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

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Outline of the Talk

- What have we learned from *ex post* studies about the impact of the CAA on emissions and ambient air quality?
- What have we learned about the health and other benefits that can causally be attributed to the CAA?
- What have we learned about the costs of the CAA?
- What do we not know about the CAA?

Impact of the CAA Air Quality & Emissions

- What we would like to know is how much of the large improvements in ambient air quality since 1970 can be attributed to the CAA
- Most of the literature focuses on whether levels of the criteria pollutants fell faster in Non-Attainment than in Attainment areas
- There is also a literature on the impact of the CAA on emissions by regulated firms
  - Most literature is post-1987 (once TRI and NEI become available)
  - Some studies of individual industries (pulp & paper, iron & steel)
  - Shapiro and Walker (2018) impact on manufacturing emissions, 1990-2008

Impact of the CAA on Ambient Air Quality

- **Ambient PM Fell Faster in Non-Attainment than in Attainment Counties**
  - **1970 – 1980: TSP fell by 9-10 μg/m3 (11-12%) more in NA counties**
  - **1990 – 2000: PM10 fell 7-9 μg/m3) (11-13%) more at monitors out of attainment**
  - **2000 – 2013: PM2.5 fell by 1.24 μg/m3 (69%) more in NA counties**
- **1977 CAAA and NOx Budget Programs Reduced Ambient Ozone**
  - **1977 – 1987: Maximum July Ozone fell 8% faster in NA counties**
  - **2003 – 2007: High ozone days fell by 35% in counties subject to NOx BP**
- **1990 – 1992: SO_2 fell 7-11% faster in NA than in Attainment counties**
- **New studies rely on satellite data (Currie, Voorheis, Walker 2020)**

But Not All Rules Improved Air Quality

- However, some regulations on reformulated gasoline did not reduce O_3
- Reid Vapor Pressure regulations were NOT effective in reducing ozone
  - In states where refiners were given flexibility in which VOCs to remove from gasoline, many chose butane (the cheapest) which did not reduce O_3
- Reformulated Gas regulations had a modest effect on reducing O_3
  - And their effectiveness depended on local NOx controls
- Regulations issued by the California Air Resources Board were, however effective
  - Because they specified which VOCs to reduce

Health Benefits Attributable to the CAA

- EPA RIAs measure health impacts using observational studies
  - Impact of PM and ozone on mortality and morbidity
- Economists have demonstrated causal impacts of air pollution on mortality and morbidity
  - These studies use a variety of instruments for air pollution (Chay and Greenstone, Deryugina et al., Currie et al., Schlenker & Walker)
- We reviewed only those studies using CAA regulations to instrument for air pollution
  - The three on the next slide link the CAA to new measures of health benefits

Health Benefits Attributable to the CAA

- NOx Budget Program reduced deaths and medical expenditures
  - The NBP reduced deaths by 2,500 each year in the 19 states in which the program operated
  - It reduced defensive medical expenditures by $800 million (2015$) annually
- TSP reductions under the 1970 CAA increased human capital and earnings
  - Children born in NA counties after the 1970 CAA had higher lifetime earnings of $6.5 billion (2008$) than children born in NA counties before the CAA
- A 1 μg/m3 fall in PM2.5 exposure under the 1990 CAAA reduced diagnoses of dementia by 180,000

Impact of the CAA on Property Values

- Capitalization of air quality into property values reflects improvements in visibility and health, as perceived by consumers
- 1970 – 1980: Reductions in TSP in Non-attainment counties raised property values by $45 billion (1982$) relative to attainment counties
- 1990 – 2000: Reductions in PM10 in Non-attainment counties raised property values by $44 billion (2000$)
- Studies suggest that increases in property values are not fully passed on to renters – so renters as well as homeowners enjoy these benefits

What Have We Learned About Costs?

- Ex ante estimates of compliance costs focus on engineering cost estimates – How do ex post estimates compare?
  - Fowlie (2010) and Linn (2008) examine how firms complied with the NBP
  - Chan et al. (2018) examine compliance with the Acid Rain Program
  - These studies suggest firms don't always cost minimize
  - Shapiro and Walker (2020) use offset trades to estimate compliance costs
- Large literature on the adjustment costs (e.g., on employment, plant location) of imposing stricter standards in non-attainment areas
- Studies of the market impacts of ARP and reformulated gas rules

Costs of Spatially Differentiated Standards

- Evidence that NA Status for O_3 shifted plant births from NA to A counties
  - NA status in 1977-87 reduced plant births by 45% (organic chemicals) and 26-29% (plastics, metal containers, wood furniture) over the 1967 – 1992 period
  - New plants larger in NA counties, suggesting more up front investment
- 592,000 manufacturing jobs lost, 1972 – 1987 in NA counties
  - Impact is relative to A counties; largest impacts are NA for CO, O_3
  - No significant impacts on value of shipments or capital stocks
- Earnings losses under 1990 CAAA for workers in regulated firms
  - 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

Market Impacts of the CAA

- Variation in reformulated gasoline standards across states segmented the gasoline market
  - Increased market power of refiners in some regional markets
  - Raised fuel prices and increased gasoline price volatility
- Evidence that environmental regulations may have acted as a barrier to entry in the cement industry
- During Phase I of the SO2 Allowance Program, railroads raised price of low-S coal to plants in the program (v. plants regulated under CAC)

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)
  - Few 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 of air pollution, could calculate health benefits ex post
- Compliance 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

What We Don’t Know about the CAA

- **Whether the benefits of spatially differentiated standards exceed the costs**
  - **Is spatial variation in regulatory stringency (fuel content regulations and differential emission standards in Non-Attainment counties) justified on benefit-cost grounds?**
- **Magnitude of Net Benefits from the CAA**
  - **Ex post studies usually focus on specific regulations; more difficult to develop a causal estimate of the net benefits of the CAA comparable to EPA’s 812 studies**
- **Distributional Consequences of the CAA**