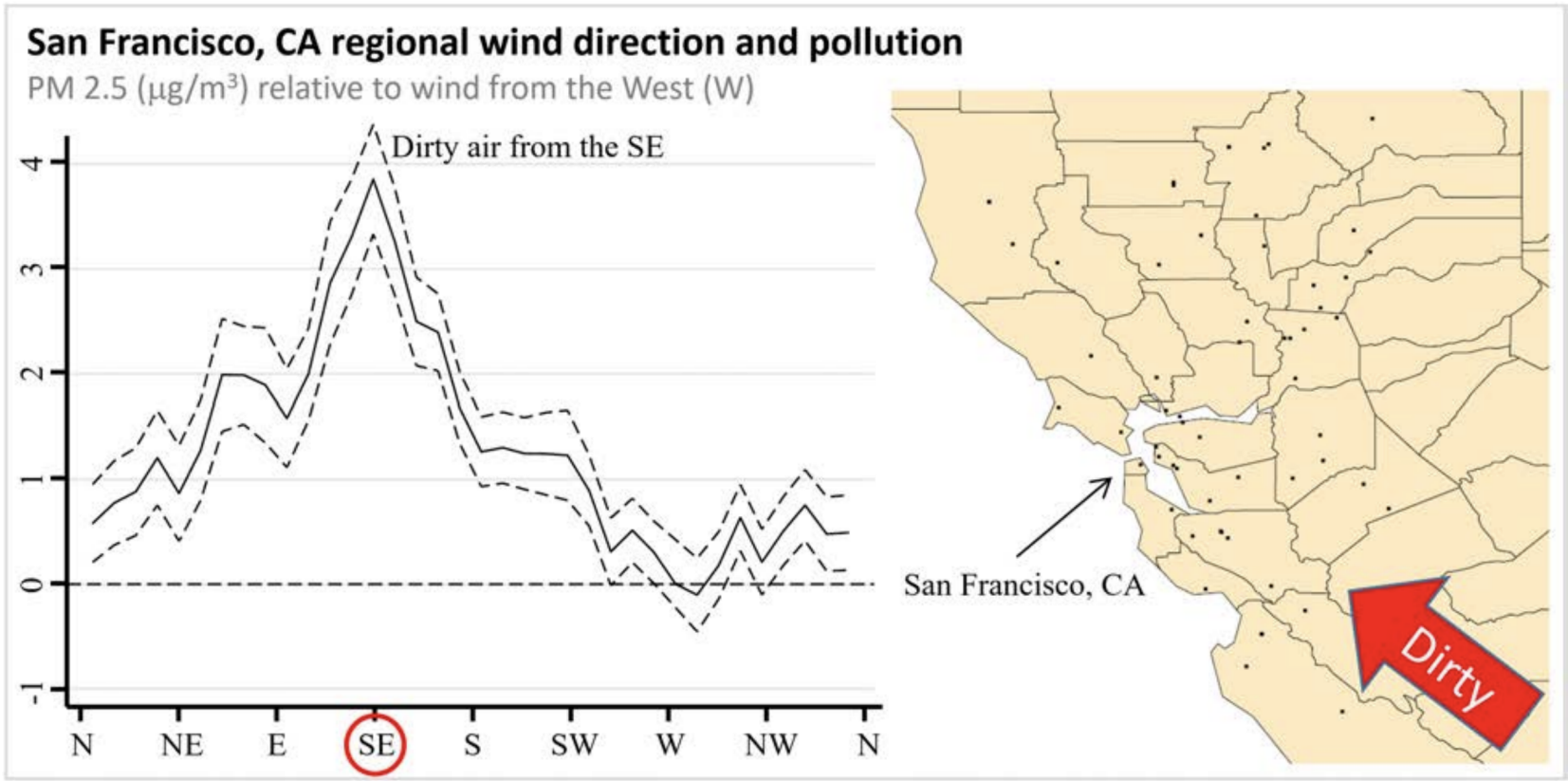
Nolan H. Miller

David Molitor

Julian Reif

AMERICAN ECONOMIC REVIEW
VOL. 109, NO. 12, DECEMBER 2019
(pp. 4178-4219)

# Wind Direction as an IV



# Regression Specification:

$$Y_{cdmy} = \beta PM2.5_{cdmy} + X_{cdmy}\gamma + \alpha_c + \alpha_s m + \alpha_{my} + e_{cdmy} \quad (11)$$

- $Y_{cdmy}$ is outcome in county c on day d in month m and year y: three-day total death rate (d, d+1, d+2) per million, hospital admissions
- daily PM2.5 levels + 2 leads + 2 lags
- High dimensional controls: daily max temp into 17 bins, same for min temp, indicators for deciles of daily precipitation and wind speed, indicators for all possible interactions of these temp, precipitation, and wind speed variables (28,899)
- County c, state-by-month, and month-by-year FE
- Cluster se at the county level and weight

# First stage:

$$PM2.5_{cdmy} = \sum_{g} \sum_{b=0}^{2} WindDir_{cdmy}^{90b} + X_{cdmy}\sigma + \alpha_c + \alpha_s m + \alpha_{my} + e_{cdmy} \tag{12}$$

- $WindDir_{cdmy}^{90b} = 1$ if daily average wind direction in county c falls in [90b, 90B + 90] and 0 otherwise
- 100 spatial group g for pollution monitors

# Wind Direction as an IV: Results

Table 2: OLS and IV estimates of effect of PM 2.5 on elderly mortality, by age group

| | (1) 65+ | (2) 65–69 | (3) 70–74 | (4) 75–79 | (5) 80–84 | (6) 85+ |
|---|---|---|---|---|---|---|
| **Panel A: OLS estimates** | | | | | | |
| PM 2.5 ($\mu g/m^3$) | 0.095*** | 0.041*** | 0.029 | 0.022 | 0.142*** | 0.425*** |
| | (0.021) | (0.014) | (0.018) | (0.022) | (0.036) | (0.072) |
| Dep. var. mean | 385 | 131 | 197 | 312 | 508 | 1,127 |
| Effect relative to mean, percent | 0.025 | 0.032 | 0.015 | 0.007 | 0.028 | 0.038 |
| Observations | 1,980,549 | 1,980,549 | 1,980,549 | 1,980,549 | 1,980,549 | 1,980,549 |
| Adjusted R-squared | 0.254 | 0.080 | 0.085 | 0.082 | 0.077 | 0.110 |
| **Panel B: IV estimates** | | | | | | |
| PM 2.5 ($\mu g/m^3$) | 0.685*** | 0.267*** | 0.329*** | 0.348*** | 0.877*** | 2.419*** |
| | (0.061) | (0.066) | (0.068) | (0.098) | (0.159) | (0.246) |
| *F*-statistic | 298 | 285 | 292 | 303 | 309 | 315 |
| Dep. var. mean | 385 | 131 | 197 | 312 | 508 | 1,127 |
| Effect relative to mean, percent | 0.178 | 0.204 | 0.167 | 0.111 | 0.173 | 0.215 |
| Observations | 1,980,549 | 1,980,549 | 1,980,549 | 1,980,549 | 1,980,549 | 1,980,549 |

Notes: Table reports OLS and IV estimates of equation (1) from the main text. Dependent variable is the three-day mortality rate per million beneficiaries in the relevant age group. All regressions include county, month-by-year, and state-by-month fixed effects; flexible controls for temperatures, precipitation, and wind speed; and two leads of these weather controls. OLS (IV) estimates also include two lags and two leads of PM 2.5 (instruments). Estimates are weighted by the number of beneficiaries in the relevant age group. Standard errors, clustered by county, are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

How large are these effects?

# Beyond Mortality: Defensive Expenditures

Health production function: pollutant concentrations and avoidance behaviors

$$h(c, a(c)) \tag{13}$$

Total derivative with respect to c:

$$\frac{dh}{dc} = \frac{dh}{dc} + \frac{dh}{da}\frac{da}{dc} \tag{14}$$

Deschenes et al (2017) find NOx program benefits from reduced medical expenditures are about 60% of mortality benefits.

- Is this a welfare loss or a transfer to pharmaceutical companies?

# Abatement Costs

# Implications for Welfare

So damages are large - what does this tell us about how air pollution should be regulated?

Remember:

$$\min_{A} \sum_{i} \omega_i (C_i(A) + D_i(A)) \tag{15}$$

Also want to minimize abatement costs

# Greenstone, Pande, Sudarshan and Ryan - QJE forthcoming

Can Pollution Markets Work in Developing Countries?
Experimental Evidence from India

- "If the number of laws were any measure of their effectiveness, India would have one of the cleanest environments in the world." Menon et al. (2012)
- "Emissions markets trade in a commodity created by the state, and these markets cannot function if the state cannot uphold the value of that commodity."
- Context: Surat, India - a city of 7 million with a large textile manufacturing sector
- Status Quo: Firms required to install abatement equipment, incomplete enforcement (see previous work by this same team)

# Surat's air is becoming poisonous, breathing becomes difficult

https://www.patrika.com/surat-news/surat-air-pollution-is-poisonous-breathing-difficult-3816317/

# How to change the world

A 12-year project:

- Get buy-in from the local regulator.

# How to change the world

A 12-year project:

- Get buy-in from the local regulator.
- Convince the regulator to install Continuous Emission Monitoring Systems (CEMS) on every plant in their jurisdiction.

# How to change the world

A 12-year project:

- Get buy-in from the local regulator.
- Convince the regulator to install Continuous Emission Monitoring Systems (CEMS) on every plant in their jurisdiction.
- Establish a trading platform and teach firms how to use it.

# How to change the world

A 12-year project:

- Get buy-in from the local regulator.
- Convince the regulator to install Continuous Emission Monitoring Systems (CEMS) on every plant in their jurisdiction.
- Establish a trading platform and teach firms how to use it.
- Decide how to allocate initial permits.

# How to change the world

A 12-year project:

- Get buy-in from the local regulator.
- Convince the regulator to install Continuous Emission Monitoring Systems (CEMS) on every plant in their jurisdiction.
- Establish a trading platform and teach firms how to use it.
- Decide how to allocate initial permits.
- Deal with missing data.

# How to change the world

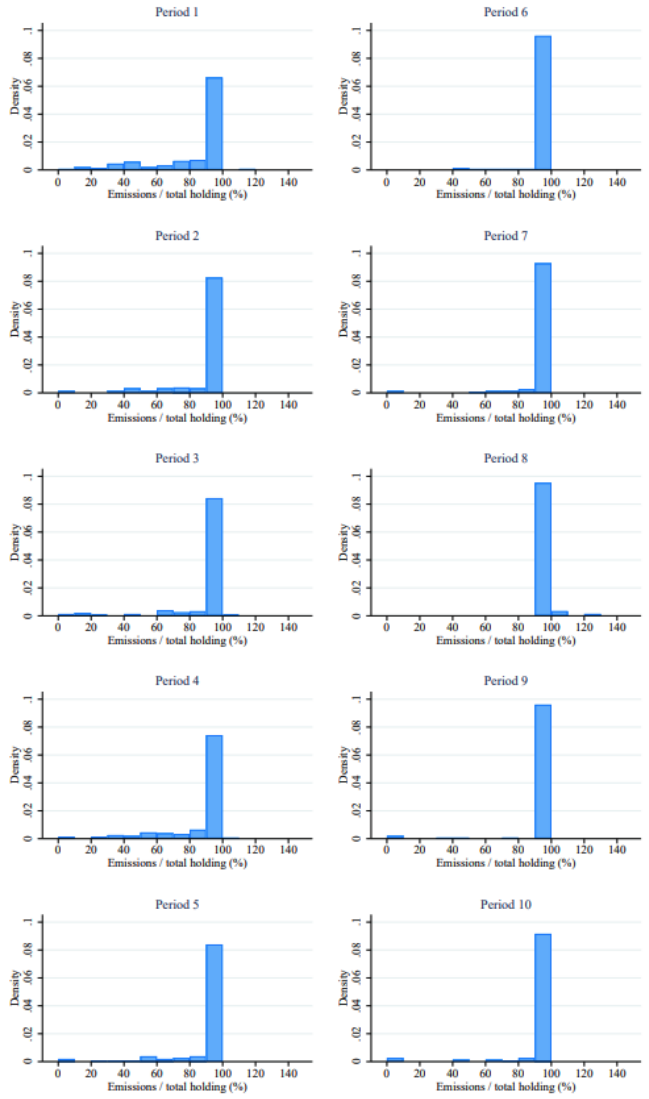
A 12-year project:

- Get buy-in from the local regulator.
- Convince the regulator to install Continuous Emission Monitoring Systems (CEMS) on every plant in their jurisdiction.
- Establish a trading platform and teach firms how to use it.
- Decide how to allocate initial permits.
- Deal with missing data.
- Have your experiment interrupted by COVID.

# Establishing Credibility

Fined 2 plants and order 1 to close after first compliance period.

Figure 3: Distribution of Emissions over Final Permit Holdings by Compliance Period

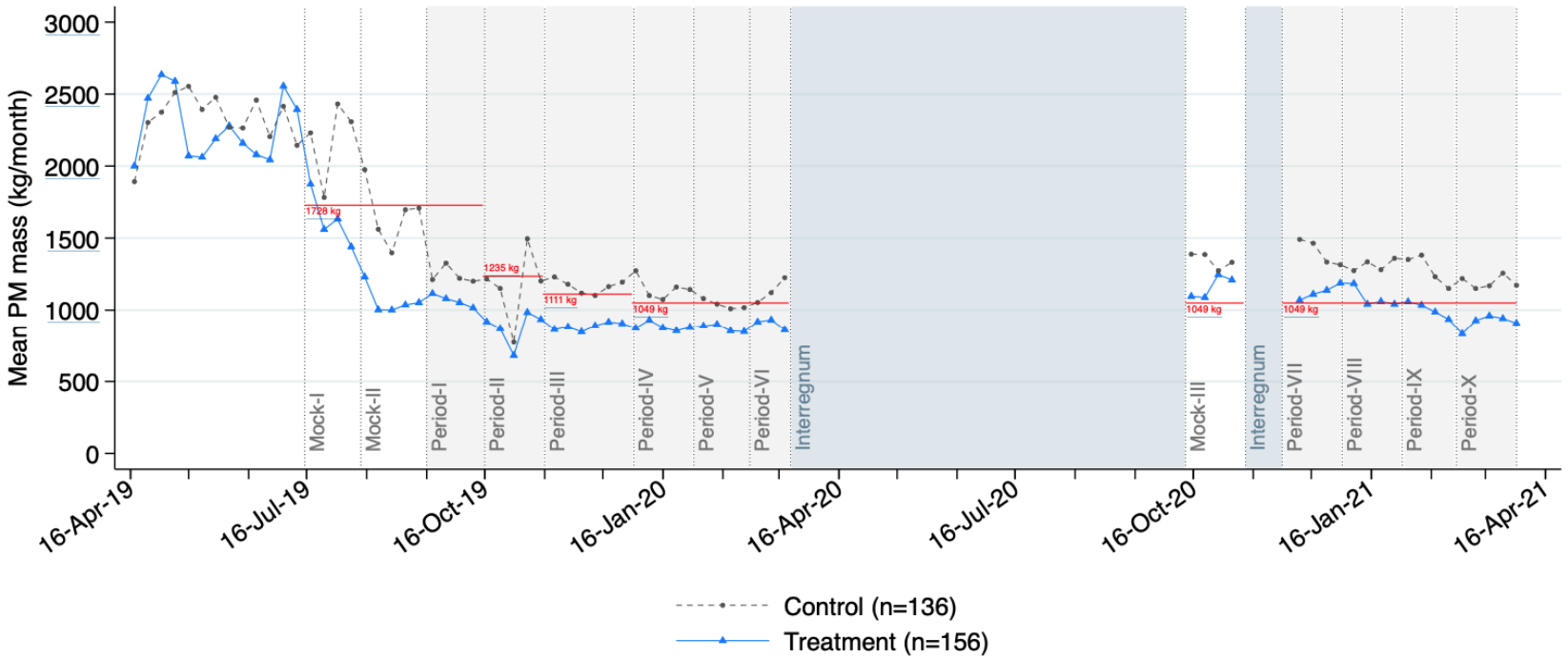


# What effects do we expect?

- On pollution?
- On fixed costs?
- On variable costs?

# Effects on Pollution

Figure 5: PM Emissions by Treatment Status



# Effects on Costs

Table 4: Treatment effects on abatement costs in survey data

| | Abatement capital costs ($1000s) | | | | | Boiler house input costs ($1000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Cyclone | Bag | Scrubber | ESP | Total | Capital | Labor | Electricity | Fuel | Materials |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| ETS Treatment (=1) | -3.467 | 0.602** | 0.530* | -0.222 | -4.281 | 11.26 | -7.178 | 1.561 | 25.21* | 26.87* | -0.142 |
| | (3.089) | (0.266) | (0.318) | (0.407) | (3.344) | (26.31) | (19.05) | (3.332) | (13.53) | (15.35) | (0.596) |
| $R^2$ | 0.90 | 0.85 | 0.83 | 0.84 | 0.89 | 0.93 | 0.63 | 0.05 | 0.65 | 0.98 | 0.19 |
| Control mean | 44.04 | 7.80 | 9.85 | 9.69 | 16.70 | 578.48 | 190.88 | 47.86 | 162.13 | 299.50 | 4.33 |
| Plants | 276 | 276 | 276 | 276 | 276 | 185 | 218 | 262 | 247 | 225 | 283 |

This table reports the effects of treatment assignment on the capital cost of APCDs (columns 1-5) and boiler house input costs (columns 6-11). In columns 1-5, the abatement capital cost is the product of the number of abatement devices at a plant and the industry-standard cost for that device for the plant's given boiler house capacity. In columns 6-11, specifications use our best estimates for boiler house costs from the endline survey (FY 2019-20). All specifications control for a corresponding baseline value (FY 2017-18) but in some cases the components of the input cost aggregate differ slightly within a category between the baseline and endline survey. Electricity costs are only reported at the plant level so are not only for the boiler house. Robust standard errors are given in parentheses with statistical significance indicated by $^{*}p<0.10$; $^{**}p<0.05$; $^{***}p<0.01$.

# Effects on Costs

Table 4: Treatment effects on abatement costs in survey data

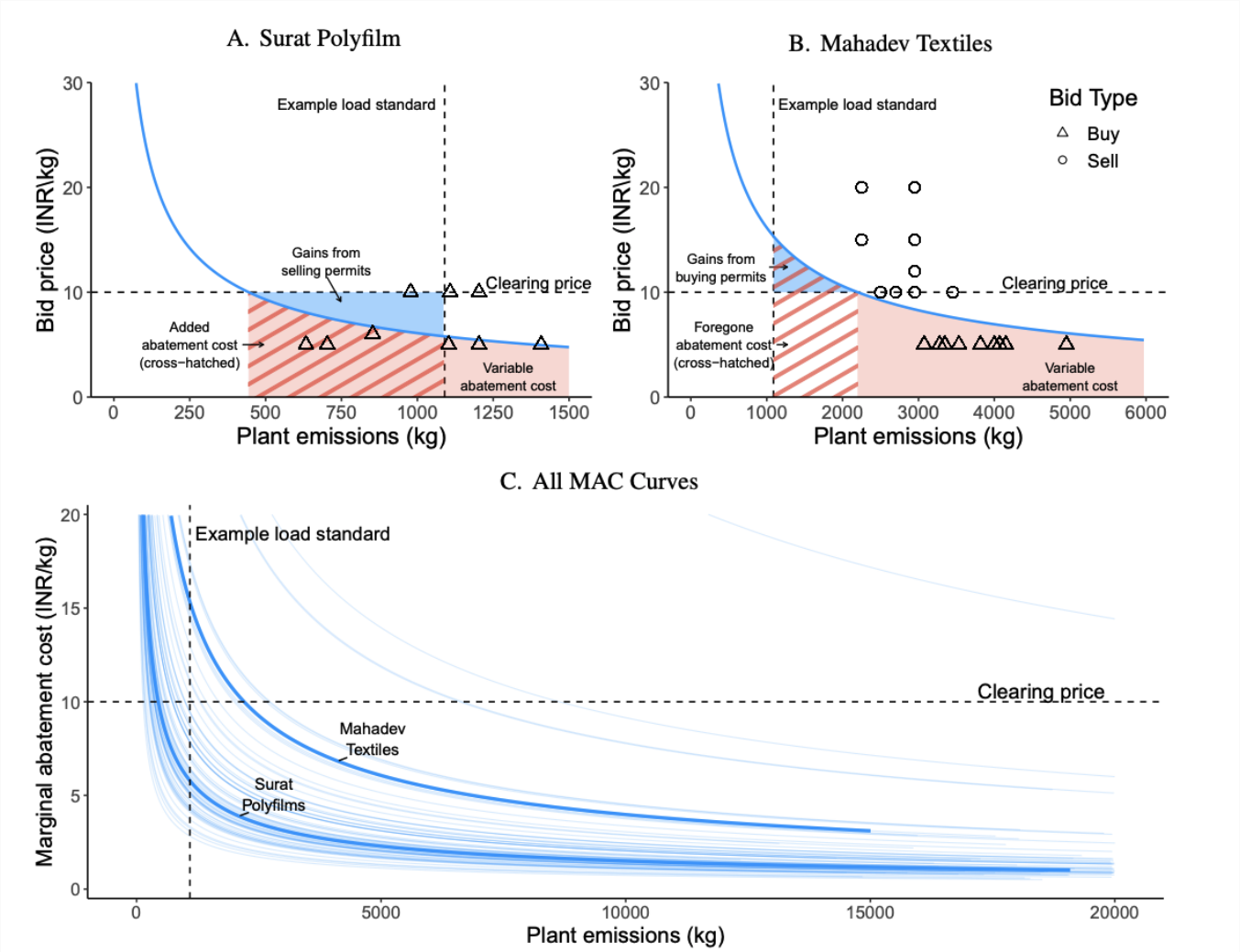
| | Abatement capital costs ($1000s) | | | | | Boiler house input costs ($1000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Cyclone | Bag | Scrubber | ESP | Total | Capital | Labor | Electricity | Fuel | Materials |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| ETS Treatment (=1) | -3.467 | 0.602** | 0.530* | -0.222 | -4.281 | 11.26 | -7.178 | 1.561 | 25.21* | 26.87* | -0.142 |
| | (3.089) | (0.266) | (0.318) | (0.407) | (3.344) | (26.31) | (19.05) | (3.332) | (13.53) | (15.35) | (0.596) |
| $R^2$ | 0.90 | 0.85 | 0.83 | 0.84 | 0.89 | 0.93 | 0.63 | 0.05 | 0.65 | 0.98 | 0.19 |
| Control mean | 44.04 | 7.80 | 9.85 | 9.69 | 16.70 | 578.48 | 190.88 | 47.86 | 162.13 | 299.50 | 4.33 |
| Plants | 276 | 276 | 276 | 276 | 276 | 185 | 218 | 262 | 247 | 225 | 283 |

This table reports the effects of treatment assignment on the capital cost of APCDs (columns 1-5) and boiler house input costs (columns 6-11). In columns 1-5, the abatement capital cost is the product of the number of abatement devices at a plant and the industry-standard cost for that device for the plant's given boiler house capacity. In columns 6-11, specifications use our best estimates for boiler house costs from the endline survey (FY 2019-20). All specifications control for a corresponding baseline value (FY 2017-18) but in some cases the components of the input cost aggregate differ slightly within a category between the baseline and endline survey. Electricity costs are only reported at the plant level so are not only for the boiler house. Robust standard errors are given in parentheses with statistical significance indicated by $^{*}p<0.10$; $^{**}p<0.05$; $^{***}p<0.01$.

...but emissions were not held constant

# Model Intuition: MAC = P

Want to estimate marginal abatement cost curves for *every* plant so that we can estimate the gains from trade



# Takeaways

The model allows us to estimate counterfactuals for different regulatory regimes

- Emissions market is 10% cheaper than command and control for same level of emissions
- For same cost, market would cut emissions by 48% (abatement costs not very elastic)
- Implies dramatic reductions in emissions possible for very little cost

What about distributional consequences?

- We haven't talked much about the $\omega_i$s yet.

# Distributional Considerations

# Are Efficiency and Equity in Tension?

**Inside Climate News**

Pulitzer Prize-winning, nonpartisan reporting on the biggest crisis facing our planet.

Donate

Justice

## Why Do Environmental Justice Advocates Oppose Carbon Markets? Look at California, They Say

Activists have long warned that cap and trade would jeopardize states' efforts to reduce carbon emissions and increase pollution in communities of color. New reports back up those assertions.



By Kristoffer Tigue
February 25, 2022

Related

Researchers Say Science Skewed by Racism is Increasing the Threat of Global Warming to People of Color

Is the California Coalition Fighting Subsidies For Rooftop Solar a Fake

PBS NEWS HOUR

Menu




By –
Bill Corcoran

By –
Byron Gudiel

## Column: Washington's carbon tax doesn't address environmental justice

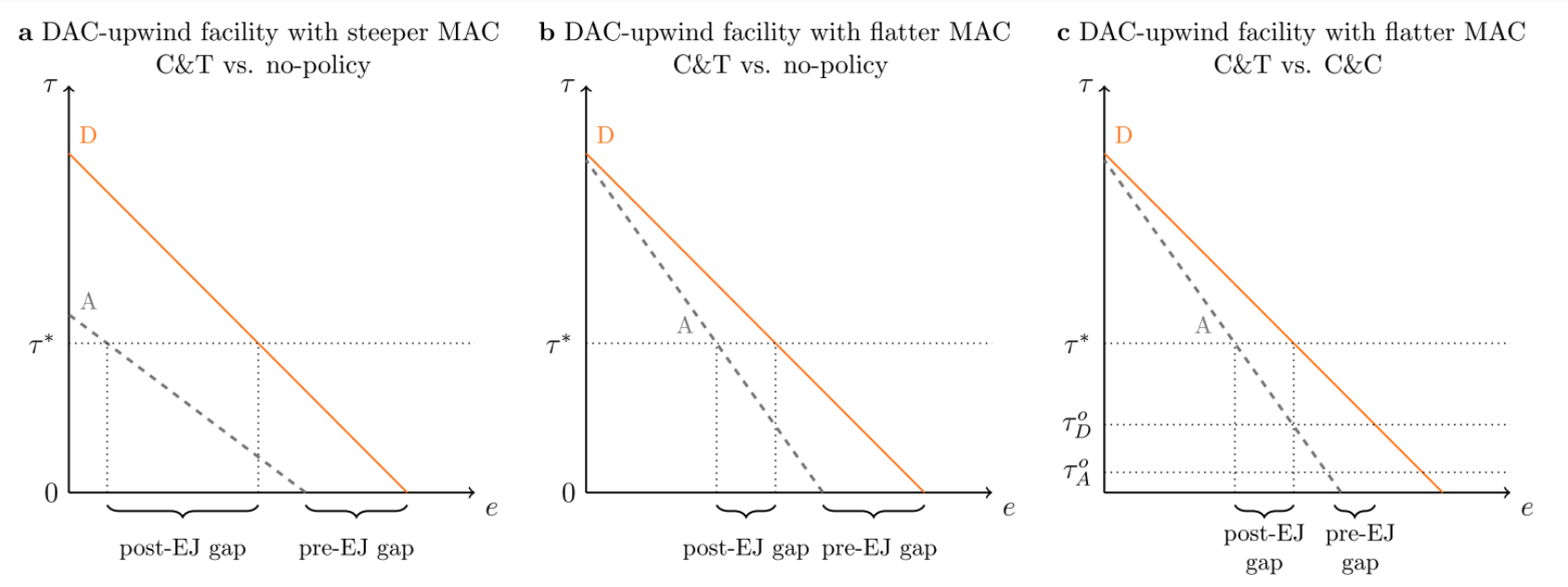
Economy Nov 8, 2016 11:40 AM EST

# Hernandez-Cortes and Meng (2023 JPubE)

Do environmental markets cause environmental injustice? Evidence from California's carbon market

- Context: California has cap-and-trade program for large stationary emitters since 2013
- Plenty of empirical work showing low-income, minority households face higher pollution levels (the 'EJ Gap')
- Why might market based instruments increase the 'EJ Gap' even while lowering overall emissions?

# Heterogeneous Marginal Abatement Costs

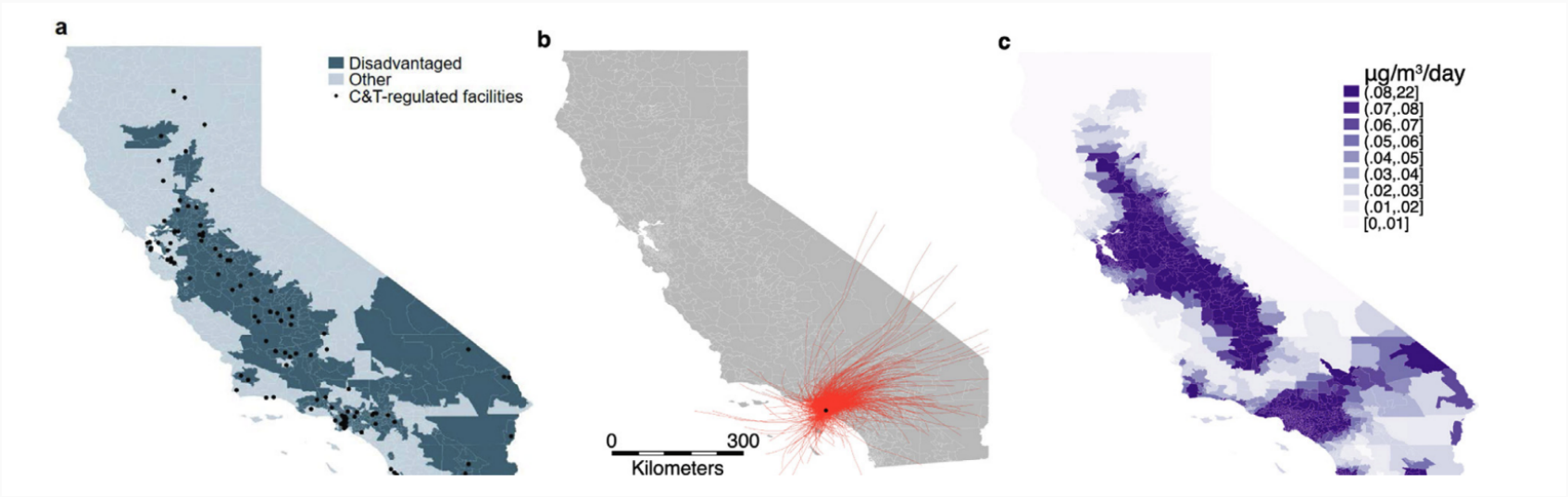



We clearly need to estimate *facility level* treatment effects.

# Outline

1. Estimate facility specific treatment effects of the policy
2. Feed these estimated reductions into an air pollution dispersal model
3. Look at how spatial distribution of pollution changes

# Baseline Exposure



# Some (very?) strong assumptions

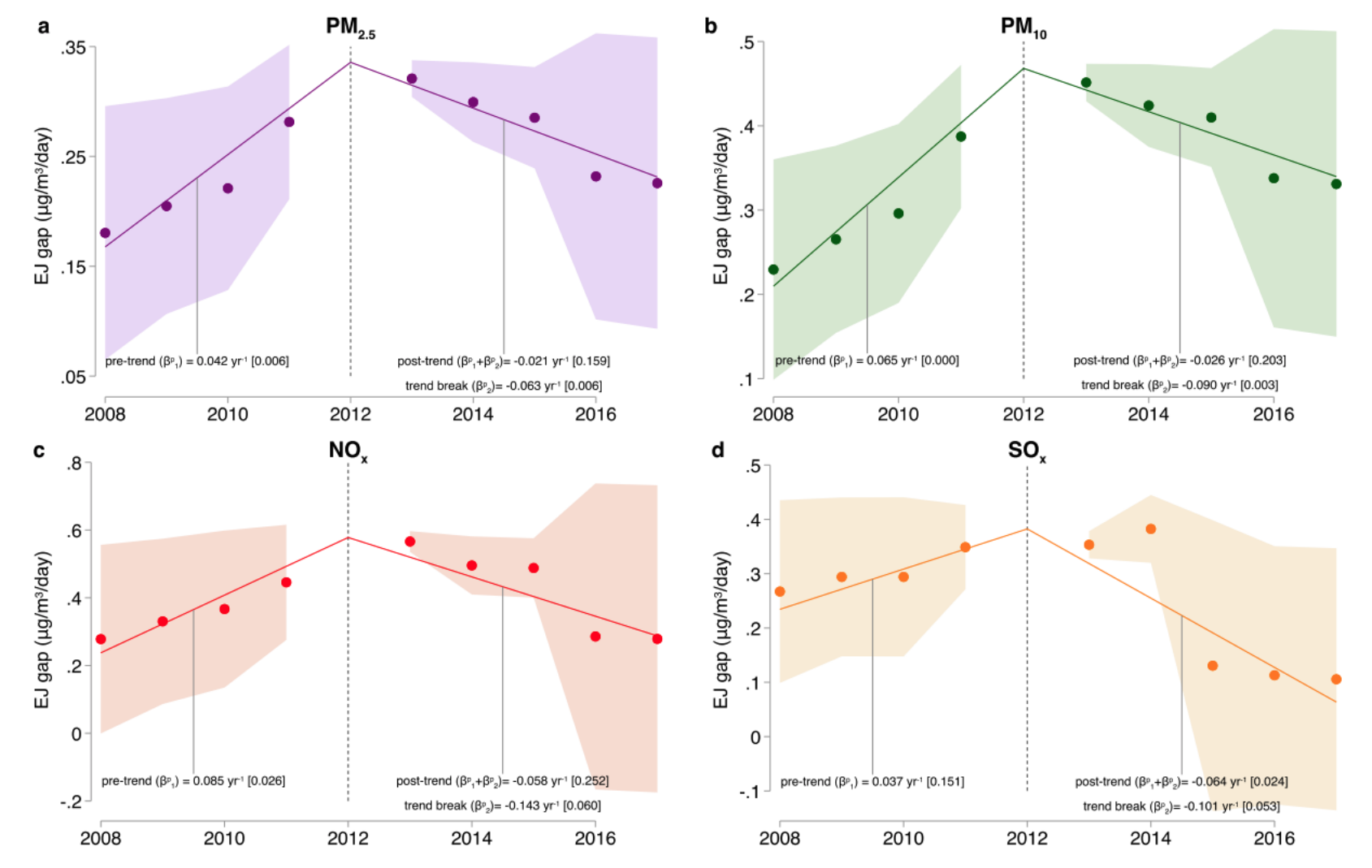
Estimate a 'trend-break' model - allows for differential pre-trends between regulated and unregulated facilities

- Control group: Regulated vs unregulated emission sources
  - Remove electricity generators, refineries, and facilities with emissions above 75 percentile.
  - SUTVA violations?
- Functional form: Linear trends, inverse hyperbolic sine of emissions
- Heterogeneity: Homogeneous percentage effect into heterogeneous facility level effects through fixed effects.

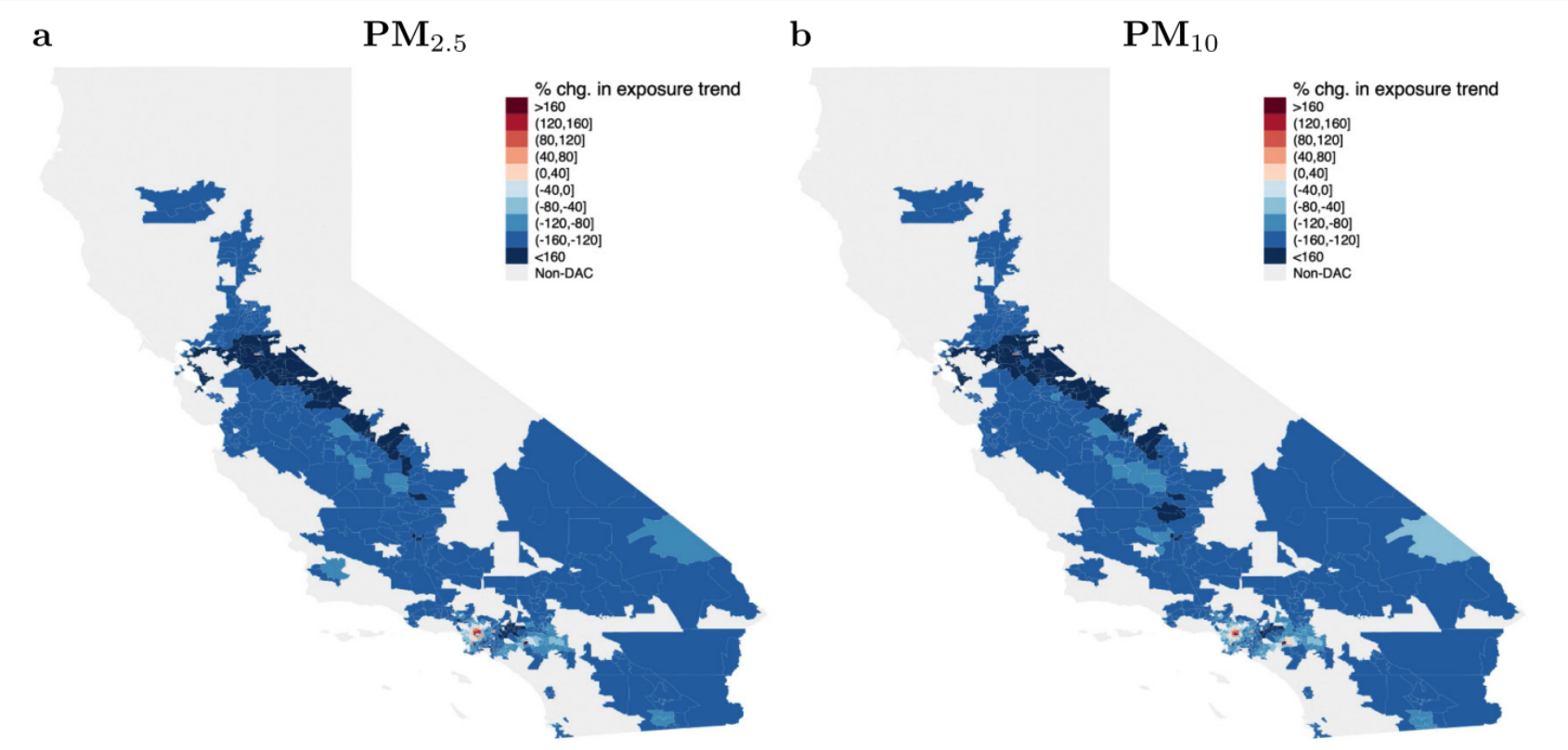
But some nice atmospheric physics

- Pollution dispersal model (previous literature typically used 1-3 mile buffer)

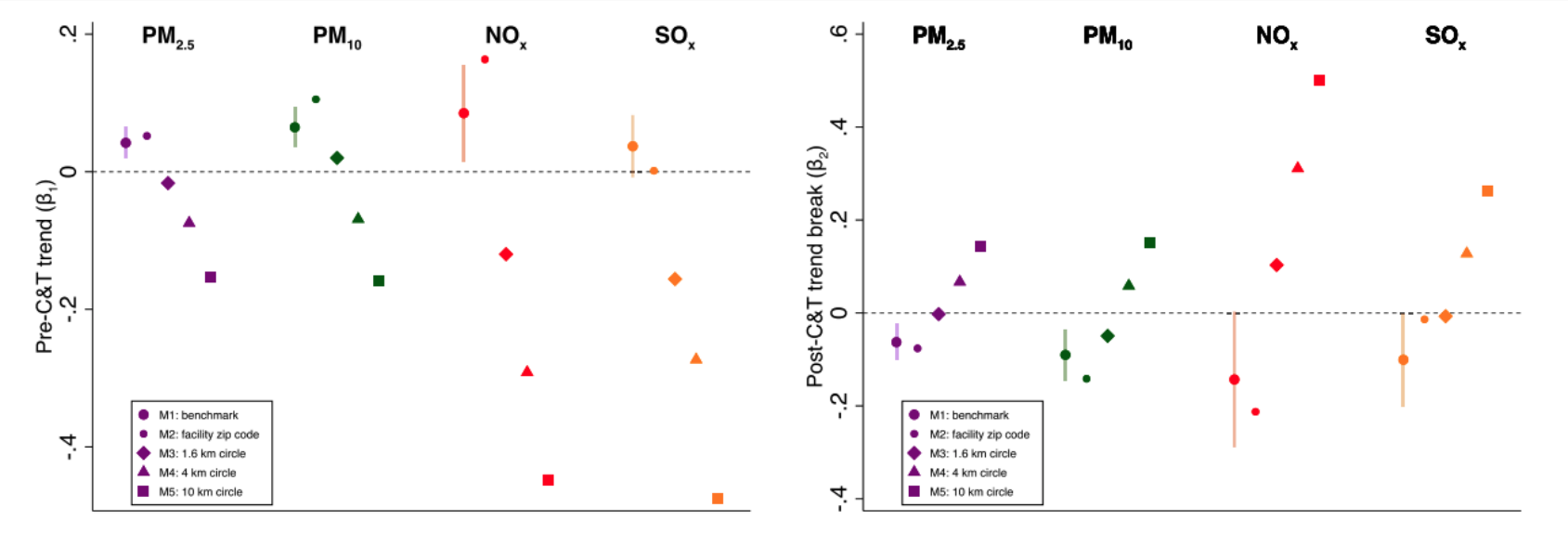
# Cap and Trade Narrows EJ Gap



# But Considerable Spatial Heterogeneity



# Importance of Pollution Modelling



# Takeaways

- They didn't actually model heterogeneous marginal abatement costs!
- But the question is well posed and they show the importance of pollution dispersal modelling
- More work to be done here
  - Deschenes and Weber: Equity Impacts of a Market for Clean Air (Working Paper)
  - Muller and Mendelsohn (2009 AER): Efficient Pollution Regulation: Getting the Prices Right
    - Should we have spatially differentiated pollution taxes?

# Other Recent Papers and Future Research

Better identifying abatement costs in different contexts, monitoring and evaluation

- Shapiro and Walker: Is Air Pollution Regulation too Stringent?
- Buntaine et al. Does the Squeaky Wheel Get More Grease? The Direct and Indirect Effects of Citizen Participation on Environmental Governance in China.
- Duflo, Greenstone, Pande, and Ryan: Truth-telling by third-party auditors and the response of polluting firms: Experimental evidence from India.

Long term (possibly intergenerational?) effects

- Colmer and Voorheis: The Grandkids Aren't Alright: The Intergenerational Effects of Prenatal Pollution Exposure.

Water pollution, solid waste, and other media

- Keiser and Shapiro: Consequences of the Clean Water Act and the Demand for Water Quality.