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The Economics of Pollution Control

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Environmental issues tend to elicit emotional responses from people across the political spectrum. This can often confuse the debate and hinder progress when it comes time to consider difficult choices related to environmental policy. Economics provides a set of tools that can be used to organize our thinking on environmental issues and help in the design of solutions.

This issue of the NC State Economist discusses how economists view pollution problems. Economic analyses of pollution and pollution management focus on tradeoffs between increased material prosperity and a cleaner environment, and use this notion to define pollution management goals. How economists think about these tradeoffs, as well as examples of environmental policy tools favored by economists, will be discussed.

The Cause of Environmental Degradation

Popular debates on environmental problems often begin by drawing sharp distinctions between polluters and people who suffer because of pollution. In many instances this takes on an *us* versus *them* flavor in which a large faceless entity (often a corporation) is the unjust *them* inflicting harm on *us*. Sometimes this simple dichotomy is close to accurate, but in most cases the issue of right and wrong is less clear. For example, in the eastern United States almost all sulfur dioxide pollution comes from a relatively small number of coal-burning, electricity-generating plants. Sulfur dioxide emissions are the primary cause of acid rain which destroys forests, poisons lakes and streams, and can have negative impacts on human health. So are the large electricity plants to blame? In one sense, yes, they produce the emissions. But in another sense, people who use electricity are to blame - which is just about everyone. So the *them* in the blame game becomes *us*: we both cause the environmental damage (through our use of electricity) and suffer its consequences (reduced enjoyment of forests, lakes, and streams).

The sulfur dioxide example illustrates a general point. While for some specific environmental problems it is easy to assign blame, in most cases blame is elusive or widespread when we look beyond the obvious. This realization has important consequences for how we think about pollution and public policy responses to it. If environmental degradation is not the result of wrong doing by a specific entity, but rather a by-product of the consumption behavior of our entire society, then policy should be aimed at managing the problem rather than punishing the perpetrators. Punishment of polluters might be a means towards the end of reducing pollution, but it should not be an end in and of itself when a society has shared blame for its environmental problems.

This viewpoint is useful for two reasons. First, it allows us to focus on examining the tradeoffs between the desirable (material well-being) and undesirable (environmental degradation) aspects of economic activity without engaging in distracting moral debates. Second, it allows us to consider a range of policy options that concern themselves first and foremost with reducing pollution with the least reduction in material well-being.

An Acceptable Level of Environmental Degradation?

Designing policy to combat environmental degradation requires first determining what an acceptable level of pollution is, and then designing a specific policy to obtain that level. What tools of environmental economics can be utilized to think about the "correct" level of pollution?

Economists approach this problem by considering tradeoffs between the benefits and costs to society as a whole of reducing pollution, relying critically on the concept of *marginal analysis*. Marginal analysis simply involves looking at things incrementally. In considering the question of an acceptable level of environmental degradation, economists ask the question "at current levels of emissions, would the benefit of reducing pollution by a small amount outweigh the costs?" If the answer is yes, the step should be taken and the question asked anew. Conceptually, then, the economist's recommendation is to incrementally reduce pollution until the benefit of the last reduction just offsets the costs, and then go no further. In this way, the correct level of environmental degradation is defined as one that balances the incremental benefits of reduction with the incremental costs of achieving the reduction.

This incremental approach requires knowledge of the benefits and costs to society of reducing a particular, context specific, polluting activity. Consider again the example of sulfur dioxide emissions by coal-fired electricity plants in the eastern United States. In general, plants can reduce emissions in three ways: (1) by switching from eastern-produced, high-sulfur coal to western-produced, low-sulfur coal; (2) by installing *scrubbers* onto smokestacks to catch sulfur before it is emitted; or (3) by shutting down. The first option is somewhat costly in that it involves purchasing and transporting coal via rail across the continent; but it can reduce emissions at a plant by perhaps 30-40%. The second option is more costly in that it involves a large capital expenditure, but it can reduce emissions by 90%. The third option reduces emissions completely, but at the cost of no electricity being produced. Because markets for electricity are inter-connected, these costs are borne by society as a whole. Thus, it is relatively inexpensive for society to remove 30% of emissions, but it becomes progressively more expensive to remove more.

The incremental benefits of sulfur dioxide reduction consist of the environmental improvements that occur when emissions are reduced. The physical improvements are determined by the resilience of natural systems. While high levels of acid rain will kill forests and poison streams with certainty, low levels can be absorbed with little or no notable impact. Thus initial reductions from a high emission baseline that move the natural system away from the threat threshold will have large environmental benefits, while subsequent decreases will have less dramatic benefits.

The acceptable level of environmental degradation in this case is determined by society's willingness to accept incrementally higher electricity prices in exchange for incrementally improved forest and stream health. The cost of complete emission reduction is very high (ceasing electricity production from coal all together), and the incremental benefits of achieving extremely small levels of emissions are very low (due to natural resilience in forest and stream systems). In other words, there is likely to be some *optimal* level of sulfur dioxide emissions greater than zero but less than the non-regulated baseline.

This story is static in that it considers the relative costs and benefits of sulfur dioxide reduction given electricity generation technology at the current point in time. Over time, however, technology can improve. For example, if alternative methods for producing electricity cheaply *without* burning coal become available it will become relatively cheaper to prevent sulfur emissions simply by switching from coal to the alternative. To a degree this has occurred. Over the past twenty years technology improvements in wind turbines have caused the cost of electricity generated from wind to fall by 90%, to the point that the cost per kilowatt-hour of electricity generated at installed plants by coal and wind are roughly comparable.

Design of Environmental Policy

The sulfur dioxide case illustrates a general point that is central to how economists think about an acceptable level of environmental degradation. At any point in time there will be costs and benefits to society associated with pollution reductions, and striking a balance between these determines the best level of reduction. Moreover, as time moves on and technology improves environmental degradation should be reduced. These two factors underpin economists' general approach to thinking about the design of environmental policy.

Economists seek policy outcomes that balance the competing desires of more material wealth with a cleaner environment. To precisely estimate just where this balancing point lies, economists attempt to determine a level of pollution reduction that equates costs and benefits, encourages technology developments that shrink the cost of pollution reductions, and finds ways to achieve these goals with the least reduction in society's material well-being. Policy ideas based on *economic incentives* have been proposed to achieve these goals. Popular debates on environmental policy tend to emphasize a coercive approach to policy in which legislation or executive order establishes acceptable behavior for polluters, and deviations from this are punished with fines or other sanctions. Economists, by contrast, prefer a subtler type of regulation in which firms are provided with incentives to reduce pollution, and do so because it is in their interest. Two types of regulation have gained favor with economists: emission taxes and transferable pollution permits.

Emissions Taxes

Emissions taxes are based on the simple idea that firms be required to pay a fixed tax for each unit of pollution they emit into the environment. Thus firms may freely choose their level of emissions, but will do so knowing that there are financial consequences of being a polluter. Because of this, polluters have an incentive to find ways to reduce emissions. So rather than prescribing particular actions, an emissions tax allows polluters to employ existing technologies to achieve a level of emission reductions appropriate to their unique circumstances.

There is an added bonus to this type of policy. Because polluting firms can avoid tax payments by avoiding emissions they have incentive to seek out and deploy cleaner production methods. This can push forward the technology envelope, and ultimately lead to both a cleaner environment and greater material wealth. This is a key point: the ability to both grow materially and maintain the environment depends critically on the development of production technologies that are both affordable to use and environmentally friendly. For this reason economists consider policies that encourage firms to invest in research and development to be inherently superior to those that do not. Importantly most types of coercive regulation do not provide this type of encouragement in that once the prescribed behavior is met firms have no additional incentive to seek further emission reductions.

Transferable Emissions Permits

The second type of regulation favored by economists is a system of transferable emissions permits. In this type of regulation the government determines the target level of total emissions per year and distributes a number of certificates to the polluting firms that sum up to the total emissions target. If a firm emits a unit of pollution, it must turn in a certificate. Thus firms need to possess enough certificates each year to cover their emissions.

Importantly, the certificates may be traded among the polluting firms. Firms with fewer emissions (and hence less of a need for the certificates) can earn additional profits by selling excess certificates to firms with larger emissions. In this way a *market* for pollution rights arises, with the total amount of pollution capped at the total number of available certificates. As with the pollution tax case, firms have incentive to reduce their emissions. This allows them to either purchase fewer or sell more certificates, and thereby improve their bottom line. For the same reason a system of transferable pollution permits also will encourage firms to seek out and deploy cleaner

production technology. Finally, the government can precisely control the overall level of emissions by its allocation of total certificates.

Conclusion

The objective of this article has been to convey an understanding of how economists view problems related to environmental pollution and to give some sense of the thought process that motivates this view. Society is best served when debates on environmental issues and solutions include several viewpoints - political and distributional as well as economic. The economist's way of thinking about pollution policy can contribute a perspective that is often lost in the emotional rhetoric surrounding environmental issues. By using the analytical tools of economics we can identify the sources of environmental degradation and consider solutions absent the usual moralizing. In this way economists can contribute disinterested logic to an area that often lacks precisely this viewpoint, and can thereby help achieve outcomes consistent with societal goals.

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