# Making Environmental Regulation Effective: Experimental Evidence from India

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Gujarat Pollution Control Board

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# Overview

- Context
- Evaluation
- Data
- Results
- Research Into Action

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# The Importance of Effective Environmental Regulations in Developing Countries

1. **Less pollution means longer, healthier lives.**

- Chen et al (2013) document substantial losses of life expectancy due to particulates air pollution in China.

# The Importance of Effective Environmental Regulations in Developing Countries

## 2. Regulation too frequently ineffective in developing countries.

- Greenstone and Hanna (2013): mixed record of success in enforcing environmental regulations in India

# The Importance of Effective Environmental Regulations in Developing Countries

## 3. Climate Change

- Projected mortality costs of climate change very high in India (Burgess et al. 2013)
- Developing countries responsible for most of the projected increase in greenhouse gas emissions
- International Climate negotiations appear to be moving toward model where countries will set and enforce their own targets

# Industrial Pollution in Gujarat

- **Gujarat is a highly industrialized state**
  - 19% of all manufacturing output, 5% of population (60 million)
  - Home to top 3 industrialized districts in India
- **Extremely high water and air pollution**
  - Contains 3 of 5 of India's most polluted rivers
  - Every large city violates air quality standards

# Context: Regulatory Framework

- **India has a stringent regulatory framework, further strengthened by recent court orders.**
  - Water Pollution and Control Act of 1974.
  - Air Act of 1981, Patterned after US Clean Air Act.
  - Delegated enforcement to State Pollution Control Boards.

# Context: Enforcement

- Gujarat Pollution Control Board regulates about 20,000 plants through command-and-control regulation

- Regulator powerful: Penalties include bonds against future performance and closure enforced by disconnecting electricity or water

# Context: Enforcement

- Gujarat Pollution Control Board has two primary tools for monitoring compliance:
  - Regulatory inspections
  - Third-party audits

# Context: Environmental Audits

But, third-party auditing system creates conflict of interest, because firms hire their auditors.

→ The auditors' interest may not be perfectly aligned to report the truth.

Gujarat installed several safeguards including:

- Auditors cannot consult for the same plant
- Rotation mandated every three years
- Audit teams must be comprised of four people with particular degrees and experience

# Context: What is an audit and what are its consequences?

## What is an Audit?

- Auditors visit three times per year
- Submit annual report with pollution readings and suggested improvements in operations

## Consequences

- Non-submission or non-compliance is punishable, in principle, by closure and disconnection of water and electricity
- False audits can lead to auditor decertification

# Context: Qualitative description of auditor market

**Strong price competition**

- In our sample, cost of conducting an audit is roughly 40K INR
- Audits can be purchased for INR 24K on average

**Audit quality**

- Regulator suspicious of audit quality
- Regulated plants sued to end audits on the grounds that GPCB was not acting upon the audit reports

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# Evaluation

**Sample:** All audit-eligible plants from GPCB regions in and around Gujarat's two most populous cities.

- Two year experiment: 233 of 473 plants assigned to audit treatment at start of first year for both years
- All interested GPCB certified auditors were included

# Evaluation

**Treatment has four components:**

1. Random assignment of auditors to firms
2. Financial independence. Fixed payment from central pool.
3. Monitoring of auditors.
4. Accuracy incentives for auditors (year 2 only).

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# Data: Three Sources

- Auditor reports of Pollution Readings
- Backcheck reports
  - Measure the same pollutants at the same plant within several weeks.
- Survey for final pollution outcomes. About 6 months after end of treatment (April-July 2011).

# Reporting outcomes for important pollutants

- Water pollutants: BOD, COD, TDS, TSS, NH3-N
- Air pollutants: SO2, NOx, SPMg.
- Pollutant readings standardized throughout the analysis

# Final-outlet water and boiler-stack air samples

## Water sampling

## Stack sampling

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# Results

1. Reporting was corrupt under status quo.

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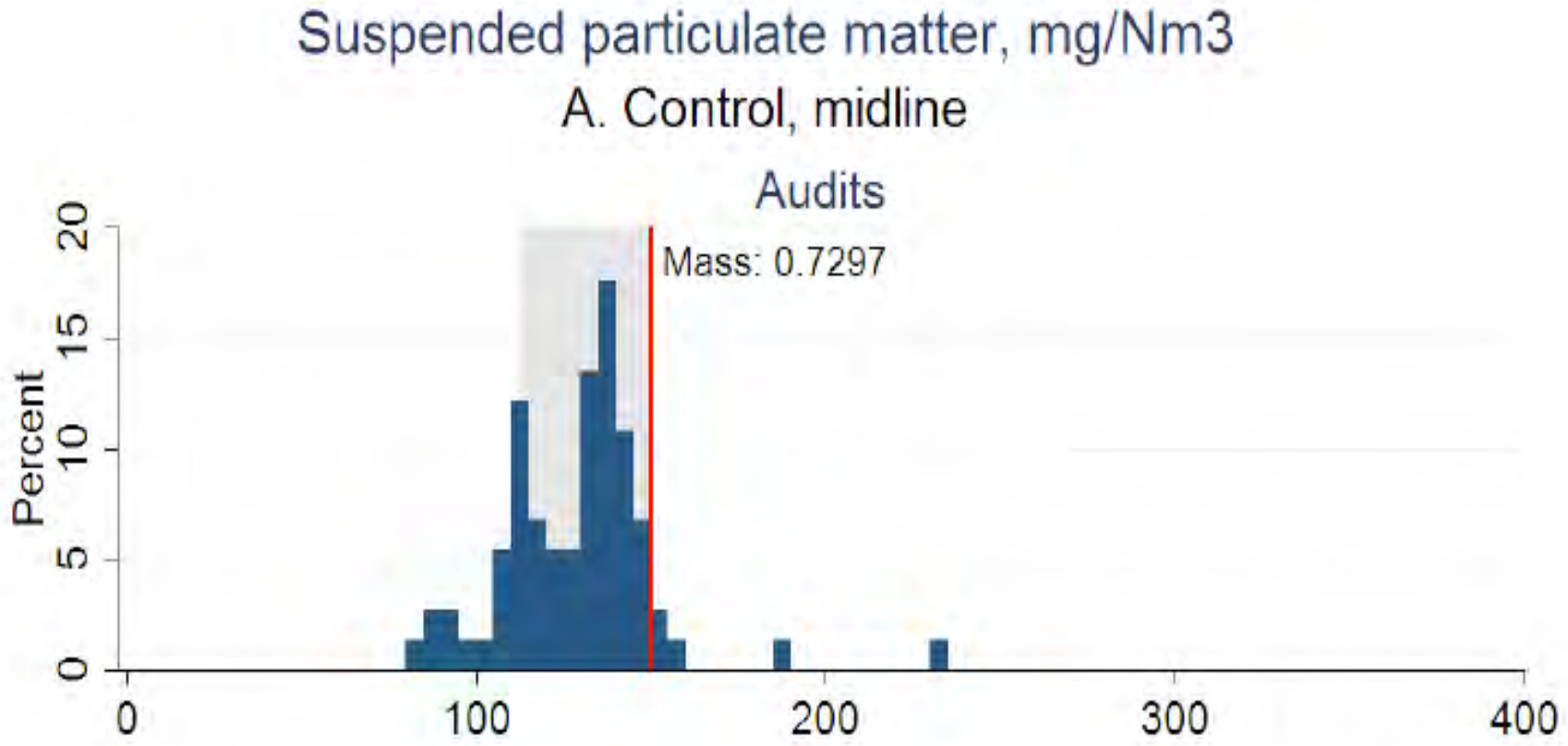
**Figure :** Control: Audit Readings for Suspended Particulate Matter (SPM)



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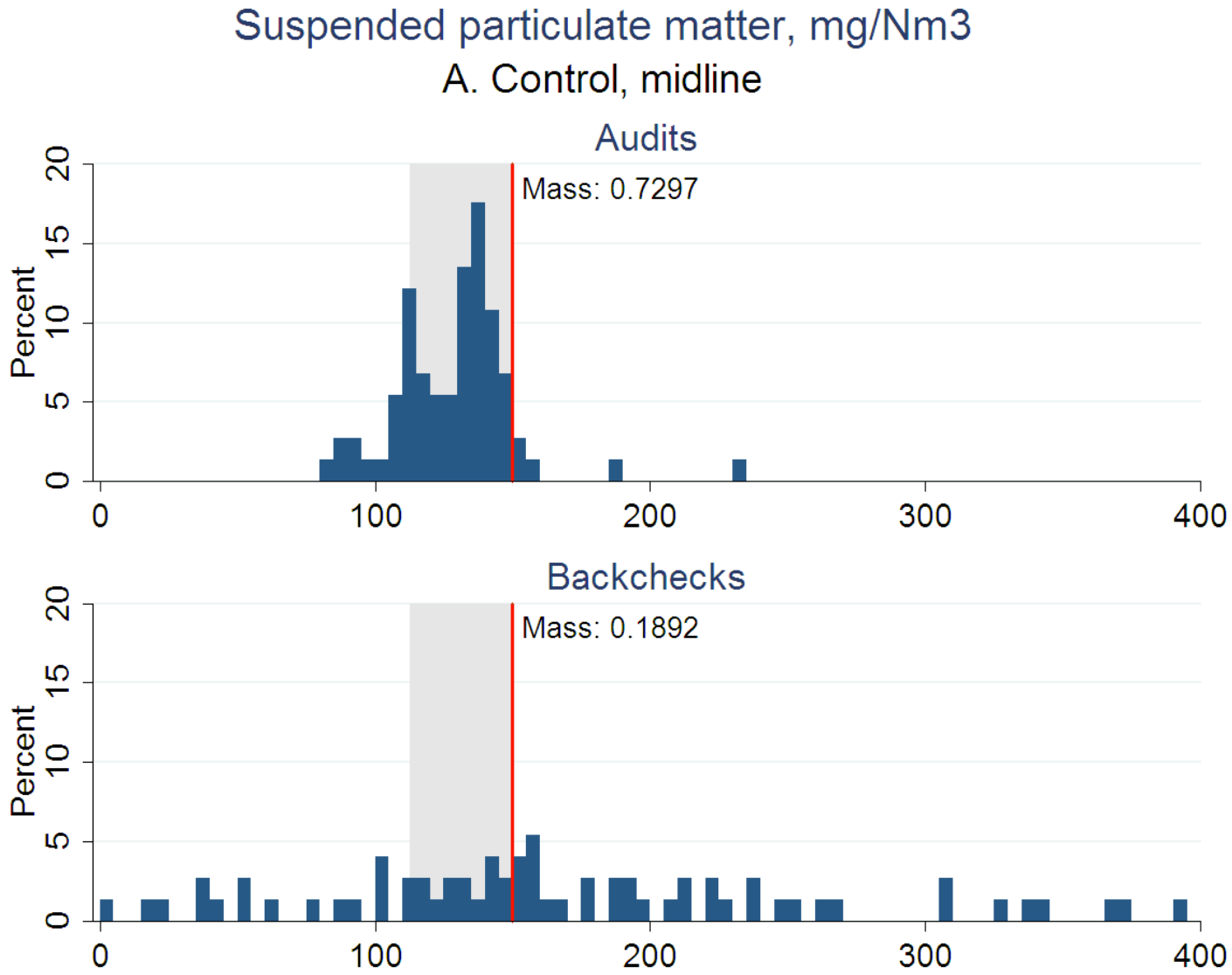

# Results

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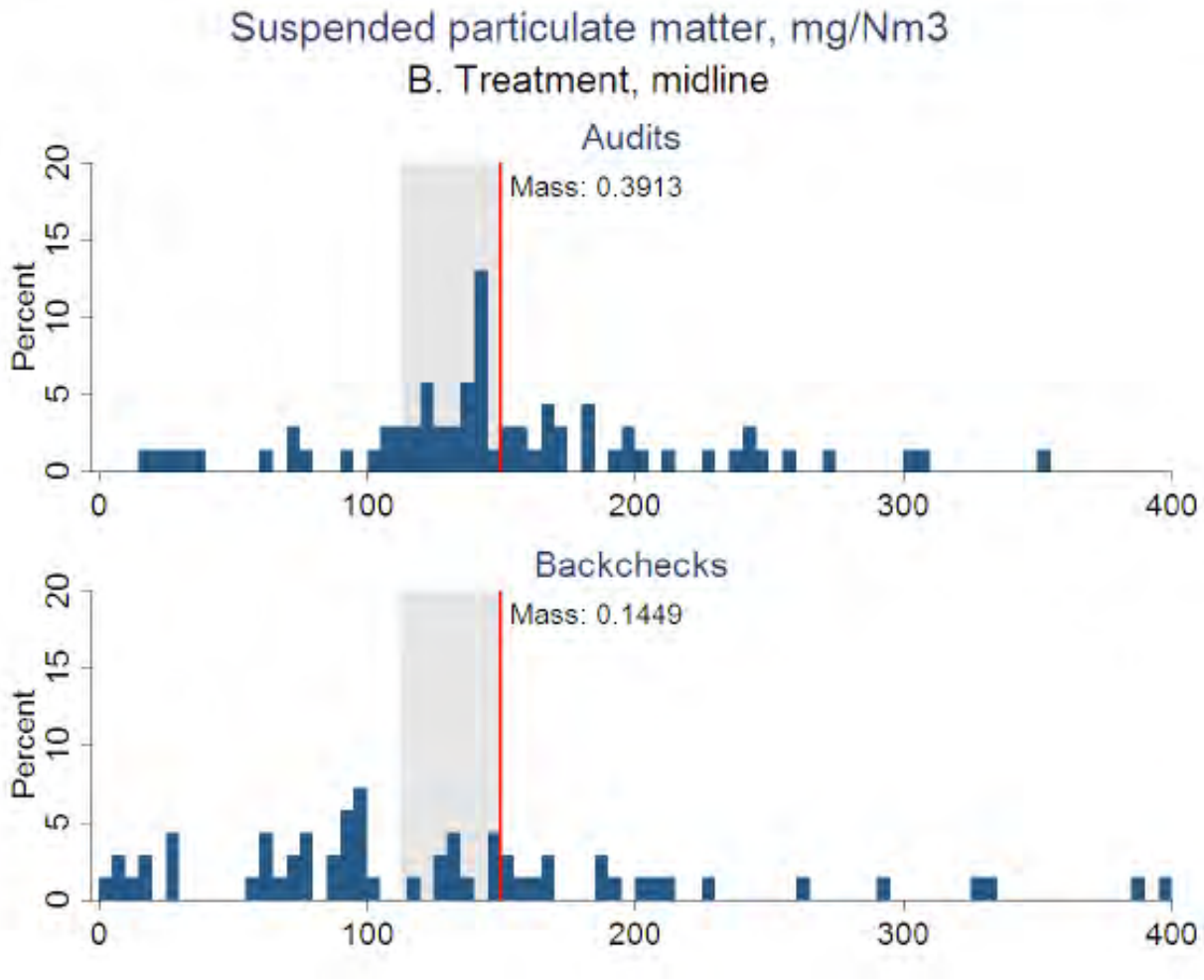
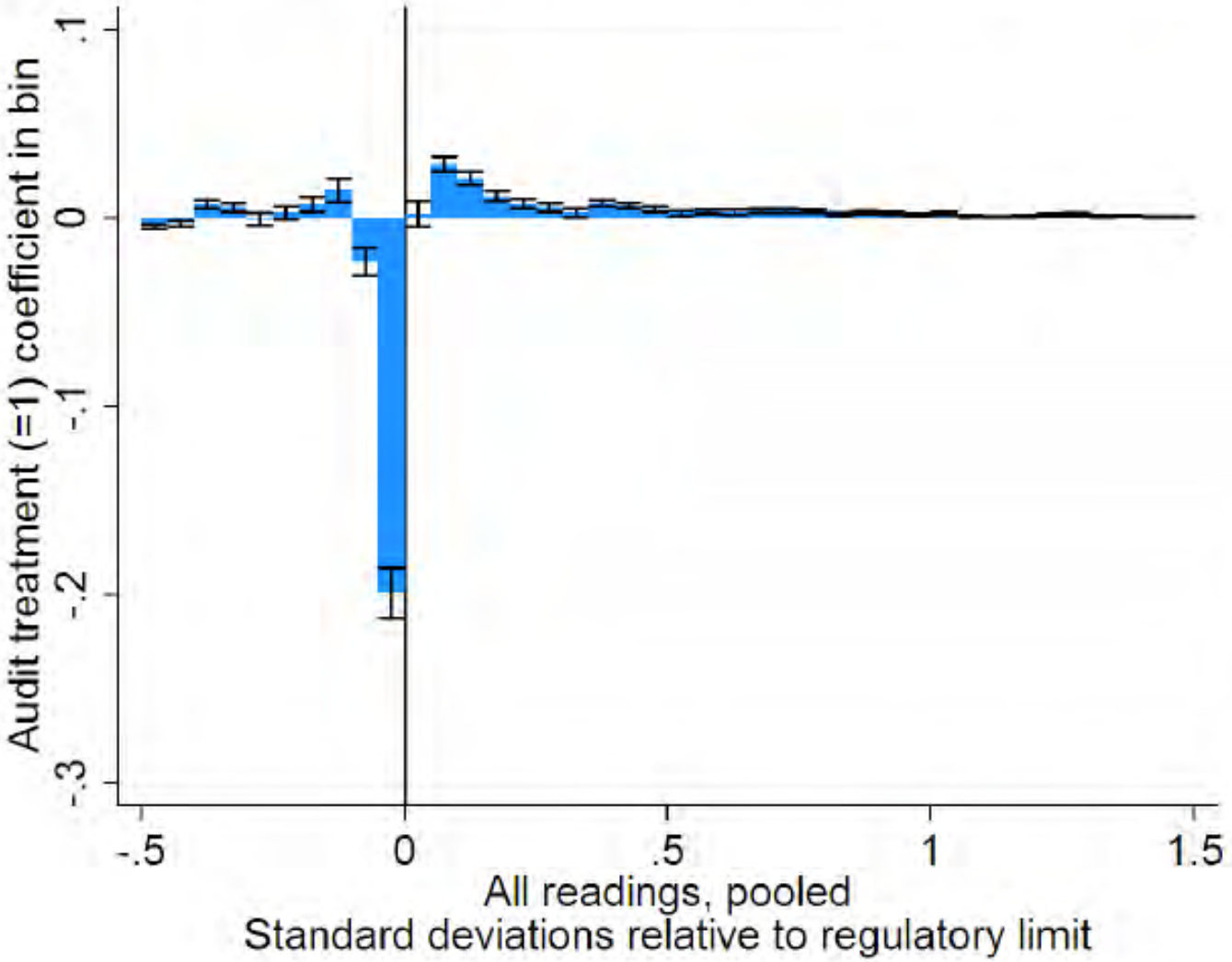


**Figure :** Audit Treatment Effect in Density Bins, All Pollutants



# Results

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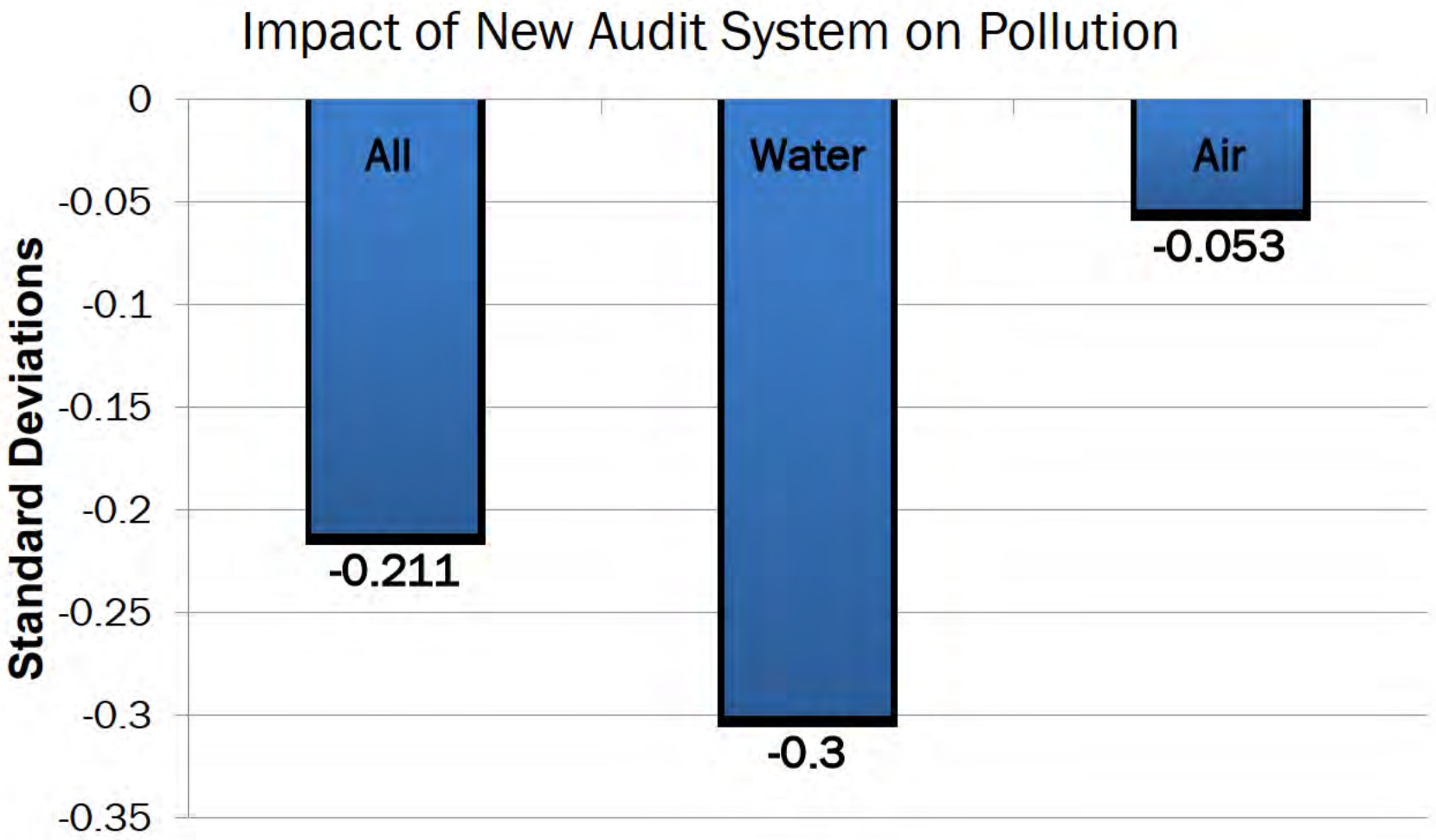
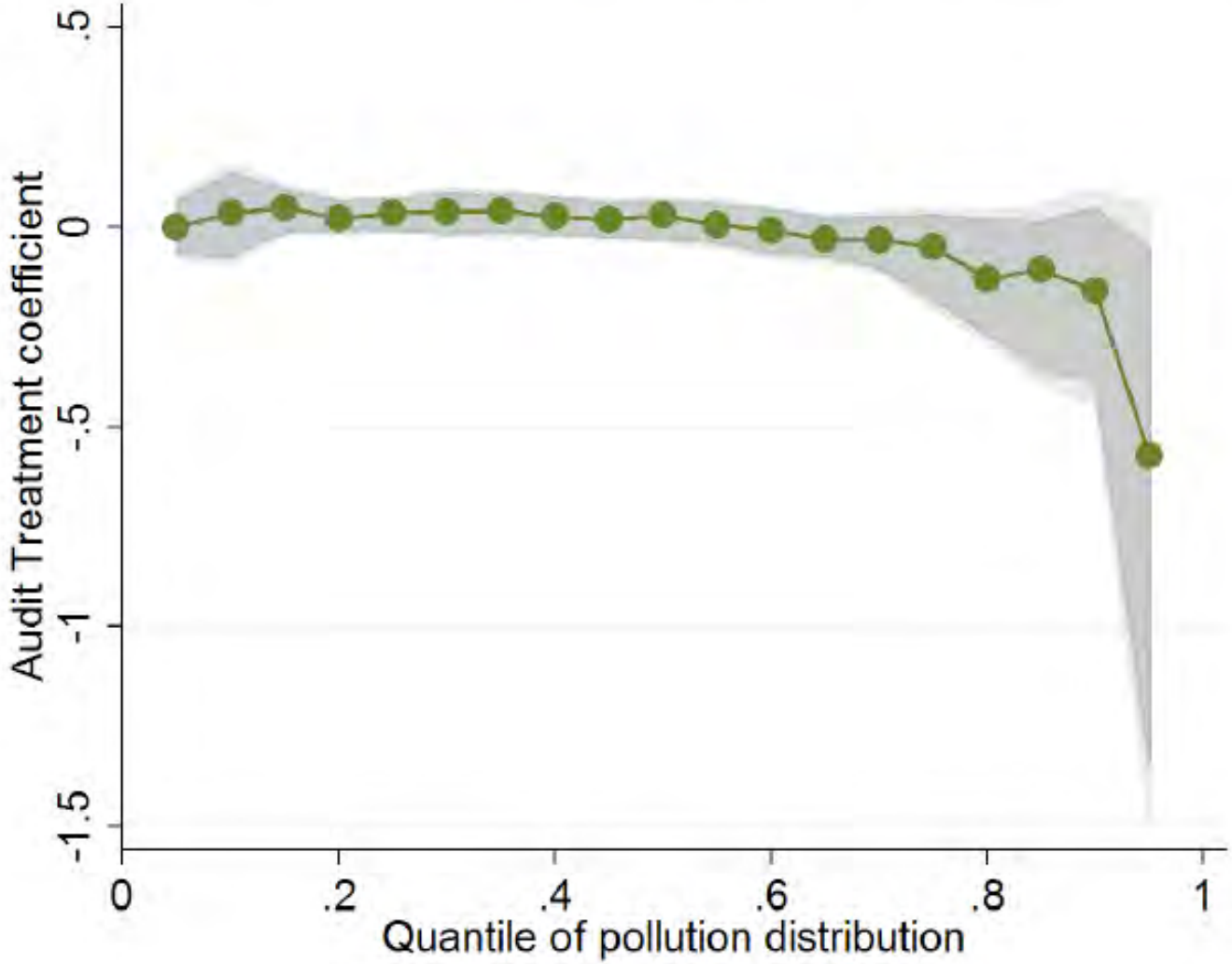


**Figure :** Quantile Regression Effects of Treatment on Endline Pollution



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# Research Into Action

Presented Gujarat Pollution Control Board with 3 recommendations:

1. Randomly assign auditors to plants
2. No negotiation between auditors and plants on their fees
3. Monitor auditors reporting through back-checks

# Research Into Action

- GPCB is changing its audit policy in response to this evidence
  - Hardik Shah (Member Secretary, Gujarat Pollution Control Board) will speaking next to explain the details

# Research Into Action

A continuing collaboration:

- Continuous emissions monitoring (CEMs)
- An emissions trading system for particulate matter—the first ever evaluations of market-based environmental regulation in a developing country


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TRANSLATING RESEARCH INTO ACTION

# Gujarat Pollution Control Board Experience with Randomized Evaluation: Improving Industrial Pollution Control

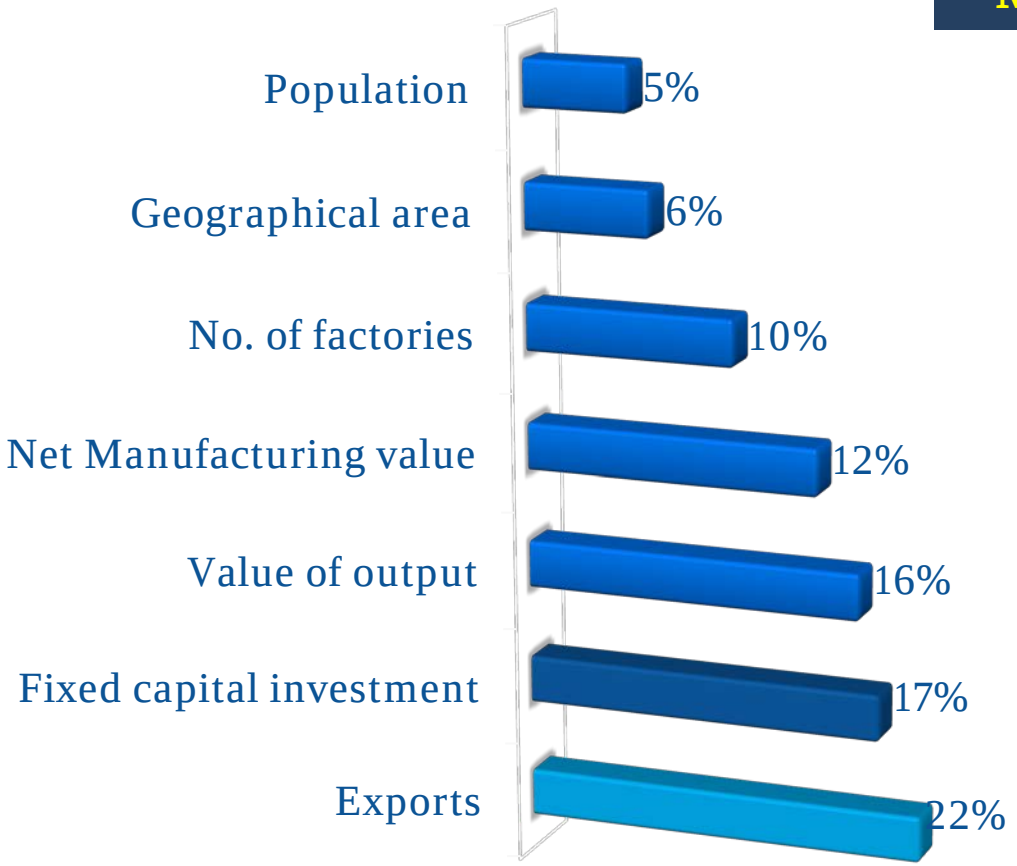
**Hardik Shah**
Member Secretary
Gujarat Pollution Control Board

E2A, CEGA, UC Berkeley
25 April 2013

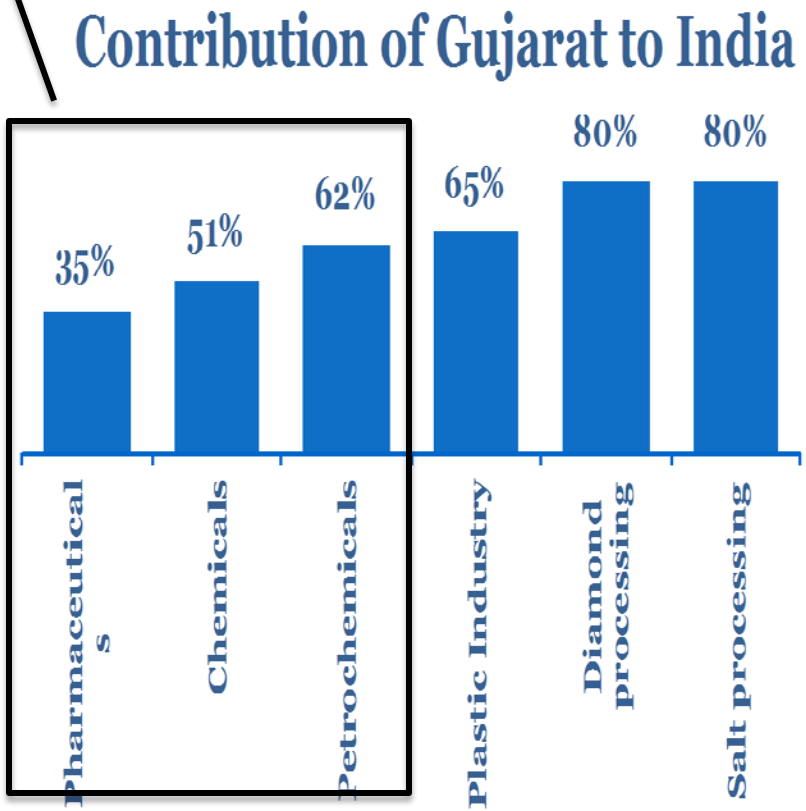
# *Gujarat – Rapidly Growing State in India*

# *Important Contribution to Indian Economy*

## Gujarat's share in India




**Pose Challenges for Environmental Management and pollution control**



# Challenges to Regulating Industrial Pollution

GPCB's monitoring of industrial emissions includes two strategies:

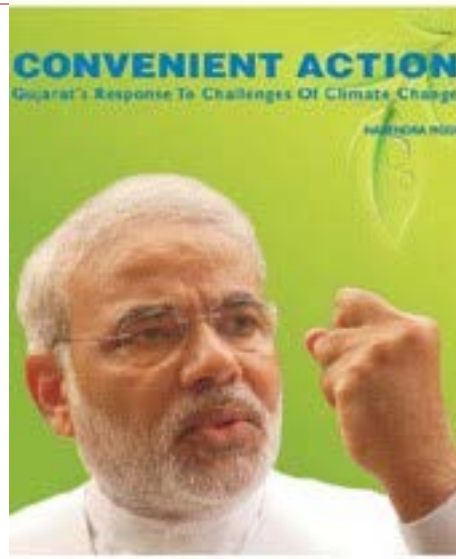
- **Regulatory inspections of industrial plants**
  - However, in the face of high industrial growth, staff time constraints limited GPCB's in-house capacity to expand inspection operations
- **Court-mandated third-party environmental audit programme**
  - However, concerns about auditor objectivity exist, since industry selects and pays private auditors
- GPCB tested two innovative solutions to these challenges
- GPCB partnered with external evaluators to measure the impact of changing these two programmes

# Court-mandated audits

- The intention had been for the 3rd-party audits to reduce GPCB's regulation burden and monitor industries from a different angle
  - But it wasn't working satisfactorily
- After a decade, suits were filed to scrap the scheme
- NEERI [National Environmental Engineering and Research Institute] wrote a report that emphasized the need for auditing system, but suggested the need for improvement
- In this context, to partner with the researchers to rigorously test the new innovations was timely action

# Partnering on the research

- Why did we decide to partner on this research?
  - State is committed for environmental protection
  - We knew the system wasn't working satisfactorily, and we wanted objective outside research that would provide convincing proof to change what was needed




- How did we partner and initiated the actual research?
  - Wrote a formal agreement for the proposed research
  - Held meetings with auditors to explain the new system and objectives of research
  - Initiated working together : GPCB and Researchers to evaluate the current policies and generated evidences

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# 3 Recommendations from the Research

1) Randomly assign auditors to the firms, instead of letting firms choose their auditor
2) No negotiation between auditors and firms on their fees
    a) Pay auditors from central pool, or
    b) Have fixed fees based on the work needed and software decides payment
3) Introduce random backchecks to auditing system

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# Using evidence for policy change

- The preliminary results from this evaluation were shared with GPCB officials and third-party auditors during a conference at GPCB in August

- Auditors suggested that adopting parts of the modified audit programme permanently would improve the quality of work they are able to provide

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# From recommendations to policy change

**How do we move from recommendations to policy change?**

- Step 1: Changes need to be decided by the board of the Gujarat Pollution Control Board
- Step 2: Any major changes have to be approved by the high court, since the auditing system began as a court mandate

# Taking the recommendations to the board

All three of the recommendations were approved by the board.

This is very unusual. Why did it happen in this case?

- The results were very clear, transparent, and persuasive
- It was clear that this would help GPCB

Broader application:

- Other Auditing systems may also test this idea

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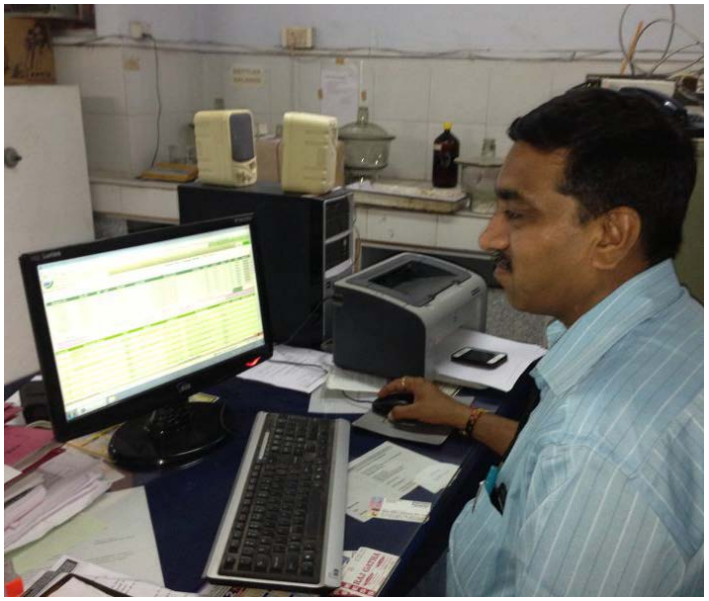
# Changing policy in practice:

- Building new modules into the software (XGN) that we use to track and manage all interaction with firms

Example:

- Introducing random backchecks this summer
  - Audit firms will feed their monitoring schedule into software (XGN)
  - The XGN will randomly select when to do a backcheck and then assign work for back-checks



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# Changing policy in practice:

Example:

- Also building a new module in the XGN that can
  - randomly assign auditors to firms (And require at least 2 years between audits by the same Auditor)
  - Decide the fees of audit based on the work required to be done by the Auditing firm
  - This may require the Hon'ble High Court consent

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# A Continuing Collaboration

- GPCB is partnering with researchers to test another pilot programme for Air Pollution Regulation with two components:
  - Continuous Emissions Monitoring System (CEMs)
  - Emissions Trading System (ETS)

- Currently working on designing a new randomized evaluation that will test a market-based approach for regulating water quality

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