A ROADMAP TOWARDS CLEANING INDIA'S AIR

Evidence-based recommendations for more effective environmental regulations

EPIC INDIA
ENERGY POLICY INSTITUTE
AT THE UNIVERSITY OF CHICAGO

HARVARD Kennedy School
Evidence for Policy Design

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The Solvable Challenge of Air Pollution in India
Michael Greenstone, University of Chicago
Rohini Pande, Harvard Kennedy School
Anant Sudarshan, University of Chicago
Santosh Harish, EPIC India

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Layout and Design
Sharib Suhail, EPIC India

Cover Photo
Ashirbad S Raha, EPIC India

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Introduction

More than 660 million Indians live in areas that exceed the Indian National Ambient Air Quality Standard (NAAQS) for fine particulate (PM2.5) pollution. Our research suggests that if India were to meet its own standards, life expectancy would increase by more than one year on average. Moreover, if India were to meet the WHO's air quality standard, its people would live about four years longer on average. The economic costs of pollution, through its impact on health care expenditures and workforce productivity, will be significant. Ascribing a monetary value to all of the damages created by pollution is difficult, but an estimate from the Organisation for Economic Co-operation and Development (OECD) suggests that ambient air pollution alone may cost India more than 0.5 trillion dollars per year (OECD 2014).

This policy brief summarizes our research publication, *The Solvable Challenge of Air Pollution in India*, published in the 2017-18 volume of the India Policy Forum. In this paper, we examine environmental regulations with the goal of identifying characteristics of policy instruments that have made success more likely, and lay out a roadmap for regulatory reforms.

We first highlight four key facts that requires attention of the regulatory authorities: the enormous health benefits by improving air pollution levels; high non-compliance to industrial norms; the limited effectiveness of traditional regulatory measures that rely on equipment mandates; and bans on polluting activities.

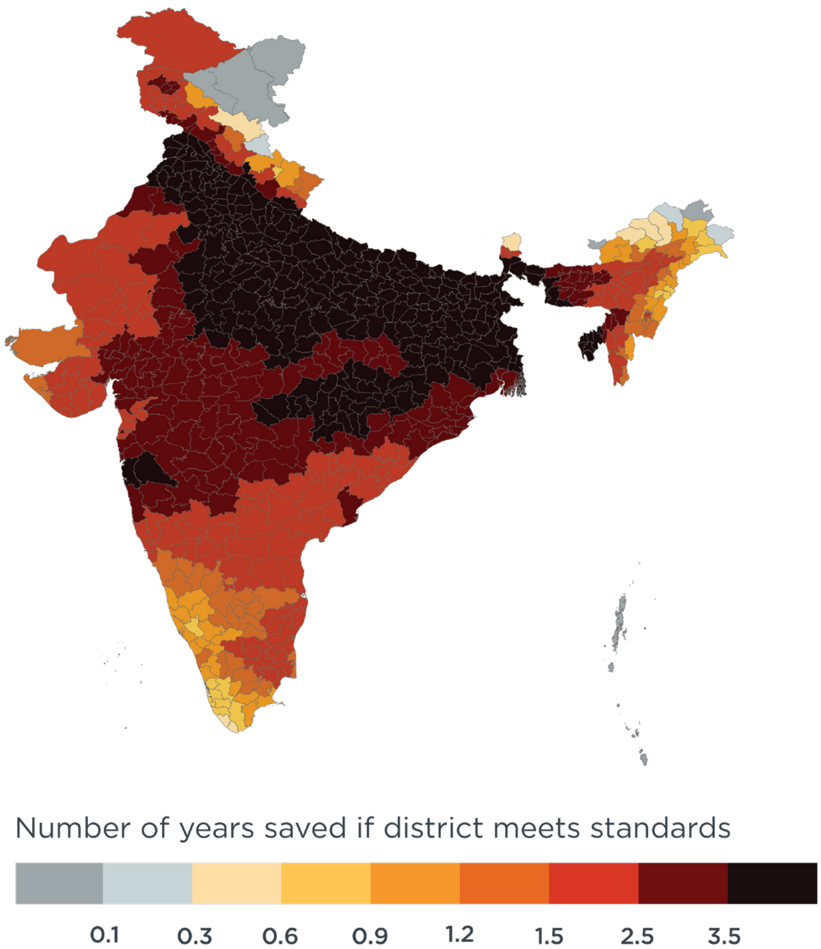
We then provide five key policy recommendations. These include increasing the quality of information about polluters' emissions that is provided to both regulators and the public, as well as introducing market based instruments to deliver the largest impact. High levels of air pollution were once commonplace in developed nations such as the U.S., England, and Japan. These countries were able to address this problem by tightening regulations and introducing new policies. Today, India faces a similar opportunity to utilize a variety of tools to improve environmental quality.

Our Learnings

Improving Air Pollution Levels to Meet Air Quality Standards has Enormous Health Benefits

India is searching for the best way to balance the dual and, at times, conflicting goals of achieving economic growth while maintaining a clean environment. EPIC-India researchers have developed the Air Quality Life Index (AQLI), a metric that provides a means to predict the overall reduction in life expectancy caused by living in places with high levels of air pollution. These health costs are not restricted to a few urban areas. The AQLI is generated by combining global datasets on air pollution with published scientific evidence on the causal effects of pollution on life expectancy based on a natural experiment (see Chen et al., 2013; Ebenstein et al., 2017).

If India were to achieve its own air quality standards, life expectancy would increase by more than one year on average. This number would increase to four years if India were to meet the WHO norms. Some of the greatest gains would be seen in the country's largest cities, such as Delhi. There, people would live six years longer if air quality met the national standards. Similar gains are expected across the Indo-Gangetic plain, including in the rural areas.



The map shows increase in life expectancy if PM2.5 levels were to meet the WHO norms. Source: Air Quality Life Index, https://aqli.epic.uchicago.edu/.

Our Learnings

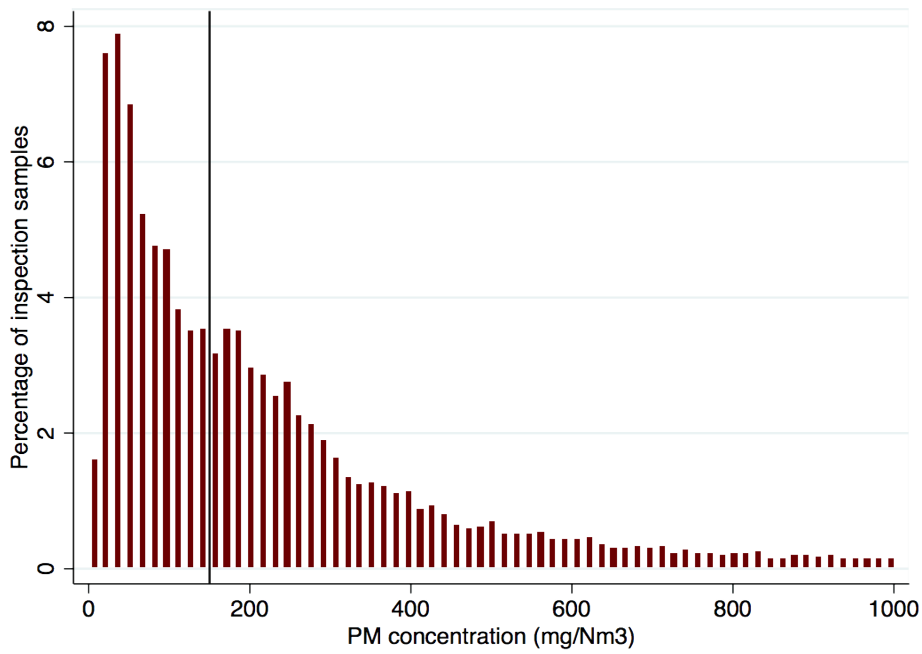
Non-Compliance to Industrial Norms is High in the Status Quo

To control industrial emissions, India's Central and State Pollution Control Boards (SPCBs) set a permissible limit on the concentration of pollutants that can be emitted from industrial unit stacks (i.e. chimneys). These limits are generally denominated in terms of concentrations: the mass of pollutants in a unit volume of air leaving a stack. A key indicator of whether such regulations are successful at reducing pollution is the degree to which industries comply with these limits.

EPIC India and EPoD affiliated researchers have conducted studies highlighting serious problems in the enforcement of existing regulations across India.

Duflo et al (2013) collected data from several regulatory inspections in the state of Gujarat, in collaboration with the Gujarat Pollution Control Board (GPCB). 59% of the industrial plants whose audits were back-checked by an independent agency were found to be polluting above the standard.

In Maharashtra, another highly industrialized state, the results of over 13,200 regulatory pollution tests spanning the period between September 2012 and February 2018 were digitized in collaboration with the Maharashtra Pollution Control Board (MPCB). Over half of all samples were found to exceed the regulatory standard.

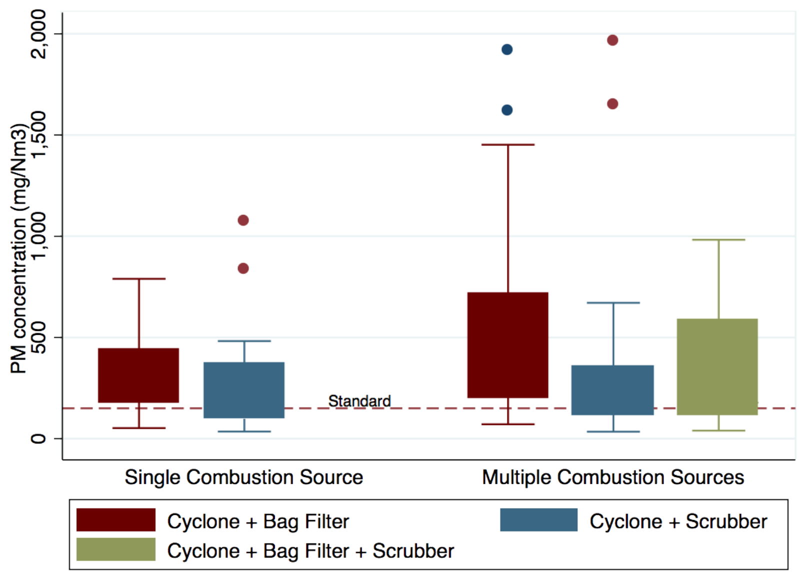


This histogram plots the number of samples from industrial plants in Maharashtra corresponding to various emissions levels, using over 13,200 digitized regulatory inspections data. While 150 milligram/Nm^3 is the most common norm for particulate matter compliance, some industries have even more stringent limits. Source: MPCB and authors' research.

Equipment Mandates May Not Be Effective in Reducing Emissions

Equipment mandates are a common form of command-and-control regulation. In the industrial sector, environmental regulators across the country have often required that plants install different types of air pollution control equipment. Although installations can be easily enforced, it is difficult for regulators to monitor and enforce their continued use. In Gujarat, EPIC India and EPoD affiliated researchers collaborated with the Central Pollution Control Board (CPCB) to conduct a survey of 311 plants, mostly in the textile sector, in and around Surat. Nearly 60% of the 311 plants had installed bag filters, often in combination with other air pollution control devices. However, plants continued to emit high levels of pollution. For instance, mean emissions from plants with the three most common bag filter combinations exceeded the prescribed standard by two-times or more.

In contrast, fuel and technology mandates have been effective in reducing pollution in the transport sector. In the 1990s, the Ministry of Petroleum and Natural Gas announced that all new vehicles would require catalytic converters in an order that extended across 45 cities. Five years after implementing this policy, concentrations of particulate matter and SO_2 dropped by 19 and 69 percent relative to 1987 – 1990 nationwide mean concentrations, respectively (Greenstone and Hanna, 2014).



This boxplot shows the emissions of surveyed industrial plants in Surat with the most common pollution control equipment combinations. The box shows the interquartile range (25th percentile and 75th percentile), with the horizontal line showing the median. Source: Harish and Nilekani (2018).

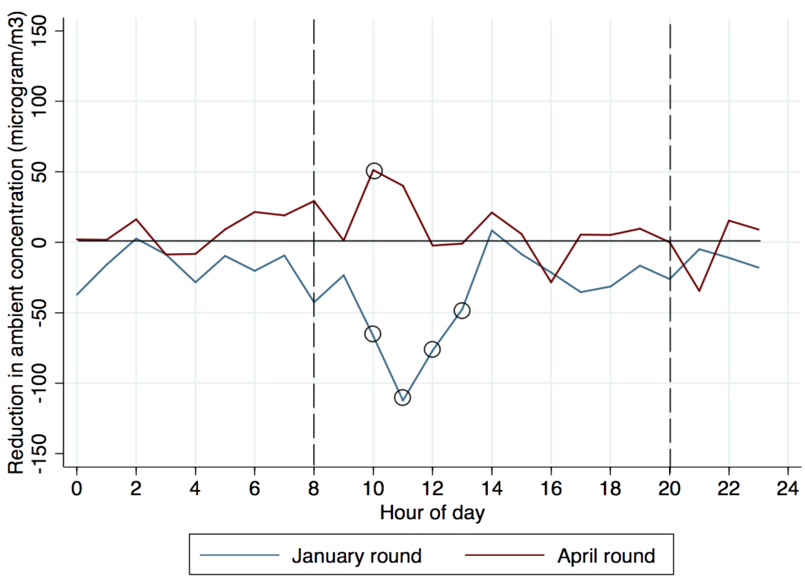
Our Learnings

Driving Restrictions May Not Be Effective in the Long Run

The most severe forms of command-and-control regulation involve banning or restricting the operations of specific categories of polluters, independent of actual emissions. Such policies have been common in India for both industries and vehicles, and have often been driven by the judiciary.

A recent and prominent example of rationing economic activity in order to reduce pollution is the "Odd-Even" driving restriction program imposed by the Government of Delhi. In the Odd-Even program, vehicles with odd-numbered license plates were permitted on the road on odd-numbered days, and even-numbered plates on even-numbered days. The Odd-Even program was effective between 8am to 8pm during the first-half of January 2016, and the second-half of April 2016. In order to evaluate the program, EPIC India and EPoD affiliated researchers analyzed how the difference in air quality between Delhi and its neighboring cities changed after the commencement of the program (i.e., difference-in-differences approach).

The analysis found evidence of a 13% reduction in PM2.5 concentrations during the January round. The effect was particularly large between the hours of 11am and 2pm, perhaps due to a reduction in traffic during the morning peak hours. In contrast, the analysis found no evidence of an effect during the April round. The absence of an April effect may have been due to greater dispersion caused by warmer temperatures. The results of the Odd-Even program suggest that driving restrictions may be most effective as emergency measures during the worst periods (e.g., winters).



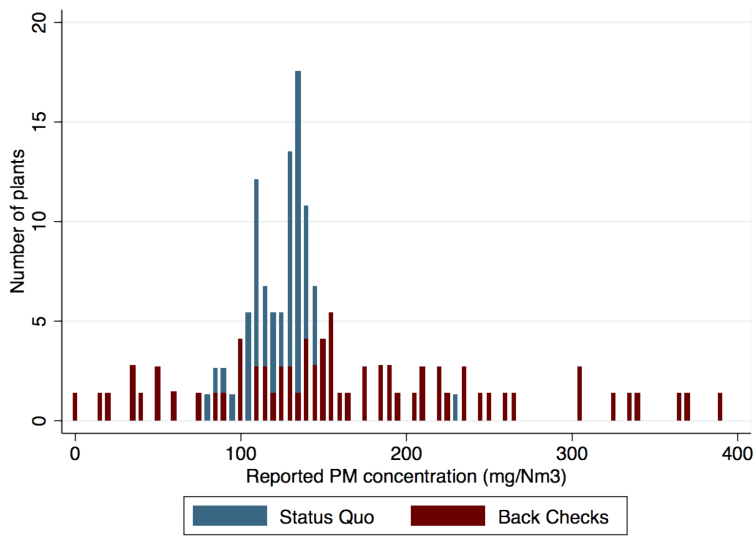
In this figure, difference-in-difference coefficients are plotted for each hour of the day. Hours with statistically significant results are shown as circled points on the graph. PM2.5 concentrations in Delhi averaged 277 microgram/m³ in January 2016 and 141 microgram/m³ in April 2016. Source: Authors' research.

Policy Recommendations

Improve Emissions Monitoring by Better Aligning Incentives of Auditors

In India, regulators typically rely on manual inspections in order to monitor the air pollution being emitted by industries. In some cases, officials from the SPCBs conduct these inspections. In other cases, industries are allowed to hire accredited laboratories to inspect their own stacks. In Gujarat, Duflo et al. (2013) studied the quality of inspections data, in collaboration with the GPCB. Monitoring reports carried out by accredited third-party labs were found to be heavily biased. For instance, independent back-check pollution readings were 0.3 standard deviations higher than the readings produced in official audits. In other words, in the status quo, 29% of industries were falsely reported to be in compliance. Duflo et al. find evidence that the primary reason for this is the conflict of interest that is created when industries are allowed to pay environmental laboratories for their own tests. GPCB, in collaboration with EPIC India and EPoD affiliated researchers conducted a randomized experiment in which auditors were randomly allocated to industries, paid from a central pool of funds, and penalized if their sampling results differed substantially from the results of an independent back-check.

The experiment reduced false reports of compliance by 80% and average pollution from industries by 0.21 standard deviations. Based on the success of this pilot, GPCB has since revised its testing protocols. The lessons learned from this groundbreaking experiment can be applied more widely to other situations in which environmental regulation is reliant on third-party audits.



This figure shows the distribution of pollutant concentrations for particulate matter in stacks of control plants from audits and backchecks, during the midline survey of the project. The regulatory maximum concentration limit is 150 milligram/Nm^3 (Duflo et al. 2013).

Policy Recommendations

Provide Regulators with Real-Time Data on Polluters' Emissions

The lack of high-quality data has been an obstacle for the effective regulation of polluting industries. Due to staffing constraints, manual inspections are carried out only a few times a year. Polluters are often able to alter their operations in order to be at their best. Improving the quality of measurement can vastly improve monitoring and enforcement activities. For example, Continuous Emissions Monitoring Systems (CEMS) are instruments that are installed at industrial stacks and can supply regulators with real-time emissions data.

In 2014, the CPCB mandated the installation of CEMS across 17 categories of highly-polluting industries. For many SPCBs, however, substantial capacity-building efforts are needed to maximize the value of CEMS technology. SPCBs would benefit from improved protocols for scrutinizing data, overseeing calibration, and using data for enforcement. For example, CEMS still require manual calibration. SPCBs must ensure that conflicts of interest are eliminated, and data quality protocols are followed to detect and take action against data corruption.

Once CEMS have been properly installed, real-time data on industrial emissions can be leveraged to enhance the effectiveness of various policy options—including public disclosure, monetary charges, and emissions trading—to reduce pollution. EPIC India and EPoD affiliated researchers have been working with GPCB and Odisha State Pollution Control Board (OSPCB) to improve the protocols for CEMS calibration and using CEMS data to augment enforcement capabilities.

EPIC-India has been working with OSPCB to improve the capacity of regulatory officials to utilize CEMS data for monitoring and enforcement.

Policy Recommendations

Provide the Public with Information about Polluters

Access to the results of inspections and emissions records is generally restricted to regulators. Public disclosure of this information can lead to public pressure from civil society groups, as well as pressure from investors and peer industrial plants, and nudge polluters towards better behavior. In addition, making information available to the public can encourage regulators to improve the reliability of data. Transparency initiatives—such as the Toxic Release Inventory (TRI) Program in the United States, PROPER in Indonesia, and the Green Watch program in China—have been shown to be effective in improving compliance and reducing pollution.

In June 2017, the MPCB, in collaboration with EPIC India and EPoD affiliated researchers, launched its groundbreaking Maharashtra Star Rating Program. In this initiative, hundreds of large industrial plants have been rated for the first time on a 1- to 5-star scale, based on their levels of particulate emissions. 1- and 2-stars typically indicate non-compliance. The 4- and 5-stars indicate compliance. The potential to earn a 5-star rating provides an incentive for polluters to maintain low levels of emissions. The pilot project has been designed in a way that will allow researchers to measure the effects of information disclosure on pollution.

The rigorous nature of the evaluation makes this pilot the first of its kind in the world. The star ratings are determined using data from the four most recent tests for particulate emissions (through manual sampling). The median test value is used to assign a rating based on the scale in the table below. The OSPCB will soon launch its own Star Rating Program, which will be accessible at ospcb.info. In the OSPCB initiative, star ratings will be determined based on CEMS data and will be updated each month. The adoption of similar transparency and public disclosure initiatives across India would lead to a radical change in efforts to control industrial pollution.

	Range of PM Emissions *(milligram per cubic meter)*			
Rating	**Minimum**	**Maximum**	**Rating Key**	**Representation**
1 Star	*250*	*250*	*Very Poor*	★☆☆☆☆
2 Star	*150*	*150*	*Poor*	★★☆☆☆
3 Star	*100*	*100*	*Moderate*	★★★☆☆
4 Star	*50*	*50*	*Good*	★★★★☆
5 Star	*0*	*0*	*Very Good*	★★★★★

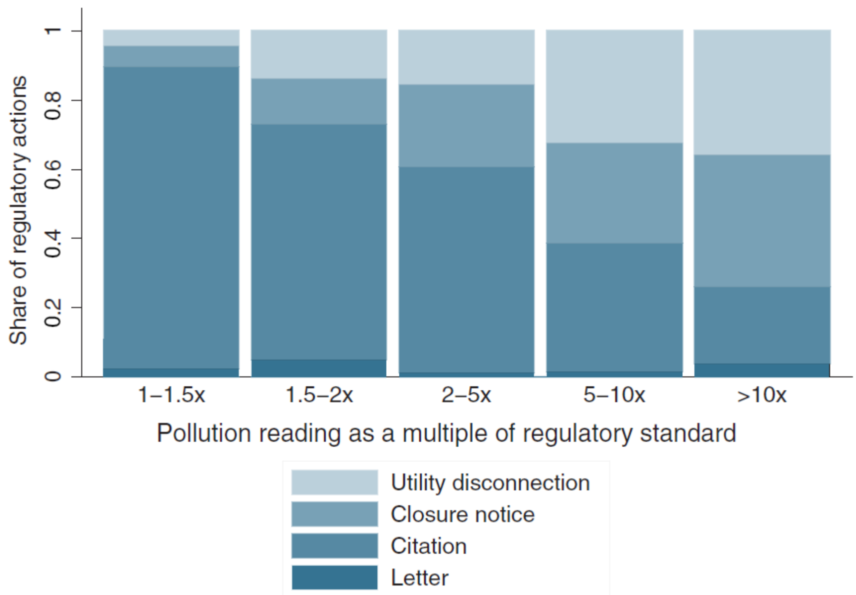
This table shows how ratings are calculated using average particulate matter emissions in the Maharashtra Star Rating Program. Industries rated at 1- and 2-stars have average emissions that are greater than the regulatory standards. Source: MPCB (see mpcb.info).

Policy Recommendations

Use Monetary Charges for Excess Emissions

Indian environmental laws rely on criminal penalties to keep industries in compliance. Command-and-control regulations can be costly because SPCBs can only enforce laws using the blunt tools of plant closures and investment hold-ups. These penalties are relatively harsh and cannot be applied in proportion to the degree of the environmental offense. Duflo et al. (2013; 2018) find that inflexible regulation leads regulators to enact strict punishments against just a small fraction of major violators, while many others are let off.

The absence of monetary charges in India lags behind not only the United States, but also China which has relied on monetary instruments since the early-1980s. In fact, China has moved beyond the original pollution levies to a formal Environment Protection Tax. Use of pollution charges for polluting industries would increase the flexibility that regulators have in responding to environmental offences, widening the number of polluters facing regulatory action. The judgments of the National Green Tribunal (e.g. NGT 2014) clarify that SPCBs are empowered under the environmental laws to use different monetary instruments in their efforts to ensure compliance and reduce pollution. Although SPCBs cannot levy penalties, they can require polluting industries to compensate for the damages inflicted due to their activities.



This figure reports the regulatory responses to pollution readings measured at different levels of non-compliance during regulatory inspections for a sample of plants over three years. Pollutant readings are shown in bins of readings at specified multiples above the regulatory standard. The bars indicate the type of regulatory action taken in response to a given reading. Actions increase in severity from the bottom (dark bars) to the top (light bars): a letter is an official, but not legal, correspondence to the firm noting the violation and possibly threatening action; a citation is a legal regulatory notice requiring a response from the firm; a closure notice is a warning that the plant will be closed unless a violation is remedied; and a disconnection is an order to the utility that a plant's power be disconnected (Duflo et al. 2013).

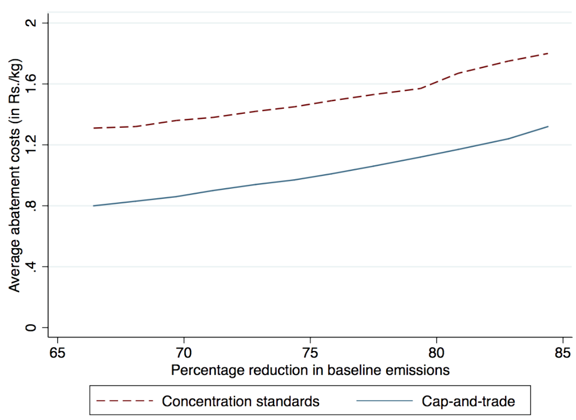
Policy Recommendations

Use Markets to Reduce Abatement Costs and Pollution

Under the traditional command-and-control regulations, polluters may be willing to trade off the risk of being detected and penalized with the avoided costs of complying, particularly if abatement costs are high and enforcement capacity is limited. In addition, there are no incentives for compliant plants to further mitigate their emissions. Emission markets seek to increase economic efficiency, reduce the costs of compliance, and remove incentive incompatibilities. Several expert committees, appointed by the Government of India, have emphasized the need to use market-based and fiscal instruments that align incentives and reduce the costs of compliance, following the "polluter pays" principle.

Under a cap-and-trade system, aggregate emissions from all regulated industries are capped; industries need to hold permits for each unit of emissions; the total amount of permits is equal to the cap; and industries are allowed to trade permits. The cap-and-trade system allows industries to strike a balance between reducing their own emissions through various abatement measures and purchasing permits. Duflo et al. (2010) outline the principles for setting up an emissions trading market in industrial clusters in India.

Under a cap-and-trade system in Surat, the industry costs of compliance are estimated to fall by nearly 40% relative to the status quo concentration standard. Conversely, we may achieve an additional 27% reduction in emissions with a cap-and-trade at the same compliance costs as with current concentration norms. Testing out a pilot cap-and-trade program would represent a dramatic step forward in combating industrial air pollution in India.



This graph plots the estimated average abatement cost per unit at different levels of aggregate emissions reductions in the Surat industrial cluster. A 66% reduction in emissions corresponds to the industrial cluster meeting existing concentration norms at the time of the CPCB survey (Harish and Nilekani 2018).

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