Chapter 8

Estimating the Benefits of Environmental Regulations

A. Myrick Freeman III

The purpose of this chapter is to identify and evaluate the available techniques and economic models for estimating other than human health related benefits from environmental regulations. The benefits associated with improved longevity, health, and safety are discussed in the previous chapter. This chapter focuses on the benefits of such things as improved productivity of agriculture and other commercially exploited ecosystems, improved opportunities for recreation, aesthetics, and so forth.

The Structure of a Benefits Estimation Model

The evaluation of any particular technique for estimating the benefits of an environmental regulation involves answering two major questions. First, is the technique based on a conceptually valid theoretical model that captures the principal physical, biological, and economic relationships? Second, are the data requirements of the model reasonable; that is, are the required data available or can they be gathered at reasonable cost? In order to get a clearer picture of the data requirements and the roles of physical, biological, and economic models in benefit estimation, it will be helpful to examine the underlying structure of the benefit estimation problem.

The ultimate objective of the analysis is to measure the welfare gains associated with an environmental regulation. A regulation affects the decisions and behavior of sources of pollution. As a consequence there are changes in the rates at which polluting substances are discharged into the environment. These changes in turn lead to changes in the concentrations of substances in the environment over some geographical area. Changes in measures of environmental quality affect the uses made of the environment by both producers and individuals acting as consumers. It is these changes in the uses of the environment which have welfare implications and which can, in principle, be measured in money terms.

The process by which the benefits of environmental improvement are produced by a regulatory policy has three distinct stages. Estimation of the benefits of a regulation requires knowledge of the relationships involved in each of these stages:

1. Regulatory policy leads to improvements in environmental quality. Emissions standards or effluent charges, if effective, induce polluters...
to reduce their discharge of polluting substances. Changes in the
temporal and spatial pattern of discharges lead to changes in the
temporal and spatial patterns of air and water quality.

2. Changes in environmental quality result in changes in the types and
levels of human uses of the environment.

3. Changes in human uses of the environment affect utility or welfare.
These changes can be measured by monetary equivalents, measured in
terms of willingness to pay.

The first stage is almost entirely noneconomic in nature because it
involves a variety of physical, chemical, and biological processes and
relationships. The third stage is wholly within the realm of economics
because it involves demand and production theory and the theory of
economic value. The second stage involves the interface between the
noneconomic and economic stages of the production of benefits.
Understanding of this stage is essential if empirical estimates of benefits are
to be made.

To formalize these relationships, consider the following highly idealized
model. Assume there is only one polluting substance discharged into the
environment. Let $D$ represent the quantity of this substance which is
discharged per year. Suppose that environmental quality can be measured
by a single parameter $Q$. Let $X$ represent the level of an activity which is
adversely affected by pollution. Finally let $W$ represent the level of
economic welfare associated with $X$, measured in money. It might be helpful
to think of the following concrete example: $D$ is biochemical oxygen demand
($BOD$); $Q$ is dissolved oxygen ($DO$); $X$ is recreation days per year. The
model can be expressed as:

\[
Q = Q(D), \quad (dQ/dD < 0) \\
X = X(Q), \quad (dW/dQ > 0) \\
W = W(X), \quad (dW/dX > 0)
\]

By substitution we have

\[
W = f(D), \quad dW/dD < 0
\]

The benefit of a pollution control regulation that reduces $D$ from $D_1$ to
$D_2$ ($= \Delta D$) is

\[
B = \Delta W = f(D_2) - f(D_1)
\]

where $B$ is an aggregate of the compensating or equivalent variations of all
people affected by the change in $D$.

Estimating the benefit of a proposed regulation entails first predicting the
responses of affected dischargers, that is, $\Delta D$, and then tracing the effects of
$\Delta D$ through the links described by Eqs. (1)–(3) to calculate the resulting
welfare changes in monetary terms. Predicting dischargers’ responses to
regulations is itself a challenging task that raises issues beyond the scope of