RESEARCH HIGHLIGHTS

Can Pollution Markets Work in Developing Countries? Experimental Evidence from India

by Michael Greenstone, Rohini Pande, Nicholas Ryan, and Anant Sudarshan

Context

Air pollution is one of India's foremost public-health concerns, with the average person in India losing about 3.5 years of life expectancy. Policymakers have struggled to reduce industrial pollution, with national PM2.5 concentrations increasing by 11.6 percent over the last two decades.

A new study shows that a cap-and-trade or pollution market is a win-win-win in Gujarat, India. Researchers worked with the Indian state of Gujarat to launch and evaluate the world's first market for particulate matter emissions. The market was implemented as a randomized control trial and the researchers found that it reduced emissions by 20 to 30 percent, decreased firms' pollution abatement costs, and increased government's success at enforcing the law.

Results at a Glance

- The plants that participated in the market reduced particulate emissions by 20 to 30 percent overall relative to plants that did not participate in the market.
- It cost plants that participated in the market 11 percent less to abate emissions compared to those plants under the command-and-control regulations.
- The emissions trading system (ETS) functioned well: plants held enough permits to cover their emissions 99 percent of the time, while those plants outside of the market met their pollution limit at most 66 percent of the time.
- In total, the benefits of the market exceed its costs by at an extraordinary amount, at least 25 times.

Pollution in India

Many countries today suffer from extraordinarily high air pollution with the average person living 1.9 years longer if global air quality complied with the World Health Organization (WHO) standard. In India, for example, nearly the entire population of 1.4 billion people breathes air more polluted than the WHO's guideline for particulate matter – often by a factor of 10 or more. To address this air pollution crisis, India relies on command-and-control environmental regulations modeled on those in the United States from 50 years ago. These regulations are stringent on paper, but weakly enforced in practice, perhaps because strict enforcement would be too costly for firms.

A powerful alternative to standards is to regulate pollution with markets. Markets have been proven effective in reducing pollution at a low cost in countries around the world. One of the largest such programs in history, the U.S. sulfur dioxide emissions trading scheme, slashed pollution by 40 percent between 1980 and 2003. Analysts have shown that the program's benefits exceeded its costs by a 40:1 ratio. Based in part on this example, successful trading markets have been adopted for a variety of pollutants in Canada and Europe. Yet, in spite of high pollution and a high concern for cost, low-income countries have not followed these examples.

A new study in the May issue of *The Quarterly Journal of Economics* examined how a new pollution market in India impacted plant compliance, pollution emissions, and abatement costs. Specifically, it studied the world's first market for particulate matter emissions, introduced by the Indian state of Gujarat in the city of Surat in 2019. The study is based on a randomized control trial that experimentally assigned some polluters to the new market and others to be regulated under the status-quo command-and-control approach.

Research Design

The study's research team collaborated with the Gujarat Pollution Control Board (GPCB) to build the institutions to support an emissions market — monitoring infrastructure to measure pollution on a continuous basis, new market regulations, and a platform to enable trade. The Surat market was introduced to accommodate a pilot study.

> "We have worked with the Gujarat Pollution Control Board for over a decade on testing policy interventions such as altering the incentives of third-party pollution monitoring and sharing emissions information with the public. This collaboration is setting a path for environmental policy across India."
>
> **NICHOLAS RYAN, ASSOCIATE PROFESSOR OF ECONOMICS AT YALE UNIVERSITY**

The GPCB mandated that 317 large, coal-burning plants install Continuous Emissions Monitoring Systems (CEMS) to measure the total amount of particulate matter emitted, as compared status quo measurements taken during periodic spot visits to the plants. From there, 162 of the 317 plants were brought into the market while the remaining plants were kept under the existing command-and-control regulations and spot-checked to ensure they met the pollution limit.

The GPCB set a cap on the total amount of particulates that could be emitted by all the plants in the market over a given compliance period. They allocated permits to treatment plants, with permits adding up to 80 percent of the cap distributed for free, in proportion to plant emissions potential, and 20 percent sold off in weekly auctions. Thereafter, treatment plants could trade permits with one another. At the conclusion of each compliance period, any treatment plant that did not hold enough permits to cover its emissions was subject to fines based on the size of the shortfall. There were a total of 10 compliance periods each of four to six weeks in duration.

The study was conducted by Michael Greenstone of the University of Chicago, Rohini Pande and Nicholas Ryan, both of Yale University, and Anant Sudarshan of University of Warwick. It is based on an evaluation that ran from September 2019 to April 2021, with an interruption due to a nationwide Covid-19 lockdown.

Findings

The market greatly increased compliance with environmental laws and functioned well. The plants within the market complied — that is, they held enough permits to cover their emissions — 99 percent of the time. By contrast, those plants outside of the market met their pollution limit at most 66 percent of the time. Further, the plants in the market traded permits often. At the end of each compliance period, plant permit holdings differed greatly from initial allocations, and plants left little money on the table in unused and unsold permits.

The market reduced particulate emissions by 20 to 30 percent. The plants that participated in the market reduced particulate emissions by 20 to 30 percent overall, relative to plants that did not participate in the market. The relative reduction in emissions for the plants that participated in the market was due both to the initial cap turning out to be stricter than command-and-control regulations, in practice, and to the regulator reducing the cap over the first several compliance periods. This lowering of the cap occurred because the market allowed the regulator to observe how inexpensive endogenously tightening regulation was after seeing the relatively low costs of compliance in the market regime.

The plants that participated in the market benefited from 11 percent lower pollution abatement costs, increasing their profits. It cost plants that participated in the market 11 percent less to abate emissions compared to those plants under the command-and-control regulations. This was due to the cap-and-trade mechanism. Plants were given an equal amount of pollution permits. Those plants that found it expensive to reduce pollution to meet the cap could instead purchase permits from plants that were able to reduce emissions inexpensively and had leftover permits to sell.

Figure 1 · Pollution Over the Trading Period

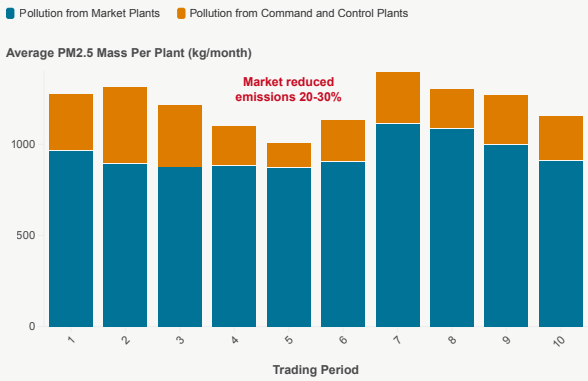
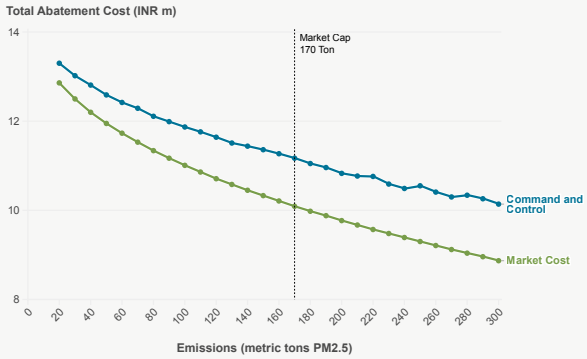


Figure 2 · Plant Cost to Reduce Emissions



The benefits of the market — from improved mortality by reducing pollution — far exceed the costs. The researchers combined their pollution and cost estimates, including the fixed costs of setting up the market, to conduct a benefit-cost analysis of a potential market expansion. This analysis found that, under a range of assumptions on the mortality damages from pollution, the benefits of the market exceed the costs by at least 25 times. It is usually a cause for celebration when a program has a benefit-to-cost ratio of 1.2, so this finding suggests there is a tremendous opportunity to be had in using pollution markets. The large benefits come from the large mortality costs of air pollution and the low costs of abatement in the market.

CLOSING TAKE-AWAY

"The market delivered a rare win-win-win by reducing pollution, decreasing abatement costs, and raising government's success at enforcing the law. And, it did all this in a setting where there was great skepticism that pollution markets could work. This success of pollution markets is generating a great deal of interest from other governments that are trying to balance the goals of economic growth and environmental quality. In addition to our continuing collaboration with the Gujarat Pollution Control Board, we're now working with other states in India and governments in other countries to scale-up the use of pollution markets."

MICHAEL GREENSTONE, MILTON FRIEDMAN DISTINGUISHED SERVICE PROFESSOR IN ECONOMICS AT THE UNIVERSITY OF CHICAGO

The Future of Pollution Markets in India and Beyond

Because of the success of the market, the GPCB expanded it to include those plants originally left out. It also launched a second market in the city of Ahmedabad — Gujarat's largest city and a major industrial hub — and is exploring expanding the market to additional industry clusters and pollutants. Meanwhile, the research team is working with another Indian state to develop a statewide market for sulfur dioxide emissions. The research team is providing strategic advice to several other Indian state governments and beginning conversations with other countries on how to use markets to meet their environmental and climate goals.

Ultimately, the study may hold insights for reducing carbon emissions as well as pollution in low- and middle-income countries.

"The exciting part of the ETS that we did for particulate matter, aside from reducing emissions, is that it provides a proof of concept that even in a setting with lower state capacity, a compliance market can work, and often will outperform the command-and-control approach."

ROHINI PANDE, HENRY J. HEINZ II PROFESSOR OF ECONOMICS AND DIRECTOR OF THE ECONOMIC GROWTH CENTER AT YALE UNIVERSITY

Research Summary By Victoria Ekstrom High And Vestal Mcintyre

The research team behind this work is affiliated with the Energy Policy Institute at the University of Chicago's India program (EPIC-India), J-PAL South Asia, and the Economic Growth Center at Yale University.

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