Policy brief
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How to regulate exposure to air pollution

In brief

- Airborne particulates kill millions of people each year. Analysis of global data describing particulate exposure suggests that an important component of exposure is determined by country-level policies.
- Statistically, the three best predictors of mean particulate exposure in a country are: Coal consumption, organic fuel consumption/ agricultural burning, and urban share of population.
- Exposure depends on having pollution and people in the same location. There is wide variation across countries in how sensitive exposure is to emissions.
- Reducing emissions will generally involve reductions of economic output. It is important that particulates are regulated with taxes resulting in tax revenue that can be used for other purposes.
- This policy brief provides an introduction to our model-based evaluation of three broad classes of particulates policies: Taxes on coal, oil, and agricultural burning for 31 countries. This should inform policymakers about the relative importance and cost effectiveness of regulating each class of particulate emissions.

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Overview of the research

It is hard to overstate the importance of particulates policies. According to the Global Burden of Disease Project, airborne particulates kill about three million people per year. Taking the value of a statistical life to be three million USD, this mortality has an annual value of nine trillion dollars. This is about 10% of the world's annual GDP. This estimate can be too large by a factor of 10 or 100 and still illustrate our point: particulates are poisonous and managing exposure is essential.

It is natural to suspect that the regulation of particulates will have unintended consequences for exposure and welfare. People should move to cleaner places and firms should move away from regulation and regulated activities. It is not hard to imagine that some rural farmers might respond to a restriction on agricultural burning by migrating to the city. This reduces exposure in the countryside but increases the population living in more polluted cities. Thus, a restriction on agricultural burning could lead to increases in average exposure in addition to increases in the cost of agriculture.

Our study investigates the determinants of equilibrium particulate exposure and the effects of simple regulatory strategies.

We proceed in two main steps. First, we assemble global remote sensing data describing ambient particulates everywhere in the world in 2000, 2005, 2010 and 2015 with a 10km resolution. By matching these data with population data, we can describe patterns of exposure. We find that:

- The geography of pollution is important. Between 2000 and 2010, average particulate levels in India increased almost three times as fast as they did in China. During the same period, exposure for an average person increased by about the same amount in both countries. This occurred because the population of China became relatively more concentrated in polluted places. The opposite happened in India.
- Ambient particulates experienced by a person in average is substantially determined by their country and not very much affected by variables at a fine spatial scale, population density and land cover in particular.
- Country-level exposure is almost entirely explained by a short and intuitive list of attributes at the country level. Coal consumption, agricultural and organic fuel burning, and urban share are particularly important.

In the second main step of our analysis, we develop the SEPIA Model which evaluates the effect of various strategies for regulating particulates. We calibrate this model for the 31 countries for which we were able to secure sufficiently complete data. These countries are home to about 60% of the world's population.

This model allows us to evaluate the impact of three simple regulatory strategies on emissions, exposure, and welfare. These policies are taxes on coal, agricultural burning, and oil. We find that:

- Countries are highly heterogenous in the way they respond to regulation. There is no one-size-fits-all best strategy.
- The link between emissions, exposure, and welfare is not a simple one. In particular, estimates of the way that emissions respond to regulation are imperfect predictors of changes in exposure and welfare. People and firms respond to regulations that increase the costs of emissions in intuitive but complicated ways. These responses often have implications for exposure that are large relative to the direct effect of regulation on emissions.
- Because combustion is so central to economic output, not all emissions reductions are welfare-improving, even when exposure is high. Reducing emissions can result in large reductions in consumption as well. Unsurprisingly, revenue-generating taxes on emission lead to welfare improvements more often than process controls that do not generate tax revenue.

The working paper provides more detail on these findings. We provide an evaluation of each of the three policies described above for each of the 31 countries for which we calibrate our model.