

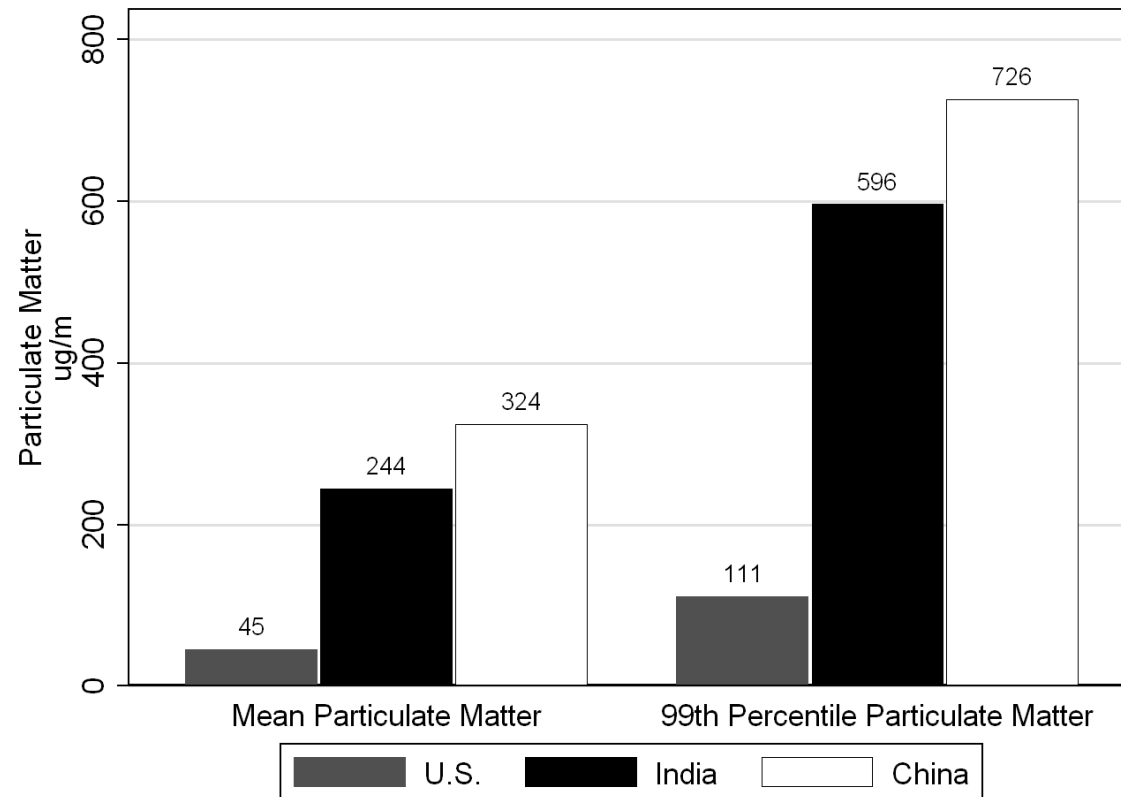
Have Environmental Regulations Worked? Evidence from India

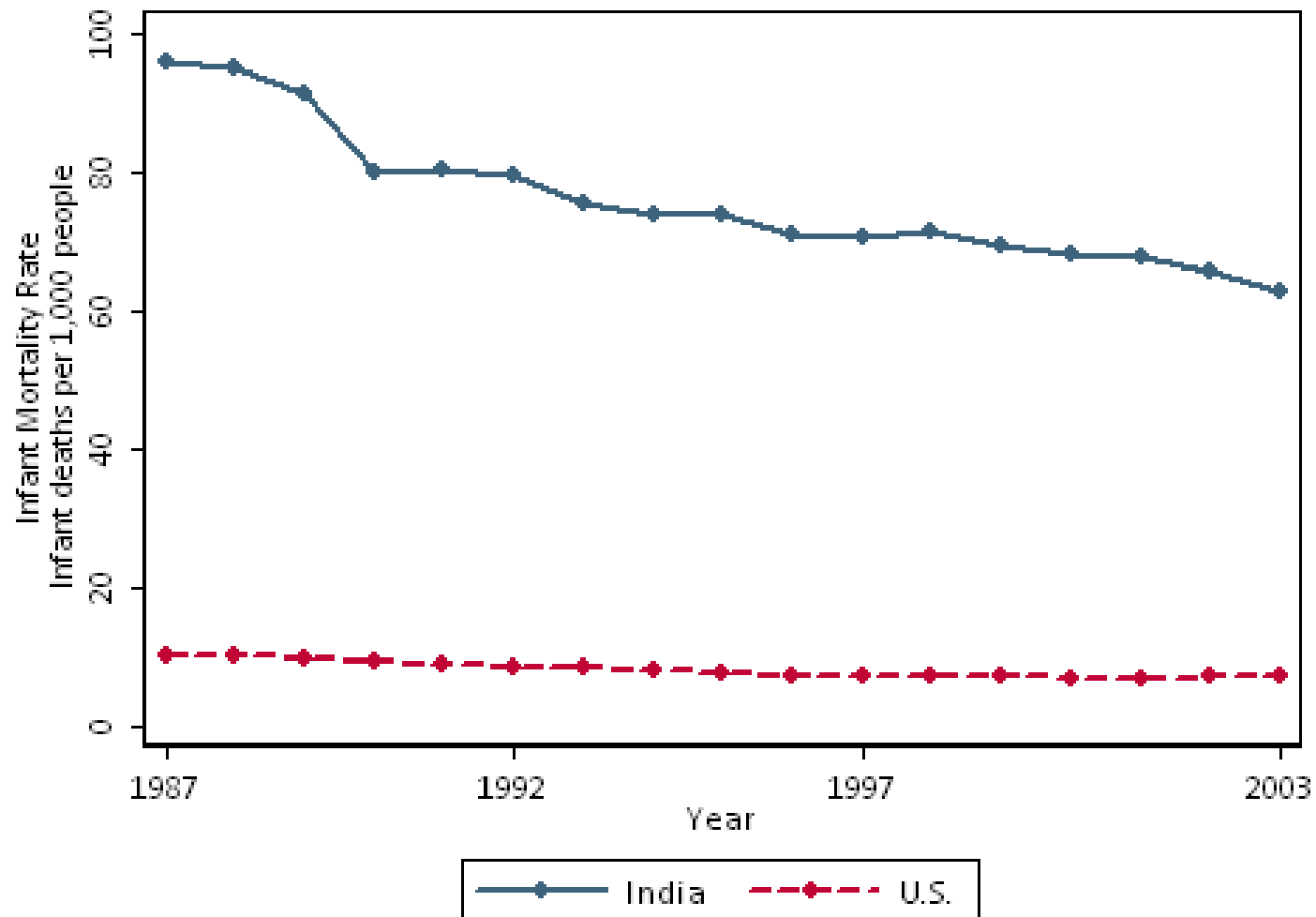
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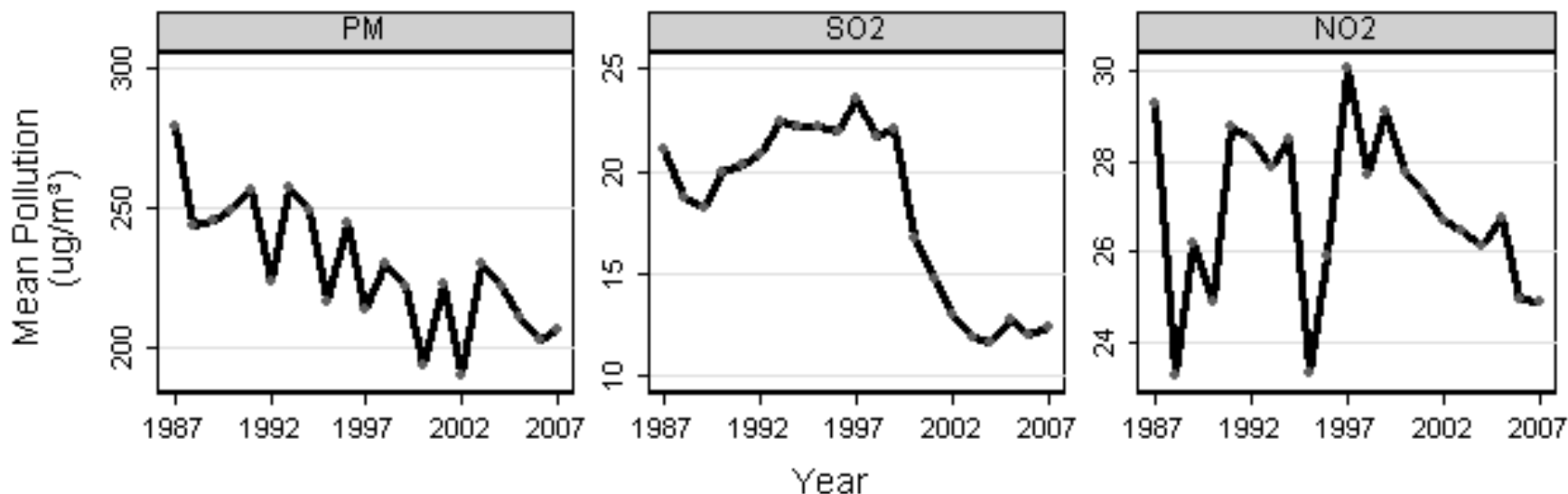
Motivation

- Air and Water Pollution levels in the developing world dwarf those in developed countries



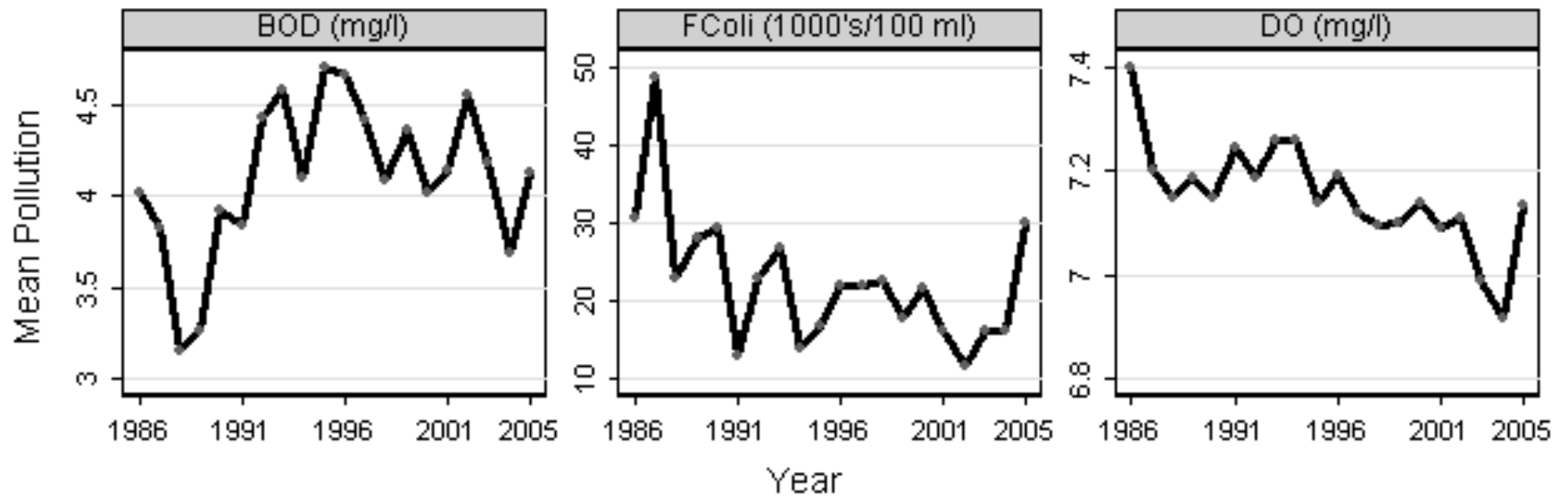


- Worse health outcomes



Trends in Air Pollution

- PM falls 17 percent from 252 $\mu\text{g}/\text{m}^3$ in 1987-1990 to 210 $\mu\text{g}/\text{m}^3$ in 2004-2007
- SO₂ falls 37 percent from 19.4 to 12.2 $\mu\text{g}/\text{m}^3$
- NO₂ roughly constant



Trends in Water Pollution

- BOD worsens
- FColi improves
- DO worsens

Questions and Motivations

- Did India's Environmental Regulations Contribute to these Trends?

Background on Environmental Regulations in India

- India's History of Environmental Regulation Began with:
 - Water Act of 1974
 - Air Act of 1981
- Analysis Focuses on 3 Key Policies

1. Supreme Court Action Plans

- Supreme Court mandated plans to reduce pollution in “critically polluted cities”
- Assigned to Delhi in 1996 and another 16 cities followed
- Actions are specific to each city:
Formation of CNG supply company,
closure/movement of certain factories,
phase-out of older vehicles,
Implementation of vehicular emissions standards

2. Catalytic Converters

- Required Installation of Catalytic Converters on all new Petrol-Fueled Cars
- 4 Cities in 1995; 45 Additional Cities in 1998
- Some issues:
 - Requires availability of unleaded fuel but not widely available until 2000
 - Stories of inconsistent implementation

3. National River Conservation Plan

- Begun in 1986 under the name Ganga Action Plan (Phase I), and then expanded to other rivers.
- Applied to Approximately 40 Cities
- Centerpiece of plan is Sewage Treatment Plants (STP): The interception, diversion, and treatment of sewage through piping infrastructure and treatment plant construction has been coupled with installation of community toilets, crematoria, and public awareness campaigns to curtail domestic pollution

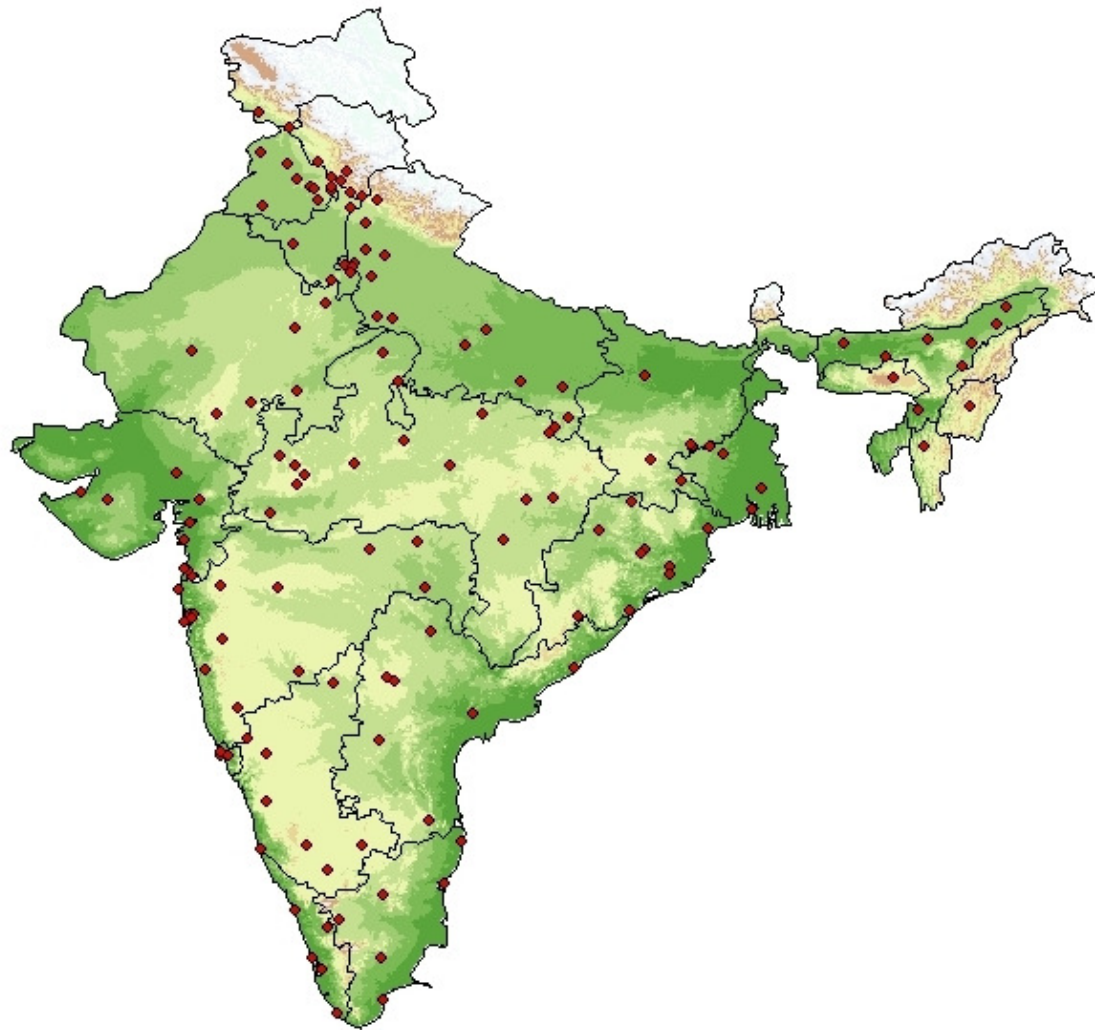
Background on Environmental Regulations in India

- Due to Data Limitations Could not Evaluate:
 - Restrictions on Sulfur in Fuel
 - Problem Area Action Plans

Data Description

Air Pollution Data

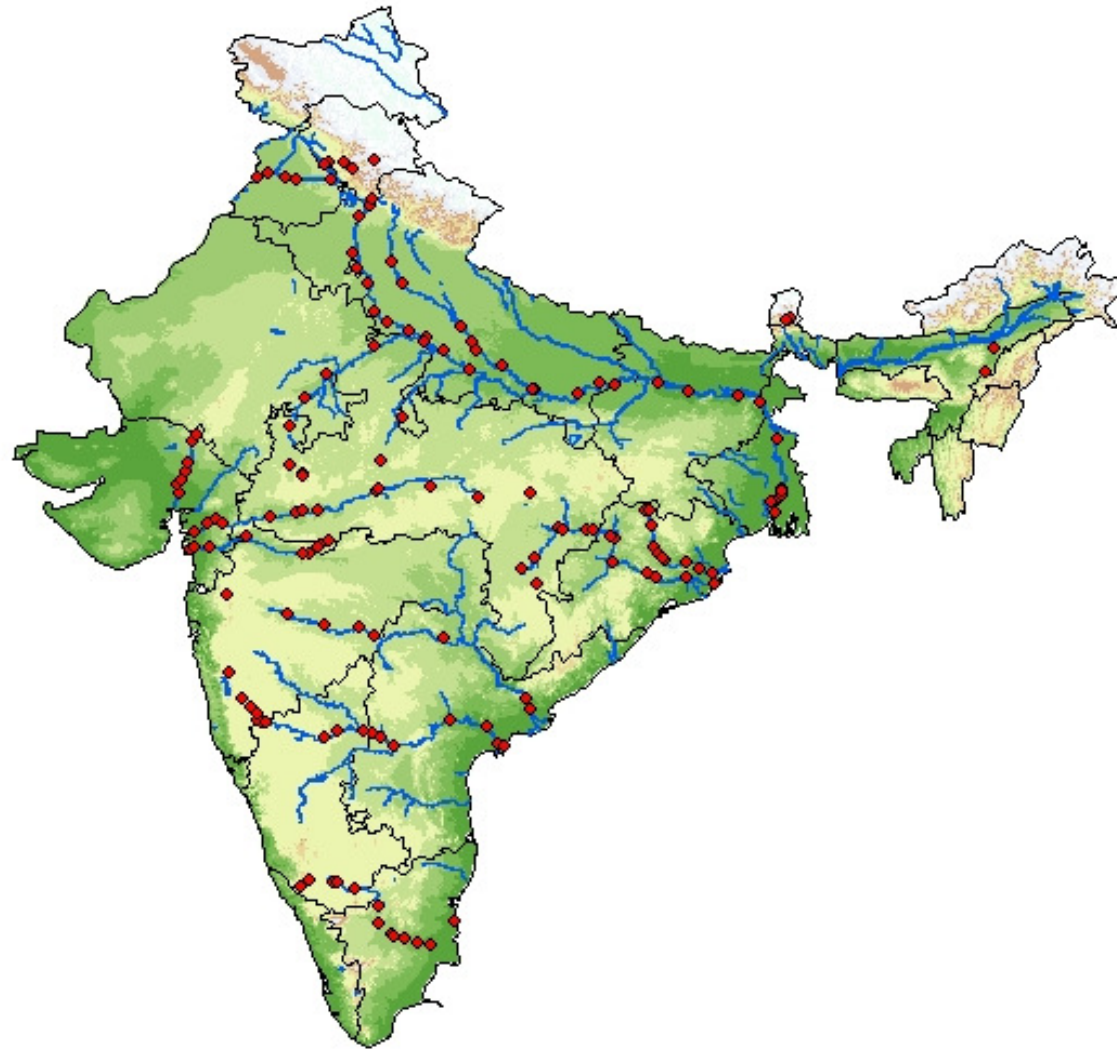
- Starting in 1987, India's Central Pollution Control Board (CPCB) compiled Air Pollution readings
- In total, the dataset includes 572 monitors in 140 cities from 1987-2007
 - Varies by year: 20 cities in 1987, while 120 are included in the 2007 data
- Three Pollutants:
 - Particulate matter with diameter less than 100 μm (PM):
 - Sulfur Dioxide (SO_2)
 - Nitrogen Dioxide (NO_2)



Air Monitoring Stations

Water Pollution Data

- 1986-2005 River data from National Water Monitoring Programme
 - 104 Cities in 1986
 - 395 Cities 2004 monitors in 424 cities along 162 rivers between the years 1986 and 2005
- Focus on 3 Measures of Water Pollution
 - Biochemical Oxygen Demand (BOD)
 - Broad indicator of water quality that measures that the quantity of oxygen required by the decomposition of organic waste in water
 - Fecal Coliforms (FColi)
 - Number of coliform bacteria present in water; measures human and animal waste and therefore indicator of domestic pollution
- Dissolved Oxygen (DO):
 - Measures the amount of gaseous oxygen (O₂) dissolved in an aqueous solution



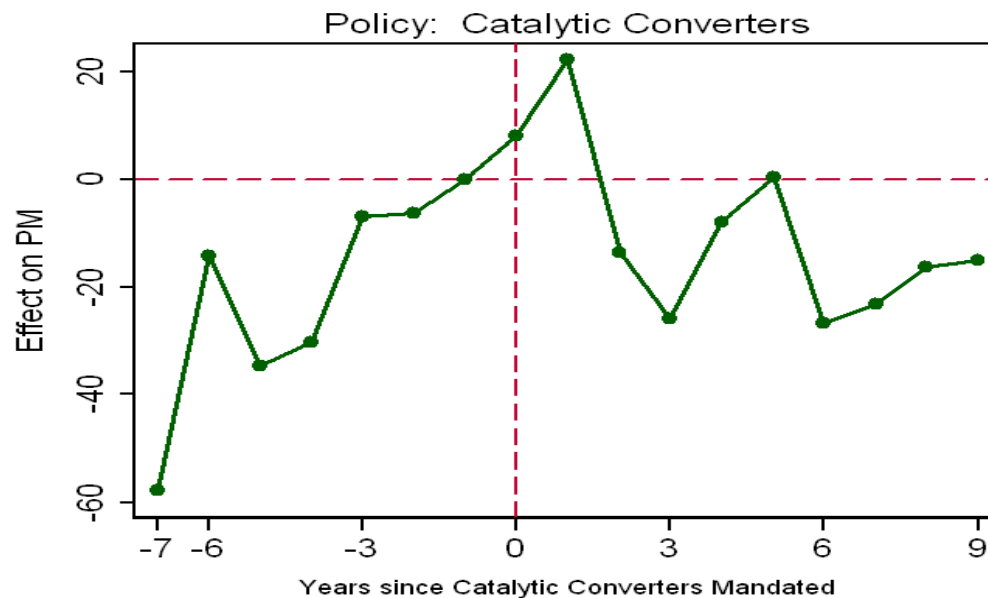
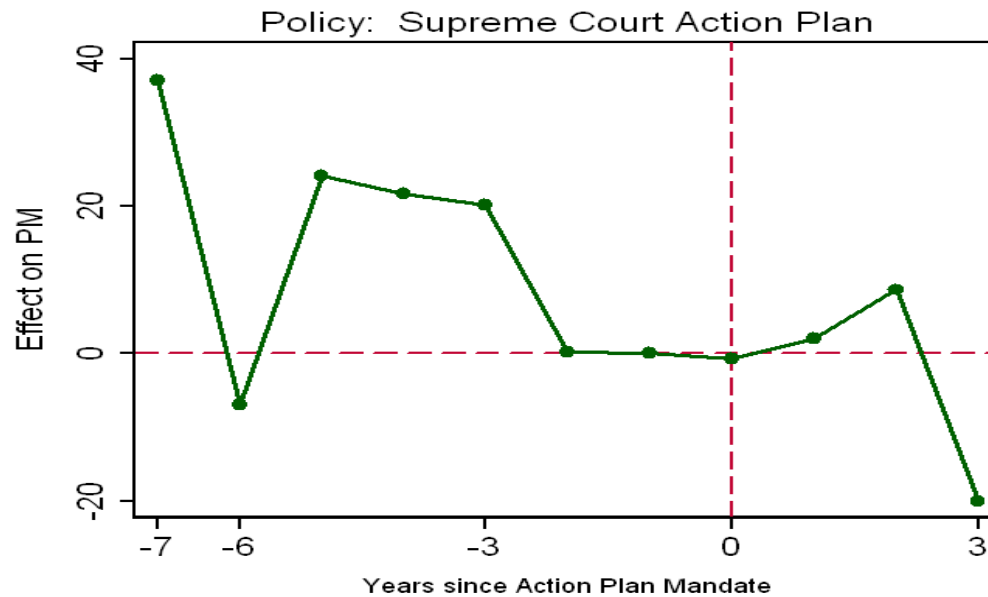
Water Monitoring Stations

Analysis

- Exploit the Differential Implementation of these Policies to Test for their Impacts on Air and Water Pollution Concentrations
- Compare Changes in City-Level Pollution Before and After Implementation of Policies
- Control for National Changes in Pollution

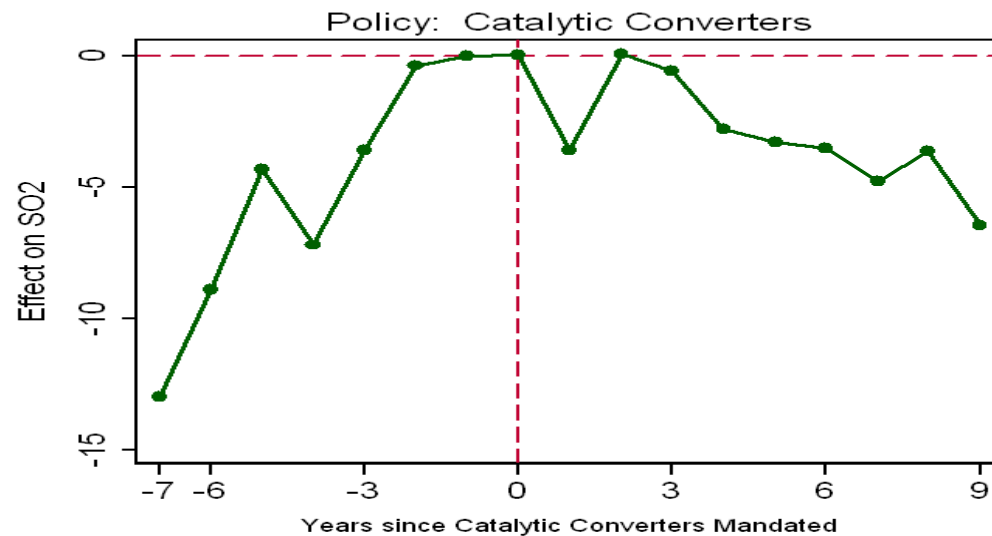
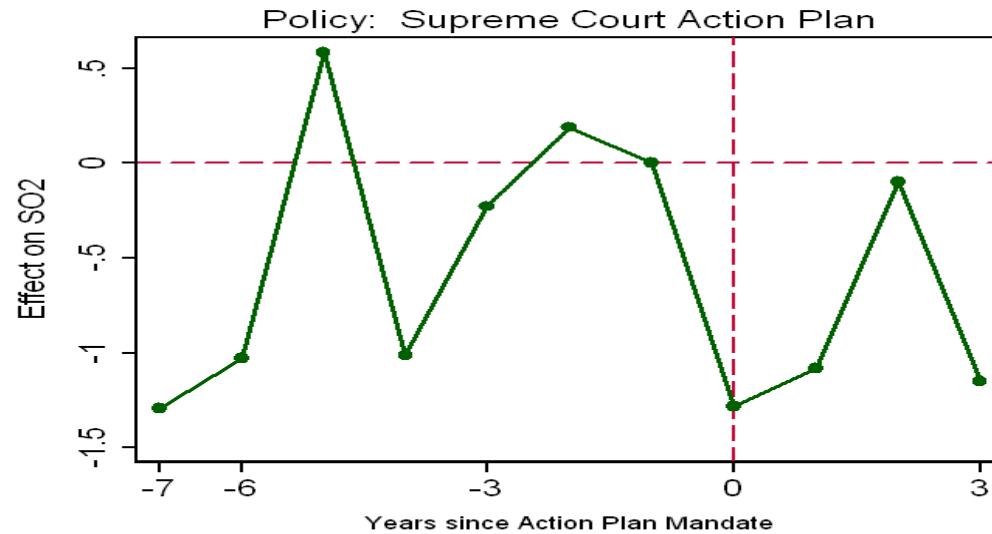
Findings: Air

Particulate Matter



- No Effect of SCAP
- Catalytic Converter Policy Associated with PM Reduction

Sulfur Dioxide

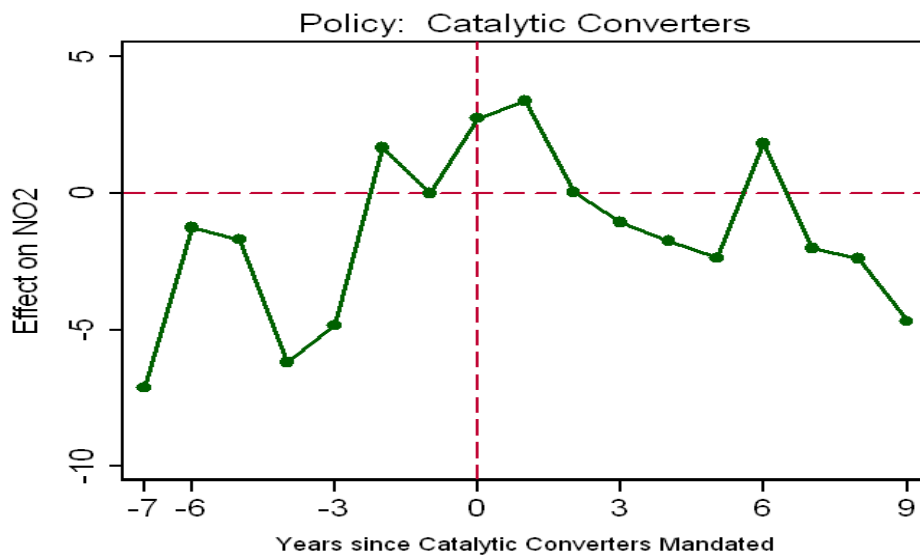
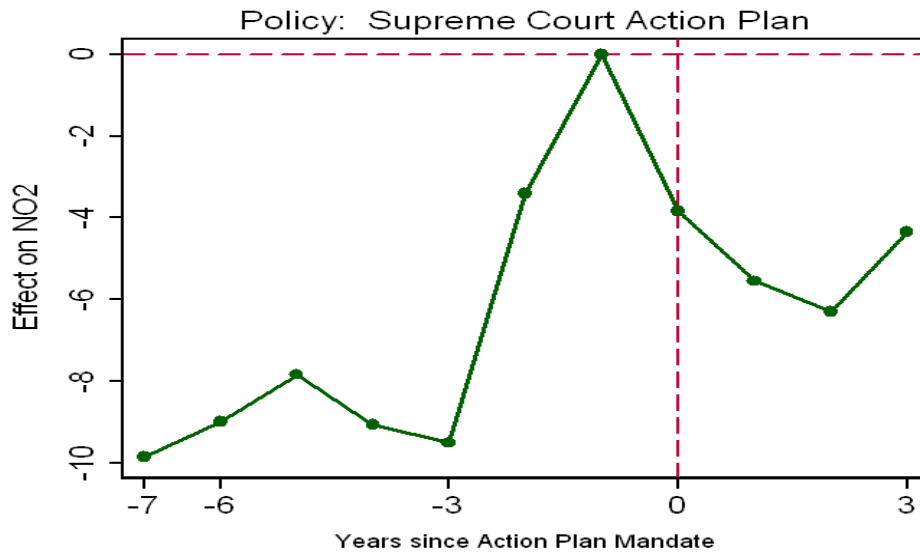


- No Effect of SCAP

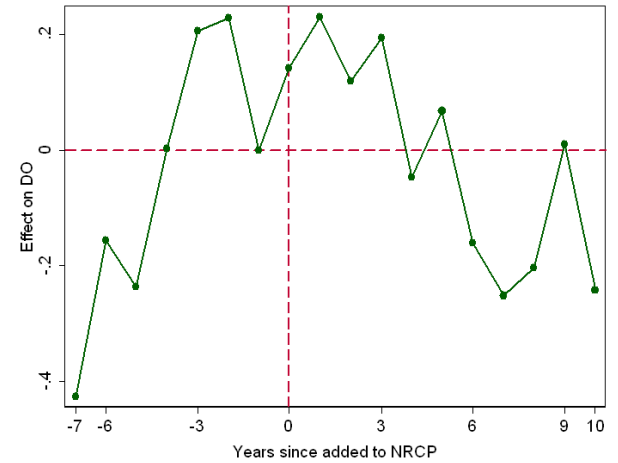
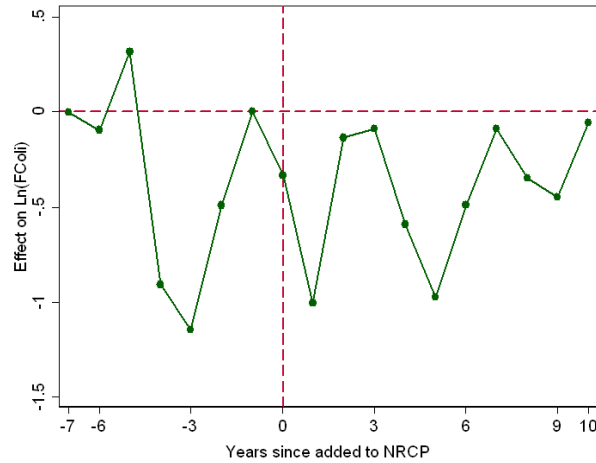
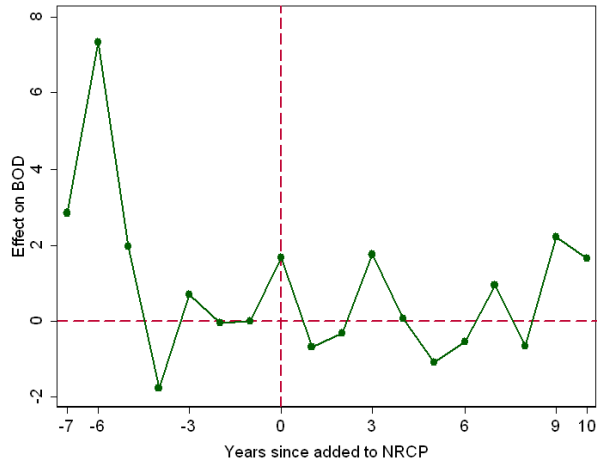
- Catalytic Converter Policy Associated with SO₂ Reduction

NO₂

- SCAP and Catalytic Converter Policies are Weakly Associated with Declines in NO₂



Findings: Water



Little Impact of National River Conservation Plan

→ Some Evidence of an Association between Policy and Worsening of Water Quality

Conclusions

Summary

- Catalytic Converter Policy was Successful in Reducing Air Pollution Concentrations
- Supreme Court Action Plans had Little Impact on Pollution Concentrations
- National River Action Plans had Little Impact on Air Pollution

Tentative Explanation for Relative Success of Air Policies

- Air Regulations Mandated by Supreme Court, while Water was Initiated by Government Bureaucracies
 - Political Legitimacy of Supreme Court
 - Jurisdiction for Water Policies is Less Clear.
 - Funding Problems. As of March 2009, 152 of 165 Cities Approved for Sewage Treatment Plants But Only 82 Have Built Any Capacity Clear.
 - 2006 Treatment Capacity was Only 18.5% of Full Sewage Burden