The Net Benefits of Incentive-Based Regulation: A Case Study of Environmental Standard Setting

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Introduction

- decentralized, incentive-based (or IB) policies are more efficient than centralized, command-and-control (or CAC) approaches

- IB policies will accomplish the same goals as their CAC counterparts, but at less cost to society
- **However IB fails to consider improvements that exceed the standards**
- Empirical Evidence..
- data on the costs and benefits of controlling a common air pollutant, total suspended particulates (or TSP), in Baltimore.
- They estimate the MC and MB associated with a variety of alternative air quality standards which take the form of maximum permissible concentrations.

- Suppose that we have a specific *"region"* in which there are m sources of pollution

- Environmental quality is defined in terms of pollutant concentrations at each of n "receptor points" in the region.
  - Measure environmental quality by a vector $Q = (q_1, q_2, ..., q_n)$ whose elements indicate the concentration of the pollutant at each of the receptors.
- The dispersion of emissions from the m sources in the region is described by an $m \times n$ matrix of unit diffusion (or transfer) coefficients:

$$D = \begin{matrix} . \\ . \\ ...d_{ij}... \\ . \\ . \end{matrix}$$

- d_{ij} indicates the increase in pollutant concentration at

- Denote by e_i the level of emissions by source i, then the pattern of waste emissions in the region is:
  - $E = (e_1, e_2, ..., e_m)$.
- The levels of pollution at the various receptor points can then be determined by mapping the vector of emissions through the diffusion matrix:
  - $ED = Q$
- Abatement Cost Function $C_i(e_i)$
- Standard:maximum permissible level of pollutant concentration at any receptor point in the region.
- **CAC:**the agency might specify abatement technologies for the sources
- Such a control program would result in a specific vector of emissions from sources, E_C,. And this vector would map through the diffusion matrix into a vector Q_c, of pollutant concentrations.

- **IB strategy:** *it seeks that vector of emissions (E_1) that can attain the standard at the minimum aggregate abatement cost*
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$$\begin{aligned} & \min \sum C(e_i) \\ s.t.\ ED & \leq Q^* \\ E & \geq 0 \end{aligned}$$

- IB, by definition, achieve the standard at a cost less than (or equal to) CAC program
- the IB vector will entail higher levels of emissions and higher levels of pollutant concentrations at nonbinding receptor points than will the CAC solution.
- The levels of both benefits and control costs associated with a particular standard will, in consequence, tend to be higher under a CAC than under an IB.

- They used a model developed by McGartland (1983,1984) which reflects the technological control possibilities, associated particulate reduction efficiencies, and costs for about 400 actual sources in Baltimore.
- Marginal Costs:
- $C_i'(e_i\,/\,IB)$:reflects, for each possible standard considered. the least-cost combination of control options across all particulate sources that ensures attainment at all receptors.

- $C_i'(e_i / CAC)$:adopted the basic spirit of the regulatory strategy used in Baltimore:
    - all sources were categorized and similar sources grouped together
    - marginal costs for additional control were estimated for each source category
    - when additional controls were required to reduce particulate levels, the source category with the lowest cost-per-ton was targeted for further regulation;
    - all sources within that category were required to adopt the same technology regardless of their individual costs or location.

- Marginal Benefits:
- To estimate the MB associated with alternative standards, they identified the **"exposed population"** of the Baltimore metropolitan area to one of the 23 receptors in the area (ranging from as few as 3,800 people assigned to one receptor to more than 180,000 at another)
- They calculated marginal benefits from successively tighter TSP standards for four different categories:
  - reduced premature mortality,
  - reduced morbidity,
  - reduced soiling damages to households,
  - and improved visibility

- The changes in TSP levels that would accompany successively tighter standards were first translated into physical improvements:
    - fewer sick days, fewer "statistical" lives lost, reduced soiling, and increased visibility
    - They monetized these physical improvements using recent studies

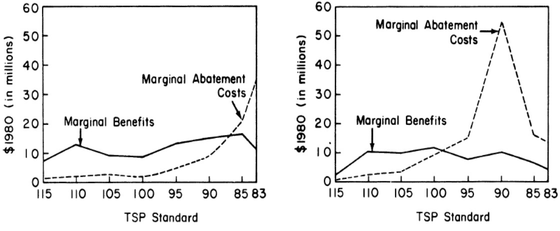
- 

FIGURE 1. LEAST-COST CASE

FIGURE 2. COMMAND AND CONTROL CASE

- by equating $MC = MB$, the IB approach would give us a more stringent standard than the CAC regime.

- However:The source of the confusion is the natural inclination to associate **air quality standards** with **air quality levels**.
  - an air quality standard maps into a vector of pollutant concentrations and the mapping itself depends upon the regulatory regime.
- IB would lead us to select the more stringent standard for air quality, but it does not necessarily follow that this would actually result in better air quality
- Thus, the same standard on the horizontal axis in our figures will produce a different vector of air quality under our two regulator systems.

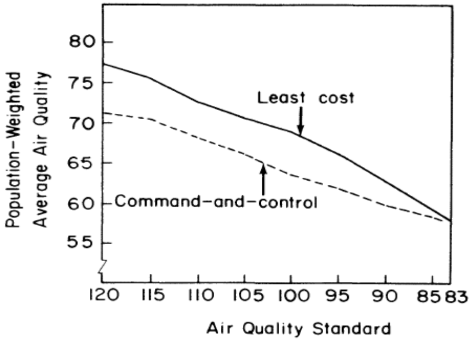
- 

FIGURE 3. POPULATION-WEIGHTED AVERAGE AIR QUALITY UNDER THE LEAST COST AND COMMAND AND CONTROL SYSTEMS

- First result: although the IB regime results in a more stringent "optimal" standard, there is really little difference in overall air quality under the "optima" of our two systems.

- This calculation is more problematic:

TABLE 3—A COMPARISON OF THE CUMULATIVE NET BENEFITS UNDER THE TWO SYSTEMS (MILLIONS OF 1980 DOLLARS)

1. *Incentive-Based Case: Net Benefits from Moving from a Standard of 120 $\mu g/m^3$ to the "Optimal" Standard of 90 $\mu g/m^3$*	
Cumulative MB	$66.17
Cumulative MC	20.97
Cumulative Net Benefits	$45.20
2. *Command & Control Case: Net Benefits from Moving from a Standard of 120 $\mu g/m^3$ to the "Optimal" Standard of 100 $\mu g/m^3$*	
Cumulative MB	$33.86
Cumulative MC	15.41
Cumulative Net Benefits	$18.45
3. *Adjustment of Net Benefits Under the CAC System*	
Cumulative Net Benefits Under CAC	$18.45
Less: Baseline Control Costs in Excess of IB Case	7.81
Plus: Baseline Benefits in Excess of IB Case	28.67
Adjusted Cumulative Net Benefits	$39.31

- The difference between the cumulative net benefits under the two systems is quite small. As Table 3 shows, the cumulative net benefits under the IB outcome exceed those under the CAC case by only about $6 million when evaluated at their respective "optima."

- Some sensitivity analysis using upper and lower bounds for our benefits estimates suggests that the "optimal" standard under both systems is quite sensitive to our choice of benefits measures.

- IB policies designed to achieve prescribed regulatory standards at least cost may not be so obviously superior to CAC approaches as has been supposed.
- When we take into account real-world regulatory institutions that require uniformity of fees, incentive-based programs may not clearly dominate well-designed CAC measures