How Well Are Our Environmental Laws Working?

Retrospective Analysis of Federal Environmental Regulation

September 16, 2019
Looking Back at Federal Regulation

• Growing interest in the issue:
  • Arguably, origins date back to the 1970s...
  • Obama, Trump Administrations support retrospective analysis of regulation
  • Key element of Evidence-Based Policymaking Act (2018) and Smart Act (bi-partisan co-sponsors Lankford/Sinema)
  • Expanding body of independent academic research
• Distinguish from ex ante ‘Regulatory Impact Analyses’
  • ‘RIAs developed at the point when least is known and any analysis must rest on many unverifiable and potentially controversial assumptions’ (Michael Greenstone, 2009)
• Ex post studies can inform public and help shape new rules
Today, We Consider Four New Papers

- What Have we Learned from Economic Studies of the Clean Air Act?
- Retrospective Cost Analyses of EPA Regulations
- Institutional Dimensions of Retrospective Analysis of Regulation
- The Accuracy of Policymaker Predictions of Compliance Costs
First Paper

“What We Have Learned from Economic Studies of the Clean Air Act”

Joseph Aldy, Maximillian Auffhammer, Maureen Cropper, Arthur Fraas, Richard Morgenstern
1970 CAA Plus 1977 and 1990 Amendments

• Most important and far reaching environmental statute in US
• Shifted focus from states to federal government
• Included targets/timetables, empowered citizens to sue
• Despite 4x GDP growth since 1970, big measured air quality gains
  • Aggregate emissions criteria pollutants decline 73%, 1970-2017
  • PM$_{2.5}$ concentrations decline 41%, 2000-2017
  • O$_3$ concentrations decline 32%, 1980-2017
  • Pb, CFC phasedown
• Costs $65 billion/year (2020) (EPA est.)
• Key Issue: causal role of CAA in air quality, health, welfare gains
Economy and the Environment 1980–2018
What Do We Want to Know About the CAA?

• Do the regulations deliver their statutory/regulatory objectives? Do they reduce emissions/improve ambient air quality?

• Do the regulations increase social welfare? Do they improve public health? Do they pass the B-C test? Do they have unintended consequences, e.g., on market power?

• What are the political economy (distributional) implications of the regulations? Do they affect employment? Have implications for plant location?
Approaches to CAA Evaluation

- *Ex ante* RIAs of individual rules: 100+ conducted since 1981, most show benefits exceed costs
- Aggregate analyses: e.g., EPA studies (1997, 1999, 2011), largely *ex ante*, all show benefits greatly exceed costs
  - Most benefits from fine PM (directly or as co-benefits)
  - Key criticisms: choice of baseline, failure to disaggregate by regulation
- *Ex post* analysis of individual rules using quasi-experimental methods; structural models also considered
  - Advantage: clear linkage between regulation and outcomes; rule changes over time/across firms/areas facilitate study of causal impacts
  - Disadvantage(s): few studies exist, difficult to conduct; mostly focus on limited outcomes; typically omit CGE, other indirect effects
Methods for Retrospective Analysis

- Randomized Control Trials (gold standard for identifying impacts) not common in environmental arena due to legal/other restrictions on withholding protections from some groups/areas. However, clever regulatory design sometimes feasible.
- By its very nature, RCT not possible looking back in time.
- Quasi-experimental methods can be used to establish realistic counterfactuals but do not involve strictly random assignment to treatment or control groups.
- Structural models may establish counterfactuals in some cases
Scope of Published CAA Ex Post Studies

- Quasi-experimental, structural models
- Pb Phasedown, CFCs
Criterion for Inclusion in Literature Review

- Published economics papers on individual CAA rules
- Plus studies using non-attainment designation as exogenous source of variation in regulatory stringency
- Counterfactuals established via quasi-experimental/structural models
- Endpoints: welfare/cost, emissions, air quality, health effects, employment
- Use of modern econometric methods
- Data: market, EPA or other government agency, proprietary
- Three dozen+ studies included, albeit thin coverage on some issues
Key Sections of the Paper

• Effects of Regulation on Stationary Sources
• Effects of Fuel Content Rules (Mobile Sources)
• Attainment Status: Metric for Regulatory Stringency
• Main Insights About Air Quality Regulation
• What Don’t We Know
Stationary Source Regulations

- Sulfur Dioxide Cap-and-Trade
- NOX Budget Trading Program
- RECLAIM
- Air Toxics
Sulfur Dioxide Cap-and-Trade

- Reduces costs ~20% compared to performance standard
- Potential gains from trading ratios that reflect spatial variation in damages
- No evidence of power sector job loss
- Railroads captured some economic value of shipping low-sulfur coal

NOX Budget Trading Program

- Reduced NOX emissions 40%, ozone concentrations 6%
  - 2000 fewer deaths/year
  - $1 billion less in medication expenditures/year
- Rate-deregulated power plants use less capital-intensive compliance strategies
- Patchwork of economic regulation contributes to spatial shift in NOX emissions
- Manufacturing job loss, especially for younger workers

RECLAIM Cap-and-Trade Program

- SCAQMD implemented local cap-and-trade program to address Los Angeles extreme non-attainment for ozone
- NOX emissions fell 20% at RECLAIM units vs. similar unregulated units
- No evidence of pollution hot spots, an environmental justice concern raised in CA policy debates

Source: Fowlie et al. AER 2012.
Air Toxics

• Hazardous air pollutant technology standards reduced pulp & paper emissions 20-33% and printing and publishing emissions by as much as 90%

• Pulp & paper emission reductions fell short of EPA RIA projection

• Some evidence of job loss in cases where EPA jointly regulated air and water emissions (Cluster Rule)
Fuels Regulation

- Reformulated Gasoline
- Reid Vapor Pressure Regulations
- Oxygenated Fuels
- Renewable Fuels Standard
More Stringent Rules on Fuels Sold in Non-Attainment Areas

Ozone Formation: An Economist’s View

- Leontief-like production function of ozone
- Requires NOX and VOCs
- VOCs differ in their reactivities
- Requires high temperatures and sunlight
- RFG and RVP regulations target fuel content, with VOC focus
- California targeted highly-reactive VOCs
RFG and RVP Takeaways

- No evidence that RVP reduces ozone concentrations
- RFG impacts on ozone small and influenced by NOX stationary programs
- California (CARB) rule targets specific, important VOCs
- Patchwork of fuels leads to segmented markets
  - Market power by refiners
  - Increase in fuel prices

Source: Auffhammer and Kellogg AER 2011.

Los Angeles County Daily Maximum Ozone Concentrations, 1990-2004
Renewable Fuel Standard

• 2007 Revisions Increased Targets Significantly
  • 9 billion gallons (2008) to 36 billion gallons (2022)
  • Targets for cellulosic, advanced, biodiesel
• Advanced biofuels and cellulosic targets too ambitious
• Implemented through tradable performance standard (RINs)
  • Biofuels subsidized by petroleum fuels
  • Incomplete pass-through of RIN prices to consumers
Using Non-Attainment Status to Measure Effects of the CAA
Non-Attainment Status under the CAA

- Counties violating National Ambient Air Quality Standards (NAAQS) designated non-attainment (NA) counties
  - States required to include plans for meeting the NAAQS in State Implementation Plans (SIPs)
  - More stringent regulations on existing sources than in attainment areas
  - New plants locating in NA areas subject to Lowest Achievable Emission Rate standards; may have to purchase pollution offsets
- Viewed as an exogenous source of regulation
  - Literature compares outcomes in NA v. A counties or uses NA status to instrument for change in ambient air quality (e.g., in studying health impacts)
8-Hour Ozone Non-attainment Areas (2015 Standard)

Nonattainment areas are indicated by color. When only a portion of a county is shown in color, it indicates that only that part of the county is within a nonattainment area boundary.
Questions Addressed in the NA Literature

- **Impact on air quality**
  - Did ambient air quality improve more in NA than in A counties?

- **Impact on manufacturing activity**
  - Did plant births shift from NA to A counties? Did investment in manufacturing industries in NA counties fall (relative to A counties)? Value of shipments?

- **Impact on employment and earnings**
  - Did employment in manufacturing in NA counties fall? Did workers suffer permanent earnings losses?

- **Benefits of the CAA**
  - Did the CAA improve health or human capital? Lead to other benefits?
Impact of NA Status on Air Quality

• NA for ozone ($O_3$) under the 1977 CAAA
  • Shift from NA to A reduces median July max $O_3$ by 8%; 4% drop in mean July $O_3$

• NA for PM10 under the 1990 CAAA
  • Reduction in PM10 7% per year greater at monitors out of attainment than at monitors in attainment

• NA for $SO_2$ under the 1977 and 1990 CAAAs
  • NA status in 1990 significantly reduced $SO_2$ by 7-11% by 1992; no effect found in earlier periods

• Important findings, but do not measure impact of regulations that affected both attainment and non-attainment counties
Impact of NA Status on Manufacturing

- Evidence that NA Status for O\textsubscript{3} shifted plant births from NA to A counties
  - Being in NA in 1977-87 reduced plant births by 45% (organic chemicals) and 26-29% (plastics, metal containers, wood furniture) over the 1967-72 to 1987-92 period
  - New plants larger in NA counties, suggesting more up front investment

- **592,000 manufacturing jobs lost, 1972-77 to 1982-87 in NA counties**
  - Impact is relative to A counties; largest impacts are NA for CO, O\textsubscript{3}
  - No significant impacts on value of shipments or capital stocks

- **When workers affected by 1990 CAAA are followed over time**
  - Workers who change firms lose earnings equal (in PDV) to 120% of pre-regulation annual earnings; no losses for workers who stay with same firm
Use of NA Status to Measure Benefits

• **Impact of TSP reductions under CAA on Housing Values, Human Capital**
  • Reduction in TSP between 1970 and 1980 led to a $45 billion (1982$) increase in housing values in NA counties, representing amenity and some health benefits
  • Reductions in TSP for children born in NA counties increased earnings at 30 years of age by 1% and lifetime earnings for the cohort by $6.5 billion (2008$)

• **What about health impacts?**
  • Reduction in TSP between 1971 and 1972 associated with health improvements but difficult to instrument using NA status
  • Recent work links 2005 NA status for PM$_{2.5}$ to dementia

• **But, growing literature on causal health impacts of PM**
  • Literature instruments for PM using wind speed and direction; causal, but doesn’t attribute impacts to CAA
Insights for Future Regulation - I

• Spatially varying regulation can harm local economics
  • Is spatial variation in regulatory stringency justified on benefit-cost grounds?
  • Can some of the negative impacts on workers be ameliorated?

• Current applications of cap-and-trade have fallen short of expectations
  • Existing regulations may reduce cost savings from cap-and-trade
  • Part of the cost savings from SO$_2$ allowance program captured by railroads

• Regulatory flexibility may not yield cost-effective results
  • Allowing refiners to reduce butane to meet RFG requirements did not improve air quality; more prescriptive regulations in California did
Insights for Future Regulation - II

• Varying fuel content regulations may have raised costs to consumers
  • Varying fuel content regulations raise production costs, increase market power in regionally separate markets and may increase gasoline price volatility
  • Do the benefits of varying (v. uniform) regulations justify the costs?

• Improvements in the design of the Renewable Fuel Standard could reduce costs
  • Annual announcement of mandates has increased price volatility in market for RIN credits
  • Announce mandates for longer periods and establish price floor and ceiling
What We Don’t Know about the CAA

• Impact of most CAA regulations on ambient air quality
  • Literature on NA status measures impacts relative attainment counties, not absolute improvements in air quality (i.e., relative to no CAA)
  • No quasi-experimental studies of impact of tailpipe emissions standards, New Source Performance Standards, New Source Review
  • If we knew air quality impacts, given expanding causal literature on health effects, could calculate health benefits ex post

• Welfare costs of CAA regulations
  • Few quasi-experimental, ex post cost studies of regulations
  • Also few studies of welfare impacts: requires structural models, although these are being developed
Thank you.

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