Abstract

Section 812 of the Clean Air Act Amendments of 1990 requires the Environmental Protection Agency (EPA) to periodically assess the effect of the Clean Air Act on the "public health, economy, and environment of the United States," and to report the findings and results of its assessments to the Congress. Section 812 further directs EPA to evaluate the benefits and costs of the Clean Air Act's implementation, taking into consideration the Act's effects on public health, economic growth, the environment, employment, productivity, and the economy as a whole. This EPA Report to Congress presents the results and conclusions of the first section 812 assessment, a retrospective analysis of the benefits and costs of the Clean Air Act from 1970 to 1990. Future reports will detail the findings of prospective analyses of the benefits and costs of the Clean Air Act Amendments of 1990, as required by section 812.

This retrospective analysis evaluates the benefits and costs of emissions controls imposed by the Clean Air Act and associated regulations. The focus is primarily on the criteria pollutants sulfur dioxide, nitrogen oxides, carbon monoxide, particulate matter, ozone, and lead since essential data were lacking for air toxics. To determine the range and magnitude of effects of these pollutant emission reductions, EPA compared and contrasted two regulatory scenarios. The "control scenario" reflects the actual conditions resulting from the historical implementation of the 1970 and 1977 Clean Air Acts. In contrast, the "no-control" scenario reflects expected conditions under the assumption that, absent the passage of the 1970 Clean Air Act, the scope, form, and stringency of air pollution control programs would have remained as they were in 1970. The no-control scenario represents a hypothesized "baseline" against which to measure the effects of the Clean Air Act. The differences between the public health, air quality, and economic and environmental conditions resulting from these two scenarios represent the benefits and costs of the Act's implementation from 1970 to 1990.

To identify and quantify the various public health, economic, and environmental differences between the control and no-control scenarios, EPA employed a sequence of complex modeling and analytical procedures. Data for direct compliance costs were used in a general equilibrium macroeconomic model to estimate the effect of the Clean Air Act on the mix of economic and industrial activity comprising the nation's economy. These differences in economic activity were used to model the corresponding changes in pollutant emissions, which in turn provided the basis for modeling resulting differences in air quality conditions. Through the use of concentration-response functions derived from the scientific literature, changes in air quality provided the basis for calculating differences in physical effects between the two scenarios (e.g, reductions in the incidence of a specific adverse health effect, improvements in visibility, or changes in acid deposition rates). Many of the changes in physical effects were assigned an economic value on the basis of a thorough review and analysis of relevant studies from the economics, health effects, and air quality literature. The final analytical step involved aggregating these individual economic values and assessing the related uncertainties to generate a range of overall benefits estimates.

Comparison of emissions modeling results for the control and no-control scenarios indicates that the Clean Air Act has yielded significant pollutant emission reductions. The installation of stack gas scrubbers and the use of fuels with lower sulfur content produced a 40 percent reduction in 1990 sulfur dioxide emissions from electric utilities; total suspended particulate emissions were 75 percent lower as a result of controls on industrial and utility smokestacks. Motor vehicle pollution controls adopted under the Act were largely responsible for a 50 percent reduction in carbon monoxide emissions, a 30 percent reduction in emissions of nitrogen oxides, a 45

percent reduction in emissions of volatile organic compounds, and a near elimination of lead emissions. Several of these pollutants (primarily sulfur dioxide, nitrogen oxides, and volatile organic compounds) are precursors for the formation of ozone, particulates, or acidic aerosols; thus, emissions reductions have also yielded air quality benefits beyond those directly associated with reduced concentrations of the individual pollutants themselves.

The direct benefits of the Clean Air Act from 1970 to 1990 include reduced incidence of a number of adverse human health effects, improvements in visibility, and avoided damage to agricultural crops. Based on the assumptions employed, the estimated economic value of these benefits ranges from $5.6 to $49.4 trillion, in 1990 dollars, with a mean, or central tendency estimate, of $22.2 trillion. These estimates do not include a number of other potentially important benefits which could not be readily quantified, such as ecosystem changes and air toxics-related human health effects. The estimates are based on the assumption that correlations between increased air pollution exposures and adverse health outcomes found by epidemiological studies indicate causal relationships between the pollutant exposures and the adverse health effects.

The direct costs of implementing the Clean Air Act from 1970 to 1990, including annual compliance expenditures in the private sector and program implementation costs in the public sector, totaled $523 billion in 1990 dollars. This point estimate of direct costs does not reflect several potentially important uncertainties, such as the degree of accuracy of private sector cost survey results, that could not be readily quantified. The estimate also does not include several potentially important indirect costs which could not be readily quantified, such as the possible adverse effects of Clean Air Act implementation on capital formation and technological innovation.

Thus, the retrospective analysis of the benefits and costs of implementing the Clean Air Act from 1970 to 1990 indicates that the mean estimate of total benefits over the period exceeded total costs by more than a factor of 42. Taking into account the aggregate uncertainty in the estimates, the ratio of benefits to costs ranges from 10.7 to 94.5.

The assumptions and data limitations imposed by the current state of the art in each phase of the modeling and analytical procedure, and by the state of current research on air pollution's effects, necessarily introduce some uncertainties in this result. Given the magnitude of difference between the estimated benefits and costs, however, it is extremely unlikely that eliminating these uncertainties would invalidate the fundamental conclusion that the Clean Air Act's benefits to society have greatly exceeded its costs. Nonetheless, these uncertainties do serve to highlight the need for additional research into the public health, economic, and environmental effects of air pollution to reduce potential uncertainties in future prospective analyses of the benefits and costs of further pollution controls mandated by the Clean Air Act Amendments of 1990.