Improving Human Health
Through a Market-Friendly Emissions Scheme

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I. Introduction: Environmental Regulation for Improved Human Health

The goal of environmental regulation is to protect human health and livelihoods from environmental harms. The harm due to air pollution in India is very large. The Ministry of Environment and Forests (MoEF) conservatively estimated that air pollution contributed to 40,351 premature deaths in only 36 cities of India in 1995, and that the total economic loss caused by air pollution in these cities that year was US$1,310 million (MoEF, 1999). While this harm is widely recognized, regulating air pollution remains difficult because many of the economic activities that create air pollution—from transport to industry and electricity production—are themselves important for growth. Tight regulation using traditional models could therefore itself do harm by lowering living standards.

Market-friendly regulatory tools can make this trade-off easier by setting explicit, ambitious environmental goals and meeting them at low economic cost (Ellerman et al., 2000; Stavins, 2003). Market incentives can induce greater compliance with regulation and stoke innovation in cleaner production to raise environmental quality over time. Using market-friendly tools may seem paradoxical given that the harm of pollution is often caused by unchecked market activity, such as an industry burning a polluting fuel because it is cheap without regard to the impact its emissions have on neighbors. The goal of market-friendly regulation, however, is precisely to check such polluting activity by filling in missing markets—in this case, making sure that the industry accounts for the full cost of its fuel, not only in its own accounts but also through its unintended impact on neighbors' health.

This paper will discuss how a market-friendly scheme can reduce particulate emissions from stationary sources and contribute to the improvement of human health. While the scope of the scheme described is narrow, covering one pollutant from one type of source, the environmental problem it addresses has important consequences for human health. Section II discusses the literature on the danger of particulate matter air pollution and Section III the particulate matter air pollution scenario in India. Market-friendly regulation can be applied to a broad range of problems, and adding it to India's environmental toolkit can encourage more holistic, efficient approaches to environmental regulation over time. Section IV, on how market-friendly regulation can limit the net adverse environmental impact of economic activity, discusses the regulatory approach and how it is well suited to address the environmental problem described in Sections II and III. Section V concludes by briefly discussing how Indian regulators may adopt market-friendly regulation in a pilot form in order to scientifically measure the effect of this regulatory tool on environmental and economic outcomes in the Indian context.

II. Health Effects of Particulate Matter Air Pollution

A large and growing body of strong evidence shows that particulate matter is harmful for human health and shortens life spans. According to the WHO, particulate matter affects more people than any other pollutant and there is no threshold concentration below which no harm to health occurs (WHO, 2008). Chronic exposure to particles, especially fine particles, raises the risk of cardiovascular disease and respiratory disease, such as bronchitis and asthma, and the incidence of lung cancer (WHO, 2008). Even apparently healthy people may have reduced lung function as a result of long-term particulate matter exposure (US EPA, 2008). Particulate matter has been demonstrated to increase mortality for both children and adults, with especially large increases for infants with high exposure during gestation (Chay and Greenstone, 2003; Currie and Walker, 2011; Chen et al., 2010). As this paper is primarily about how regulation might improve the trade-off between economic activity and health, we focus on several studies that directly link regulation to the effects of pollution on health.

An early and influential study directly linked the operation of a steel mill to disease incidence and death for nearby residents (Ransom and Pope, 1995). A steel mill in a valley in Utah, United States closed for a period of 12 months, reducing levels of PM_{10} during the winter by approximately fifty percent. As in Delhi, the climate in this valley is dry and temperature inversions, in which cool air stays near the ground and can trap pollutants, are common during the winter months. During the period when the mill was open, residents experienced higher rates of hospitalization for respiratory disease and higher mortality rates, relative to residents of a neighboring valley that were not exposed to pollution from the mill. In a population of 264,000 residents, Ransom and Pope estimate the total damage from disease and mortality, in dollar terms, to be US$42 million per year. The estimates from this study are especially convincing because they directly link the activity of a single large polluter to well-measured health effects.

In China, higher levels of particulate matter cause lower infant birth weight and higher mortality for both infants and adults (Chen et al., 2010; Tanaka, 2010). Chen et al. study the Huai river policy, which provided free home heating north of the Huai river and thereby increased coal burning. Areas north of the river had higher Total Suspended Particulate (TSP, also called SPM) pollution levels, especially during cold winters when people utilized their free heat. These higher pollution levels harmed infants and adults. An increase in TSP of 100 $\mu g / m^3$ is associated with a reduction in average life expectancies of roughly 2.5 years, which is an enormous loss across the large population of northern China. This effect is driven by elevated mortality rates throughout the lifespan. Further, the same increase in TSP during the prenatal period is associated with declines in birth weight of 14 grams; some recent research finds that lower birth weights can reduce labor market earnings later in life (Black et al., 2007). Tanaka (2010) studies a different policy, also in China, that imposed more stringent regulations on emissions from power plants. Tanaka finds that these regulations reduced air pollution and that this lower air pollution, in turn, reduced infant mortality—a one percent reduction in TSP pollution reducing the infant mortality rate by 0.95 percent.

Although somewhat less persuasive than the previous literature on the overall impacts of TSP, there is emerging evidence that suggests the impacts of particulate matter air pollution falls disproportionately on disadvantaged parts of the population. For example, Tanaka (2010) finds greater effects of pollution among infants from families of low socio-economic status; Jayachandran (2009) finds greater effects of prenatal pollution exposure in poorer areas of Indonesia; and Chay and Greenstone (2003) find greater sensitivity of black infant mortality to particulate pollution in the United States. Kumar and Foster (2011) estimate long-term exposure to air pollution for about four thousand residents of Delhi. They find that air-quality interventions such as the conversion of commercial vehicles to natural gas had a greater effect for the generally poor individuals who spent more time out-of-doors. An earlier study by Cropper et al. (1997) found that a 100 µg / m^3 increase in TSPs in Delhi raised total daily deaths there 2.3 percent. Exposure may also be greater for industrial workers. Sivacoumar et al. (2001) measure high exposures to fine particulates for workers in the Indian stone-crushing industry.

III. Particulate Matter Air Pollution Scenario in India

Particulate matter is by far the most problematic air pollutant on a national scale, with annual average concentrations of Suspended Particulate Matter (SPM) exceeding the NAAQS in most cities (CPCB, 2006; MoEF 2009). India's national average of 206.7µm/m^3 of Suspended Particulate Matter (SPM) in 2007 was well above the old National Ambient Air Quality Standard (NAAQS) of 140 µg / m^3 for residential areas. Most Indian cities exceed, sometimes dramatically, the current NAAQS of 60µm / m^3 for Respirable Suspended Particulate Matter (RSPM). Average annual concentration of RSPM in Delhi is about 120 µg / m^3, as against a residential National Ambient Air Quality Standard of 60 µg / m^3 and World Health Organization (WHO) guidelines of 20 µg / m^3 (CPCB, 2006; WHO, 2008). Five of six cities covered in a recent report exceeded the standard in all years 2000-2006 (CPCB, 2011). By contrast, sulfur dioxide (SO_2) and nitrogen oxides (NO_x), two of the largest air pollution problems in the United States, are less of a problem in India. Most cities are below the NAAQS for these pollutants.

The figures above have referred to both Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM). SPM is a broader category referring to all suspended particulate matter less than 100 micrometers in diameter. Research on the health effects of particulate matter indicates that the smaller particles in RSPM are more dangerous for health because they penetrate deeper into the lungs (USEPA, 2008). In India, RSPM is defined as fine particles less than 10 µm. Other countries refer to this pollutant as PM_{10} and may also measure $PM_{2.5}$, for smaller particles less than 2.5 µm in diameter.

Indian standards recognize the danger of air pollution. In November 2009, the MoEF announced a new National Ambient Air Quality Standards (NAAQS) (CPCB, 2009). Compared to the previous version from 1994, the revised NAAQS brought six new pollutants under regulation, tightened the acceptable ambient concentration for other pollutants and eliminated the distinction between industrial and residential areas. As a result, many urban areas—which may have been out of compliance even with the older norms—must significantly cut emissions to move towards the more stringent, uniform standards now in place. The shift from regulation of ambient SPM to RSPM in the new NAAQS in particular is significant in directing the focus of regulation to those pollutants that matter for human health.

IV. Market-Friendly Regulation to Limit Net Adverse Environment Impact

Lowering particulate matter pollution requires a holistic approach to environmental regulation, as recognized by the Environment (Protection) Act, 1986 and accompanying Environment (Protection) Rules. Rule 5 specifies that regulation can take into account the "net adverse environment impact" likely to be caused by an industry or operation—that is, not only the narrow details of the activity, but its overall effect on the site and population. Regulation should consider the sources of particulates for an area as a single whole and work to reduce emissions from these sources at a low cost.

Introducing a market-friendly emissions scheme for industrial particulate matter emissions is one important step in this direction. A market-friendly scheme will encompass all significant fixed sources within a given area and explicitly target reductions in total emissions levels. Such a scheme provides incentives for industry to abate emissions at the lowest possible cost and to seek cleaner ways to produce over time. By lowering abatement costs, now and in the future, such a scheme also empowers regulators to target and achieve more ambitious emissions cuts.

Though industries are only one source of particulate matter emissions, market-friendly regulation of industries is a sensible place to introduce a market-friendly regime for at least three reasons. First, as noted by CPCB (2011), "pollution levels are the highest at industrial sites (e.g. SPM, maximum ~ 1400 µg / m^3 and PM10 maximum 1000 µg / m^3 in Delhi) in all cities compared to their corresponding residential and background locations" (CPCB, 2011). A number of industrial clusters across the country are critically polluted with respect to air (CPCB, 2009). These maximum pollution concentrations pose serious threats to human health. Second, though particulates come from many sources, industries burn fuel that generates the fine particles (RSPM) that are most damaging to health. Therefore industry contributes a greater share of RSPM than SPM emissions load (Kothai et al., 2008). Third, as a practical matter, identifying and monitoring emissions from large point sources of particulates can be easier and less costly than checking hundreds of thousands of vehicles and cooking fires. In the United States, market-friendly industrial programs have been extremely cost-effective (Ellerman et al., 2000), whereas annual vehicle emissions checks are thought to be of too high a cost given the reductions in emissions they achieve (Freeman, 2002; McConnell, 1990).

A market-friendly particulate emissions scheme will work to improve the Indian environment most broadly by transforming the trade-off between environmental quality and growth. An emissions trading scheme is a regulatory tool used to reduce pollution emissions at a low overall cost. In such a scheme, the regulator sets the overall amount of emissions but does not decide what any particular source will emit. Industrial plants and other polluters, rather than being told a fixed emissions limit or concentration standard, face a price for their emissions and choose how much to emit, within reasonable limits, taking this price into account. The price of emissions makes pollution costly and gives polluters an incentive to cut back (Duflo et al., 2010).

This market-friendly form of regulation builds in several features to improve environmental quality. The regulation sets an overall cap on emissions levels from a group of sources, which is what matters for health impacts. The lower cost of meeting environmental targets means that emissions limits can be more ambitious, and innovation driven by market incentives means environmental quality targets can improve over time. Lastly, important for the Indian context, continuous monitoring and incentives can lead to better compliance with regulatory standards. We will discuss each of these features in turn.

A. Overall Cap on Emissions Levels.

Emissions markets target the total mass of particulate emissions, which is what affects health, whereas traditional forms of regulation target emissions concentrations. Emissions markets fix the overall level of emissions from a group of sources by allocating a fixed number of permits to emit a certain mass of a pollutant; this limit on emissions will correspond to some limit on ambient pollution levels, given fixed emissions from sources of other types. The regulator can therefore establish the market parameters to target a given level of total source emissions.

Traditional regulation, by contrast, cannot target aggregate source emissions in order to improve health. Current regulations of industrial emissions in India specify that the concentration of Suspended Particulate Matter (SPM) not exceed 150 mg / normal m^3. (The standard may vary by industry and type of control equipment installed.) While limiting concentrations are important, this concentration limit itself does not imply any limit on the total emissions in an area. One large industry, or many small industries, may remain in compliance with the particulate concentration limits at all times and yet emit such a large overall mass of particulates as to contribute to dangerously high ambient levels. This appears to be the scenario in some industrial clusters—while compliance with particulate norms may not be complete, the far greater harm to the environment comes about from the sheer number and size of industrial units. But as norms are specified in concentration the regulator has no means to check aggregate emissions other than totally barring new investment, which is very costly in terms of economic growth.

B. Cost Reductions and Emissions Targets.

The second major benefit of market-friendly regulatory instruments is that the cost reductions they create can facilitate the promulgation of more ambitious environmental goals. Market-friendly regulation can achieve levels of environmental quality that would be prohibitively expensive or impossible to attain with traditional regulation. Emissions markets achieve cost reductions by being flexible with respect to who emits while keeping total emissions strictly constant. With most common pollutants, what matters for health is, after all, not who emits them but the total emissions within a given area. By fixing this total and allowing trade between different firms for the right to pollute a certain share, emissions trading schemes allow firms who can more cheaply reduce emissions to achieve more of the overall reductions. This trade therefore lowers the overall cost of meeting the pollution target. By contrast, mandating the same standard everywhere will generally miss the best opportunities for abatement.

A lower cost of regulation allows regulators to target lower emissions levels. In the United States, the experience of the Acid Rain Program has borne this advantage out. The program immediately met steep emission cuts of 50% and these targets have been made tighter over time, contributing to a 76% decrease in the national average of sulfur dioxide from 1980 to 1999 (Ellerman et al., 2000; US EPA, 2010). Innovation in meeting emissions goals may have allowed these more ambitious targets. Industry sought out low-sulfur coal from new or underused sources after the Acid Rain program was introduced. This fuel-switch, driven by the emissions market, unexpectedly lowered the overall costs of abatement under the program.

C. Compliance and Transparency.

A third major benefit of market-friendly emissions regulation is an increase in transparency and compliance. Running an emissions market requires continuously measuring emissions from each participating source with great accuracy in order to aggregate emissions over each compliance period. This close attention prevents clandestine emissions and may help under-resourced SPCBs reach environmental targets. (See CSE, 2009 on the apparent inadequacy of SPCB staffing.) The emissions market, in turn, provides steady incentives to abate emissions. By contrast, the present system of infrequent visits and large but unpredictable penalties for noncompliance may encourage firms not to comply.

The emissions and compliance data collected in market-friendly regulation can also be publicly disclosed in order to promote a higher level of transparency and accountability. At present the level of pollution emissions in various clusters can be hard to ascertain and the functioning of SPCBs can be opaque. By collecting far more data and making this data publicly available at a lag sufficient to protect industry confidentiality, the Boards will commit to well-defined goals for total emissions and may be held accountable for meeting them by an active public.

V. Conclusion: Piloting Market-Friendly Regulation

Market-friendly regulatory instruments can transform the trade-off between environmental quality and growth, if these instruments are properly designed and implemented,. The benefits of market-friendly regulation mentioned above, of meeting environmental goals and lowering abatement costs, depend on the development of an active emissions market with complete compliance. Piloting a market-friendly emissions scheme as a regulatory experiment in several states, covering critically polluted areas, would therefore provide important proof of the viability of this form of regulation in the Indian context.

The goals of this piloting are twofold. First, implementing market-friendly regulation in critically polluted areas in several states would test its viability. A smaller scale would allow careful focus on the emissions monitoring infrastructure and market rules and the development of expertise in this new form of regulation. The government can then use the results of an evaluation of the pilot to determine the applicability of market-friendly regulation to additional pollutants and geographic areas and to inform the design of future regulations. This learning effect can be very important, for example, to help the regulator set an appropriate cap on aggregate emissions (Ellerman and Buckner, 2008).

The second goal of piloting is to prove the effectiveness of market-friendly regulation to industry and the Indian public. A pilot experiment can collect extensive, accurate data on how the regulation affects abatement costs, of interest to industry, and emissions, of interest to citizens. This form of regulation has the potential to be a true win-win policy, advancing the goals of both groups by lowering cost and emissions at the same time. An experimental pilot will offer gold-standard evidence to show whether market-friendly regulation has achieved these goals in practice.

VI. References

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