Regulatory Innovations: Creating Environments for Entrepreneurship in Developing Markets

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The State and the Economy

- Governments participate in many ways in the economy
  - It can directly control the production of goods and services through state-owned enterprises
  - It can procure goods and services from private companies
  - It can regulate private companies on behalf of consumers
- The extent to which it does these things fluctuates over time.
Types of Regulation

• We distinguish between economic and Environmental Health Safety regulation.

• Economic regulation usually involves regulatory commission oversight
  • Price setting
  • Entry restrictions
  • Service obligations
  • Cost and investment oversight

• EHS regulation is typically “command-and-control”
Regulation and Entrepreneurship

- Both types of regulation are likely to influence entrepreneurship
- Belief that in low-income settings, limited information, credit constraints and weak institutions imply that regulation often constrains entrepreneurship
- .. or, atleast, causes entrepreneurship to depend on the behavior of social, political and regulatory actors

**Research Agenda:**
- What shapes the behavior of these actors?
- How do we identify mechanisms that regulate while enabling entrepreneurs in private, social and political spaces to innovate and make these spaces work better?
Talk Overview

- **India as the testing ground**
  - Average quarterly GDP growth of 7.45% (since 2000; except for last quarter!) *yet* home to a third of the world’s poor.
  - The world’s largest democracy *yet* estimates suggest over 1% of GDP is annually pocketed as bribes.

- **Use field experiments to ask:**
  - Does the design of financial products (and economic regulation) influence entrepreneurial incentives? The case of microfinance
  - Can EHS regulatory innovations create an environment where firms can profitably choose to invest rather than pay bribes? The case of pollution standards
Outline

1 Introduction

2 Improving Incentives for Social Entrepreneurship

3 Improving the Regulatory Framework
   Reducing Opportunities for Corruption

4 Introduction: Third-Party Auditing
   Background on environmental regulations

5 Experimental Design

6 Model of Auditor Reporting
   Set-up
   Solution
   Experiment

7 Data and Empirical Strategy

8 Results on Auditor Reporting

9 Policy Relevance
The Case of Microfinance

• Microenterprises employ a substantial fraction of the poor
• Lack of credit widely cited as key constraint on growth.
• Microfinance as the great hope? In 2008:
  • Over 150 million MFI borrowers and over 43 billion USD in outstanding loans to self employed poor entrepreneurs
  • High repayment rates on collateral free loans
  • Debt contract typically designed by MFI who faces limited regulatory oversight but uses capital markets for liquidity
Microfinance: From promise to performance

- Recent studies find widespread use of microfinance for consumption and very small (if any) impacts on average business growth and poverty reduction.

- Media coverage and policy concern about financial distress caused by onerous terms of repayment specified in debt contract.

- Growing discussion that regulatory oversight be increased: borrowing by the poor and interest rates should be capped.

- Our research (with Field, Papp and Rigol) suggests the opposite: Regulation needs to enable innovation by MFIs in offering a portfolio of financial products.
Can a small design change to the MFI contract influence entrepreneurship?

- Classic Grameen contract: Clients repay small amounts very frequently starting very soon after loan disbursement
- Our experiment evaluated the impact of introducing a grace period in the MFI debt contract.
- We worked with a large MFI in Kolkata and randomized 845 female borrowers into alternative contracts (average loan size per client 200 USD to be repaid over 44 weeks)
  - Control group (Classic Grameen Contract): Start repayment 2 weeks after loan disbursement
  - Treatment group: 2 month grace period before repayment
  - Once repayment began, all clients repaid the same amount on fortnightly basis
The Impact of a Grace Period Contract

• Case study evidence (a sari seller and Tailor) suggests profitable opportunities existed:

  • **Increase inventory** Needed to put aside less for initial repayments; by investing more was able to benefit from larger wholesaler discounts

  • **Greater willingness to take risks** Expand variety of saris being sold and travel to neighboring state to establish business connections.

• We study impacts on default and long-run impacts on profits and income (three years later)
Clients on grace period contract earn more.

**Figure:** Income and Profits (three years later)
Effects Economically Large

- Three years later weekly business profits and household monthly income for grace period clients were 33% and 18% higher

- Monthly return to capital: between 6% and 13%: Very similar to other estimates

- **But** they were also more than three times as likely to have defaulted on their loan

- Two questions: extent of heterogeneity (risk aversion (+), patience (+), wage-earner/saving (-)) *and* viability
Viability of Grace Period Contract

- By design we shut down selection. We calibrate a model of client selection (and behavior).

- Benchmark: interest rate that equalizes the profits from offering just a grace period contract with offering just a regular contract.

- Next, introduce selection induced by both the grace period contract and the higher interest rate required to equalize profits.

- Clients asked whether preferred GP or regular contract at equal interest rates. If GP contract, then increase hypothetical interest rate until report preferring the regular contract.

- If no moral hazard, we can use repayment data for clients who received GP contract and report preferring GP contract to calculate the fraction of the present value of the loan repaid.

- Finally incorporate moral hazard by allowing fraction repaid to vary with the interest rate of the grace period contract \( r \) (0.25% and 0.5%)
Simulation
MFI Incentives and Contract Design

• High repayment rates need *not* imply that socially optimal investments occur.

• Why are MFIs not offering a grace period contract?
  
  • Too much moral hazard?
  • Few incentives to Innovate Increasing interest rates broadly perceived as mission drift. Officially capping interest rates will further reduce incentives

• Default aversion: MFI credit rating in capital markets (where they raise funds) depends on achieving high repayment rates

• Open questions: Can regulators come up with better mechanisms to identify costs of lending? Can financing institutions be encouraged to consider other measures of entrepreneurial success?
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Industrial Growth and Pollution

- **High Pollution** Current air pollution levels in China and India exceed those ever recorded in any developed country. Likely to have significant health and economic costs.

- **Ineffective Regulation**: Low compliance with strict Air and Water regulations and widespread corruption.

- **Regulatory Challenge**: How can we improve functioning of the regulator so firms are able to remain competitive while investing in cleaner, more efficient technology, rather than finding it cheaper to pay a bribe?
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The promise of third-party auditing

- Third party audits are the norm in financial regulation
  - Public companies typically required to provide audited financial statements
  - In many countries credit-rating agencies determine regulatory capital (Bank of International Settlement Survey, 2009).
- And gaining importance in other sectors, such as environmental regulation.
  - Check compliance with domestic regulatory standards: either voluntary (US and UK) or mandated (India, Chile)
  - Enforcing international environmental standards like ISO 14001 and carbon offsets (Potoski and Prakash, 2005; Bhattacharyya, 2011).
- In all cases, the audited company hires and pays the auditor. There is a perception that this creates a conflict of interest for auditors needing to maintain their business.
But quality poor in many settings

- The Financial Crisis exposed severe problems
  - 80% of collateralized debt obligations rated AAA by Standard & Poor’s in 2005-2007 were downgraded to below investment grade by mid-2009

- As have International Accounting Frauds:
  - PriceWaterhouseCoopers complicit in Satyam Computer fraud in India, threatening confidence in outsourcing industry.

- And observational studies of environmental audits
  - Self reported self audits of firms in US show higher compliance than EPA audits (Pfaff and Sanchirico).

- Bolton et al. (2011) show that competition among CRAs can lead to rating shopping and rating inflation. Reputation for leniency can attract business when enough naive investors.
Experimentally remove the conflict of interest

- Work within environmental audit system in Gujarat, India (with Duflo, Greenstone, Ryan)
  - Introduced by High Court in 1996 to reduce water pollution.
  - At baseline in 2009, perception that pollution was high but audit reports low and untrustworthy.
  - Sample all audit-eligible plants in the state’s two largest cities.

- Audit treatment reforms three aspects of existing system
  1. Random assignment of auditors (prevents shopping) and fixed payment from central pool (financial independence).
  2. Backcheck auditors on performance (monitoring).

In year 2 of the experiment, additionally,
  3. Auditors paid for accuracy relative to backchecks (accuracy incentives).
Results show a huge impact on auditor reporting

1 Baseline
   • Auditors working in control systematically underreport, especially just beneath the regulatory standard.

2 Auditor response
   • Treatment reduces false compliance readings in audit reports by 23%.
   • Effects present within-auditor.
   • Backchecks and accuracy incentives have independent effects.

3 Plant response
   • Plants reduce pollution. Reductions for targeted water pollutants as large as the change in reporting by auditors.
Background on environmental regulations: India has a rich history of environmental laws

- Water Pollution and Control Act of 1974 created Central Pollution Control Board as coordinating body to set pollution standards and delegated enforcement to State Pollution Control Boards.
- Air Act of 1981 has many features patterned after the U.S. Clean Air Act.
- Greenstone and Hanna (2011) find some evidence that air regulations have been successful but little evidence that water pollution regulations have worked.
Background on environmental regulations:
Enforcement of regulations up to states

- Gujarat Pollution Control Board regulates about 20,000 firms.
- Strict regulatory standards set by Water and Air Acts may be tightened but not relaxed by states.
- Two main tools for monitoring compliance with regulations.
  - Regulatory inspections.
  - Third-party audits.
- Regulator powerful: Plants need regulatory consent for product, quantity, investment to expand capacity, etc. Penalties include fines (forfeit of guarantees) and closure enforced by disconnecting electricity or water (10% disconnection rate in 2008).
- Primary tool is command and control regulation.
Background on environmental regulations: Environmental audit system

High Court of Gujarat mandated regulator to introduce audits in 1996 in response to severe urban water pollution.

*The control mechanism through the system of internal and external audit is very much known in the fields of company law and income tax. We see no reason why such audit should not be made obligatory in respect of capital provided by nature.*

Built with several common safeguards

- Auditors cannot consult for the same plant.
- Rotation mandated every three years.
- Reports for other plants disallowed if auditor decertified.
- Audit teams can perform at most 15 audits per year.
- Audit teams must be comprised of four people with particular degrees and experiences.
Background on environmental regulations: Which plants are audited?

- Schedule based on pollution potential: product; where it sends effluent; and volume of effluent.
  - Schedule I (high pollution and large) plants must be audited by an engineering college or similar institution
  - Schedule II (medium or high pollution and somewhat smaller) plants must be audited by a private auditor.
- This experiment covers all Schedule II plants in two GPCB regions.
Background on environmental regulations: What is an audit and what are its consequences?

- Auditors visit three times per year for one day at a time.
- During the visit, they take pollution readings and observe the plant’s environmental management.
- Auditors submit report with pollution readings and suggested improvements in operations by subsequent February 15.
- Consequences of Audit.
  - Non-submission is punishable, in principle, by closure and disconnection of water and electricity.
  - Non-compliance can lead to closure and payment of fines.
  - False audits can lead to decertification of auditor and void of other reports.
Background on environmental regulations: Qualitative description of auditor market

Audit prices

- Audits can be purchased for INR 10-15k.
- Cost of conducting a thorough audit ranges between 20-40k, depending on the industry and size of the plant.

Audit quality

- Quality auditors driven from market and used staff in environmental consulting work instead.
- Regulated plants suing to get scheme lifted on the grounds that GPCB was not acting upon the audit reports.
- Regulators blame plants for using corrupt auditors.
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Audit-eligible plants randomly assigned to audit treatment

- Sample of 473 audit eligible plants from the GPCB regions in and around Gujarat’s two most populous cities.

- 233 of 473 plants assigned to modified audit treatment
  1. Random assignment of auditors (prevents shopping) and fixed payment from central pool, to create financial incentives for independence.
  2. Auditors backchecked on performance by Schedule I auditors (20% for T throughout, and \( \approx 50\% \) for T and C end-2010).
  3. Auditors paid for relative accuracy (year 2 only).

- Plants assigned to audit treatment once but auditors randomly assigned to treatment plants at the beginning of each year.
Incentive pay in year 2

Average absolute difference (mean 0, SD 1) over all backchecks for each auditor.

\[
WatDiff = \left( \frac{\sum_{b=1}^{B} |WatDiff_b|}{B} \right) / B \quad \text{AirDiff} = \left( \frac{\sum_{b=1}^{B} |AirDiff_b|}{B} \right) / B
\]

Overall performance index is the average for water (6 measurements) and air (3 measurements).

\[
ParDiff = \frac{(WatDiff + AirDiff)}{2}
\]

Table: Relative Pay Scale (Mean of Rs.45,000)

<table>
<thead>
<tr>
<th>Performance group</th>
<th>Base pay (Rs.)</th>
<th>Bonus pay</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least accurate 25%</td>
<td>30,000</td>
<td>5,000</td>
<td>35,000</td>
</tr>
<tr>
<td>25 to 50%</td>
<td>30,000</td>
<td>10,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Most accurate 50%</td>
<td>30,000</td>
<td>22,500</td>
<td>52,500</td>
</tr>
</tbody>
</table>
Set-up

Consider a three-stage game between firms, auditors and the regulator.

1. Firm chooses whether to abate from \( p_h \) to \( p_l \) and what payment to offer auditors to send report to regulator.

2. Auditor observes pollution level \( p \) and submits report \( \hat{p} \), or declines, in which case firm selects another auditor.

3. Regulator decides whether to impose a fine on firm based on report. With probability \( q \) a report is verifiable and the regulator decides whether to disbar auditors that have reported falsely.
Set-up: Firms

Firms produce output with pollution by maximizing the objective

\[ S - 1\{\text{Abate}\} \cdot c - w - 1\{\text{Fine Imposed}\} \cdot f. \]

- \( S \) value of output assumed large (firms do not shut down)
- \( c \) drawn from \( G(\cdot) \) the cost of abating from \( p_h \) to \( p_l < p_h \), in compliance with standard.
- \( w \) payment to auditor for report conditional on pollution level. E.g. \( w_{lh} = w(\hat{p} = p_l | p = p_h) \) so four-part schedule.
- \( f \) fine to regulator.

Firm aims to minimize cost of production by choosing \( p \) and \( w \), where \( w \) is a function of \( p \) and \( \hat{p} \).
Set-up: Auditors

Auditors observe pollution \( p \) and report \( \hat{p} \) to the regulator. They earn

\[
w(\hat{p}|p) - a + \mathbb{E}V(\hat{p}|p)
\]

- \( w \) conditional payment to auditor for report.
- \( a \) (opportunity) cost of audit. E.g. do consultancy instead. Competitive market but auditors may get some rent from being certified.
- \( \mathbb{E}V(\hat{p}|p) \) continuation value, where a reputation for leniency is valuable to auditors, so \( V_{lh} = V(p_l|p_h) > V_{hh} = V_{hl} = V_{ll} = V_0 \). Let \( \Delta V = V_{lh} - V_0 \) as the reputational benefit of falsely-low reporting, i.e. the benefit of notoriety.
Set-up: Regulator

Regulator cares about pollution and minimizes $p$.

- Focus on auditor and firm behavior.
- Regulator observes truth of audit report with probability $q$ based on backchecks or own inspections. Cannot use this to penalize firms (legal restriction).

Regulator can take two actions

- Fine firms a fixed $f$ for reports of $\hat{p} = p_h$
- Disbar auditors if report is verifiable, which happens with probability $q$, and is found to be false.
Solution: Firms have three strategies in practice

Consider equilibria with regulation, defined as equilibria in which the regulator imposes fines when \( p_h \) is observed and always disbars auditors reporting falsely.

To gain intuition, consider when \( p = p_h \):

1. Will auditor report \( p_l \)? Yes if:
   - higher payoff from false reporting
     \[
     w_{lh} - a + (1 - q)V_{lh} \geq w_{hh} - a + V_0
     \]
     \[
     w_{lh} \geq w_{hh} + qV_{lh} - \Delta V
     \]
   - participation constraint
     \[
     w_{lh} - a + (1 - q)V_{lh} > V_0
     \]
     \[
     w_{lh} \geq a - \Delta V + qV_{lh}
     \]
Solution: Firms have three strategies in practice

Will plant pay for auditor report of $p_l$?

- must be profitable

$$w_{lh} \leq w_{hh} + f$$

- and sufficient to induce auditor

$$w_{lh} \geq w_{hh} - \Delta V + qV_{lh}$$

Plant will only pay minimum needed. Buying auditor worth it if:

$$w_{lh} \leq w_{hh} + f$$

$$w_{hh} - \Delta V + qV_{lh} \leq f + w_{hh}$$

$$qV_{lh} - \Delta V \leq f$$

Additional payment $qV_{lh} - \Delta V$ necessary to induce false reporting.

$$qV_{lh} = \text{cost of disbarment}$$

$$\Delta V = \Delta \text{ in continuation value from cheating}$$
Solution: Firms have three strategies in practice

Will plant abate instead?

There is a unique subgame-perfect equilibrium with regulation in which one of three outcomes obtains. Firms

• *clean up* if \( c \leq \min\{f, qV_{lh} - \Delta V\} \),
• *underreport* if \( qV_{lh} - \Delta V < \min\{c, f\} \) and
• *defy* the regulation if \( f < \min\{c, qV_{lh} - \Delta V\} \).
Figure: In equilibrium, one of three outcomes will obtain

Figure: Firm decision margin whether to defy (submit high)
Experiment: What is observed at baseline / in control?

Probability $q$ of detection very low. Therefore assume $qV_{lh} - \Delta V < f$.

- Share $G(qV_{lh} - \Delta V)$ of firms abate. As $q \to 0$ this is very small.
- Share $1 - G(qV_{lh} - \Delta V)$ of firms pay off auditors. Widespread false reporting.
- Fines based on audit reports not observed.
Experiment: Backchecks aim to shift margin of decision

*Backchecks.* Backchecks increase $q$, the probability an audit report is verifiable and therefore raises the cost of a falsely low report. A raise in $q$ from the baseline sufficient for $qV_{lh} - \Delta V > f$ induces a share $G(f)$ of firms to abate.
Experiment: Random assignments and fixed fees also increase abatement

Random assignment removes firm option of hiring another auditor

- Modeled as firms no longer being able to offer conditional payments, as *ex post* auditors will submit whatever report is best for their reputation. This reduces $\Delta V (\equiv V_{lh} - V_0)$.
- Fixed fee to assure the participation constraint satisfied.

NB: Fixed fee unlikely to work on its own because rating shopping remains.
Experiment: Incentive pay augments continuation value for honesty

Incentive Pay. The incentive pay treatment augments the auditor continuation value for accurate reports. Inducing low reporting is more costly than a fine if \( q(V_{lh} + B) - \Delta V > f \), where \( B \) is the incentive pay bonus.
Experiment: What to expect

Depends on strength of treatment.

- **Weak treatment**, \( q(V_{lh} + B) < \Delta V \). No real effects. Firms buy compliant audit reports regardless of pollution status.

- **Strong treatment**, \( q(V_{lh} + B) \geq \Delta V \). Removes buying lower report as an option.
  - Change in reporting but no abatement if expected fine less than abatement costs for most firms.
  - Change in reporting and abatement if expected fine greater than abatement cost for some firms.

Preview of results: experiment will fall in this last case.
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Data from three sources

- Sample largely consists of small and medium sized textile firms.
- Audit reports (with pollutant readings) for all firms.
- Backcheck reports (conducted by independent engineering colleges) submitted to researchers during experiment.
  - Conducted for 20% of treatments in 2009 and 2010. Also conducted for total of 130 treatment and control plants at end of third season of audit visits in 2010
  - Measure the same pollutants at the same place within several weeks. Median lag 17 days.
  - Auditors knew they faced a 20% likelihood of being back-checked. Use of backchecks not specified in first year.
Reporting outcomes for important pollutants

Pollutants are important general measure of air and water quality

- Water pollutants measure oxygen demand required to stabilize samples and solid content, ammonia nitrogen content. $Water = \{\text{BOD, COD, TDS, TSS, NH}_3\text{-N}\}$.

- Air pollutants principle byproducts of combustion and all EPA criteria pollutants. $Air = \{\text{SO}_2, \text{NO}_x, \text{SPM}\}$

- $All = Water \cup Air$.

Most pollutant readings standardized throughout by subtracting pollutant mean $in backchecks$ and dividing by pollutant standard deviations $in backchecks$. 
Final-outlet water and boiler-stack air samples

**Figure:** Water sampling

**Figure:** Stack sampling
More severe violations provoke more severe penalties.
Empirical strategy uses experimental variation

We estimate ordinary least-squares regressions of the form:

\[ y_{ij} = \beta T_j + \alpha_r + \alpha_y + \alpha_a + \epsilon_{ij}, \]

where \( y_{ij} \) is an outcome variable of interest \( i \) at plant \( j \), \( \alpha_r \) are fixed effects for the region \( r \), \( \alpha_y \) are fixed effects for the year \( y \in \{2009, 2010\} \) and \( \alpha_a \) are auditor fixed effects.
Outcome variables pollutant indices

Two main outcomes

1. Recorded concentration of pollutants in the audit reports.
   - Bigger sample of all audit reports.
   - But doesn’t control for changes in pollution due to treatment.

2. Whether report is compliant with regulatory standard.
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Figure: Audit Readings for Suspended Particulate Matter (SPM)

Suspended particulate matter, mg/Nm³
A. Control, midline

Audits
Mass: 0.7297
Figure: Audit Readings for Suspended Particulate Matter (SPM)

Suspended particulate matter, mg/Nm3
A. Control, midline

Audits
Mass: 0.7297

Backchecks
Mass: 0.1892
Figure: Audit Readings for Suspended Particulate Matter (SPM)

Suspended particulate matter, mg/Nm3

B. Treatment, midline

Audits

Mass: 0.3913

Backchecks

Mass: 0.1449
Figure: Audit Readings for Suspended Particulate Matter (SPM)

Suspended particulate matter, mg/Nm3

A. Control, midline

Audits

Mass: 0.7297

B. Treatment, midline

Audits

Mass: 0.3913
Excess mass below pollutant standards sharply reduced

**Table**: Likelihood of Pollution Report Between 75% and 100% of Regulatory Standard, Across All Pollutants

<table>
<thead>
<tr>
<th></th>
<th>(1) Control</th>
<th>(2) Treatment</th>
<th>(3) Ctl + Trt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit report (=1)</td>
<td>0.270***</td>
<td>0.0851***</td>
<td>0.270***</td>
</tr>
<tr>
<td></td>
<td>(0.0253)</td>
<td>(0.0228)</td>
<td>(0.0252)</td>
</tr>
<tr>
<td>Audit report X Audit treatment</td>
<td></td>
<td></td>
<td>-0.185***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.0339)</td>
</tr>
<tr>
<td>Constant (Backcheck)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Audit treatment</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>1132</td>
<td>1104</td>
<td>2236</td>
</tr>
</tbody>
</table>

Pooled, standardized final-stage effluent and boiler-stack air samples. Midline audit reports that reached GPCB and midline backchecks.
Similar evidence on declines considering pollution levels as outcome variable

**Table: Audit Treatment Effects on Auditor Reporting**

<table>
<thead>
<tr>
<th>Audit treatment</th>
<th>(1) All</th>
<th>(2) All</th>
<th>(3) Water</th>
<th>(4) Water</th>
<th>(5) Air</th>
<th>(6) Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit treatment</td>
<td>0.103***</td>
<td>0.131***</td>
<td>0.117**</td>
<td>0.131**</td>
<td>0.0852***</td>
<td>0.132***</td>
</tr>
<tr>
<td>Auditor fixed effects</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Control mean</td>
<td>-0.291</td>
<td>-0.291</td>
<td>-0.350</td>
<td>-0.350</td>
<td>-0.194</td>
<td>-0.194</td>
</tr>
<tr>
<td>Observations</td>
<td>13172</td>
<td>13172</td>
<td>8373</td>
<td>8373</td>
<td>4799</td>
<td>4799</td>
</tr>
</tbody>
</table>

*Panel A: Audit Report Levels on Treatment Status*

Regressions include region fixed effects and year fixed effects. Standard errors clustered at the plant level in parentheses.
Figure: Audit Treatment Effect in Density Bins, All Pollutants
Level effects economically large

- Effect size for BOD, an important water pollutant, implies that a report at the standard would move to 89% above the standard in treatment.
- Effect size for SO$_2$, an air pollutant, implies that a report at the standard would move to 35% above the standard in treatment.
- Change in reports shifts many plants from compliance to non-compliance and is economically significant.
But possibly attenuated

- Treatment may be decreasing pollution levels even as it raises the accuracy of reports, attenuating treatment effect in level specifications.
- Address this by restricting to 2010 3rd-season “midline” sample of matched audit - backcheck pollutant pairs.
- Estimate a diff-in-diff spec to see whether compliance with standard low for firms in treatment, i.e. is $\beta_1 < 0$:
  \[ C_i = \beta_1 A_i \times T + \beta_2 A_i + \beta_3 T + \epsilon_{it} \]
False compliance in audit reports reduced

**Table:** Likelihood of Pollution Report Below Regulatory Standard, in Audits Relative to Backchecks, and Treatment Relative to Control

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Water</td>
<td>Water</td>
<td>Air</td>
<td>Air</td>
</tr>
<tr>
<td>Audit report X Treatment</td>
<td>-0.234***</td>
<td>-0.234***</td>
<td>-0.166***</td>
<td>-0.166***</td>
<td>-0.345***</td>
<td>-0.345***</td>
</tr>
<tr>
<td></td>
<td>(0.0388)</td>
<td>(0.0390)</td>
<td>(0.0501)</td>
<td>(0.0506)</td>
<td>(0.0555)</td>
<td>(0.0564)</td>
</tr>
<tr>
<td>Audit report (=1)</td>
<td>0.288***</td>
<td>0.273***</td>
<td>0.311***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0233)</td>
<td>(0.0327)</td>
<td>(0.0322)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditor fixed effects</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2236</td>
<td>2236</td>
<td>1378</td>
<td>1378</td>
<td>858</td>
<td>858</td>
</tr>
<tr>
<td>$H_0$: Audit compliance = bcheck compliance in treatment (t-stat)</td>
<td>1.88*</td>
<td>2.88***</td>
<td>-0.76</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regressions include region fixed effects.
Pooled, standardized final-stage effluent and boiler-stack air samples.
Midline audit reports that reached GPCB and midline backchecks.
Standard errors clustered at the plant level in parentheses.
*p < 0.10, ** p < 0.05, *** p < 0.01
Linking misreporting with penalty structure

Figure: Compliance Against Regulatory Citations (for Control Group)
## Incentive pay break in 2010 reporting

**Table:** Audit Reports on Treatment Status Over Time

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Audit treatment</strong></td>
<td>0.103***</td>
<td>0.218***</td>
<td>0.180***</td>
</tr>
<tr>
<td></td>
<td>(0.0354)</td>
<td>(0.0627)</td>
<td>(0.0568)</td>
</tr>
<tr>
<td><strong>Incentive pay (year=2010)</strong></td>
<td>0.0561**</td>
<td>0.00187</td>
<td>-0.00610</td>
</tr>
<tr>
<td></td>
<td>(0.0273)</td>
<td>(0.0325)</td>
<td>(0.0325)</td>
</tr>
<tr>
<td><strong>Incentive pay X treatment</strong></td>
<td>0.257***</td>
<td>0.261***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0920)</td>
<td>(0.0976)</td>
<td></td>
</tr>
<tr>
<td><strong>Years (fractional) from Jan 1, 2009</strong></td>
<td>0.0290</td>
<td>-0.00168</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0226)</td>
<td>(0.0192)</td>
<td></td>
</tr>
<tr>
<td><strong>Years (fractional) X treatment</strong></td>
<td>-0.220***</td>
<td>-0.169***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0677)</td>
<td>(0.0631)</td>
<td></td>
</tr>
<tr>
<td><strong>Auditor fixed effects</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>13172</td>
<td>13172</td>
<td>13172</td>
</tr>
</tbody>
</table>

Regressions include region fixed effects. Standard errors clustered at the plant level in parentheses.
Effect on Pollution Emissions
**Firms reduce pollution**

<table>
<thead>
<tr>
<th></th>
<th>(1) all</th>
<th>(2) all</th>
<th>(3) water</th>
<th>(4) water</th>
<th>(5) air</th>
<th>(6) air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit treatment assigned (=1)</td>
<td>-0.211**</td>
<td>-0.456*</td>
<td>-0.300*</td>
<td>-0.982*</td>
<td>-0.0528</td>
<td>0.0237</td>
</tr>
<tr>
<td></td>
<td>(0.0993)</td>
<td>(0.266)</td>
<td>(0.159)</td>
<td>(0.528)</td>
<td>(0.0566)</td>
<td>(0.101)</td>
</tr>
<tr>
<td>Auditor fixed effects</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Control mean</td>
<td>0.077</td>
<td>0.077</td>
<td>0.114</td>
<td>0.114</td>
<td>0.022</td>
<td>0.022</td>
</tr>
<tr>
<td>N</td>
<td>1439</td>
<td>1439</td>
<td>860</td>
<td>860</td>
<td>579</td>
<td>579</td>
</tr>
</tbody>
</table>

*Final-stage effluent and boiler-stack air samples; endline survey; inspection control group. Standard errors clustered at the plant level in parentheses.*
Firms reduce pollution

- Response in water pollutants under regulatory scrutiny
- No change in effluent volume—real reductions in pollutant load.
- Not shown today: abatement appears to have come cheap. Little difference in costs by treatment status.
Outline

1 Introduction
2 Improving Incentives for Social Entrepreneurship
3 Improving the Regulatory Framework
   Reducing Opportunities for Corruption
4 Introduction: Third-Party Auditing
   Background on environmental regulations
5 Experimental Design
6 Model of Auditor Reporting
   Set-up
   Solution
   Experiment
7 Data and Empirical Strategy
8 Results on Auditor Reporting
9 Policy Relevance
Broader Implications

1. While regulatory and legal environments vary across markets and countries, conflict of interest problems are likely severe whenever reputation incentives are weak
   - Little regulatory follow-up may be equivalent to lack of investor skepticism in financial markets
2. In the setting studied, entry (fixed) costs are relatively low. May be harder to verify a corporations’ finances.
   - Could alter parameters such as length of rotation to account for fixed costs.

Basic insights likely to hold:
- Reducing conflict of interest has large, fast and nearly complete effect on auditor reporting.
- Clearly driven by incentives: present within auditors.
Changing Auditor Incentives Influences Firm Behavior

- This regulatory innovation made it cheaper for many firms to reduce pollution rather than *ex post* bribe.

- **Open question**: How do we ensure the costs of compliance are the most efficient so that growth is not hampered?

- Right now, plants with different costs are (separately) subject to the same unpredictable regulatory enforcement.

- This unpredictability harms growth and opens possibilities for corruption.

- Can we use market mechanisms to rewards plants with low abatement costs and encourage them to cut pollution by more?