The Impact of an Emissions Trading Scheme on Economic Growth and Air Quality in India

Researchers:

Michael Greenstone

Rohini Pande

Nick Ryan

Anant Sudarshan

Sector(s): Environment & Energy

Location: Gujarat (Surat), Maharashtra (Dombivali, Aurangabad, Jalna, Chandrapur), Tamil Nadu (Chennai)

Sample: 292 industrial plants

Target group: Small and medium enterprises

Outcome of interest: Pollution Transparency and accountability Climate change mitigation

Intervention type: Pricing and fees Regulation enforcement programs

AEA RCT registration number: AEARCTR-0003860

Research Papers: Can Pollution Markets Work in Developing Countries? Experimental Evidence from ...

Partner organization(s): Government of India, State of Gujarat Pollution Control Board (GPCB)

Globally, air pollution causes billions to live shorter, less healthy, and less productive lives. However, common regulatory policies may be costly and difficult for governments to enforce. In partnership with the Gujarat Pollution Control Board, researchers evaluated the impact of the first-ever emissions trading scheme for particulate air pollution on air quality and compliance costs for industrial plants. Compliance with the emissions trading scheme was high and participating firms substantially reduced their particulate matter emissions without large increases in abatement costs, suggesting that markets for air pollution can be a cost-effective pollution reduction strategy.

□□□□□□□ □□□□□□□

Globally, air pollution causes billions to live shorter, less healthy, and less productive lives.[1] The World Health Organization estimates that outdoor air pollution accounted for 4.2 million deaths in 2019.[2] Common pollution regulation policies such as command-and-control regimes, which impose compliance costs on firms and require that firms invest in pollution abatement technology, are often costly and difficult for governments to enforce, which can allow firms to pollute more than the regulations permit.

An alternative approach is to create market-based mechanisms, which could help to strike a balance between improved air quality and economic growth. One example is an emissions trading scheme (ETS) in which the government sets a cap on emissions and distributes emissions permits to firms. Since firms decide how to allocate permits among themselves, ETS minimizes the costs of meeting the emissions target. Firms that find it cheap to reduce pollution cut back and profit by selling excess permits. ETS has been implemented in the European Union to address carbon emissions, as well as to reduce carbon,

sulfur dioxide, and nitrogen oxide emissions in the United States. However, it is not clear whether they can work in lower-income countries with less regulatory capacity. Can an emissions trading scheme for particulates improve air quality and reduce compliance costs for industry?

□□□□ □□□□□□□

India faces one of the world's worst air pollution crises. As of 2019, air pollution was the second highest cause of death and disability—ranking higher than smoking, high blood pressure, and poor sanitation.[3] Reducing ambient air pollution throughout India to the WHO's standard could increase life expectancies by up to five years.

One source of air pollution is industrial emissions, regulated in India through a rigid command-and-control policy, set by India's central pollution control board with enforcement delegated to individual states. The policy includes mandates on pollution control equipment and absolute emissions standards. In Gujarat, where this evaluation took place, the Gujarat Pollution Control Board (GPCB) enforces national pollution laws and regulations. These policies have included third-party audit systems, and environmental inspections of high-polluting industrial plants. Despite mandates, compliance with regulations is often low. This is partly because regulators have difficulty reliably monitoring pollution emissions. In practice, large penalties are only levied against serious violations, allowing smaller violations to escape enforcement. Investing in the physical equipment required to abate pollution is also often costly for firms, and the regulations do not differentiate between larger firms where abatement may be more costly and smaller or less active firms that pollute less even without the regulations.



Factories emit air pollutants in India. Photo: Yuanjian Li, J-PAL

□□□□□□□ □□□□□□□ □□ □□□□□□

In partnership with GPCB, researchers evaluated the impact of the first-ever emissions trading scheme for particulate air pollution on air quality and compliance costs for industrial plants. Due to the limitations of the command-and-control model, the GPCB collaborated with the research team and NCDEX e-Markets Limited (NeML), a subsidiary of the National Commodity and Derivatives Exchange in India, to introduce an ETS scheme in the industrial city of Surat, where the majority of polluting firms were part of the textile industry. Around 30 percent of these firms were polluting more than the national standard. The average level of fine particulate matter in the air near the plants was between ten and twenty times higher than the World Health Organization's recommended maximum concentration.

The evaluation followed the introduction of continuous emissions monitoring systems (CEMS) devices across the state, which take live readings of particulate emissions and transmit the readings to India's central pollution control board. Industrial plants that consumed solid fossil fuels, produced at least one ton of steam per hour, and had large enough stacks to install the CEMS were eligible to participate in the study.

Prior to the start of the intervention, the GPCB introduced the market through a series of workshops for stakeholders. Firms in Surat received training on how to set up the CEMS devices and information about the market rules, permitting and emissions accounting, data quality, and other relevant information. Researchers collected CEMS data from 292 factories, which made up the sample for this study and were randomized into the market intervention group, or the comparison group.

1. *ETS group* (156 firms): Firms in the ETS group were given permits that allowed the firm to emit 1 kg of particulate matter per permit. Each permit was valid for one 4–6-week compliance period. Firms received permits that covered 80 percent of their initial particulate matter emissions and had the opportunity to trade permits with regulators or other firms at weekly auctions or by making individual trades for a market price between INR 5 and INR 100 through a custom trading platform hosted by NeML. During the first compliance periods, the cap on total pollution in the market was set at 280 tons per month, but was reduced to 170 tons per month in later periods.
2. *Command-and-control (comparison) group* (136 firms): Firms in the command-and-control group were outfitted with CEMS devices but did not participate in the ETS and were subject to the status quo regulation policy described above.

ETS firms engaged in two periods of mock trading beginning in July 2019, with the market and evaluation officially launching in September 2019. The evaluation spanned ten compliance periods between September 2019 and April 2021, though market operations were suspended between March and December 2020 due to the nationwide Covid-19 lockdown. Researchers conducted an in-person baseline survey in December 2018, where firm owners were asked about their plants' energy consumption, sales, inputs, and outputs. Researchers also used the in-person survey to observe the sources of pollution and pollution abatement equipment at each plant. A follow-up survey was conducted over the phone in November 2020. Researchers also collected data from the CEMS devices installed at all of the participating plants and data on permit purchases from the trading platform.

□□□□□□□ □□□□□□□ □□□□□□□□□ □□□□ □□□□□□□□

Compliance with the ETS was high, and participating firms substantially reduced their particulate matter emissions without large increases in abatement costs, suggesting that the ETS was a cost-effective pollution reduction strategy.

Compliance: Firms in the ETS group were considered compliant with the market rules as long as their emissions did not exceed their permit holdings. Nearly all of the firms participating in the market complied with the regulations. Two noncompliant firms that were identified during the first compliance period received heavy fines and reduced their emissions below their permit holdings in later periods. Researchers believe that the fines helped the market and regulators establish credibility. At the same time, firms typically only held as many permits as were needed to cover their emissions, suggesting that firms were able to trade

permits fairly easily. Results suggest that the market functioned well overall and that in addition to high compliance, low and fairly consistent per-permit prices enabled firms to acquire permit holdings equal to their emissions.

Pollution: Firms participating in the ETS emitted between 20 and 30 percent less particulate matter than firms following the standard command-and-control policy. The average emissions from plants in the ETS group were less than 1,000 kg, the maximum particulate matter emissions allowed per plant per month, during every compliance period. Pilot data suggested that the CEMS devices alone had no impact on emissions. The researchers attribute the reduction in emissions to high compliance with the market and the ease of permit trading between firms, as well as the clear cap on emissions in the market, rather than the availability of emissions data exposing more violations.

Abatement costs: Participating in the ETS had no effect on firms' abatement costs. Researchers suggest that because the majority of firms had equipment installed before the ETS began, the amount they would need to invest in additional abatement would likely be low. However, because the ETS also lowered firms' emissions, additional abatement for ETS firms would likely be more costly, making it unclear why the ETS had little impact on costs. Using a model of abatement costs for firms under the command-and-control policy versus the ETS based on firms' willingness to pay for emission permits, researchers estimate that the cost to abate an additional ton of pollution is lower for firms participating in the ETS compared to firms in the comparison group at both high and low levels of baseline emissions. The researchers suggest that because firms were able to trade permits easily, smaller firms or firms where reducing pollution was less costly were able to sell their permits to larger or less efficient firms that would have expended more resources trying to reduce their emissions under the command-and-control policy.

The results suggest that the emissions trading scheme was not only effective in reducing particulate matter emissions from industrial firms but was also highly cost-effective once established.

Use of Results

Based on these promising results, the research team is working with government partners to scale the ETS in Gujarat and other highly-polluted Indian states. In 2022 the Government of Gujarat scaled the ETS to 294 industrial plants in Surat, a city with 5.9 million people living in its airshed. In 2023, the government launched a second ETS in Ahmedabad, the largest city in Gujarat with 9.3 million people residing in its airshed, reaching 120 industries. The government of Gujarat plans to expand the market to up to 600 additional industries across the state by 2025. The research team is also working with the Maharashtra Pollution Control board to scope a potential new market for sulfur dioxide (SO_2) emissions in Maharashtra.

Greenstone, Michael, Rohini Pande, Anant Sudarshan, and Nicholas Ryan. 2025. "Can Pollution Markets Work in Developing Countries? Experimental Evidence from India." The Quarterly Journal of Economics 140(2):1003-1060. https://doi.org/10.1093/qje/qjaf009.

---

1. Institute for Health Metrics and Evaluation. 2019. *State of Global Air 2019: A Special Report on Global Exposure to Air Pollution and Its Disease Burden*.
2. World Health Organization. 2022. "Ambient (outdoor) air pollution." Accessed May 5 2023. https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
3. Institute for Health Metrics and Evaluation. 2020. "India." Accessed May 17. http://www.healthdata.org/india