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## Introduction

*Edwin S. Mills, Princeton University*

The papers and comments printed in this volume were delivered at a conference held at the University of Chicago, November 10 and 11, 1972. The conference and conference volume were jointly sponsored by the Universities-National Bureau Committee for Economic Research and Resources for the Future, and were financed partly from a grant to the National Bureau by the National Science Foundation. Both the exploratory committee and the planning committee consisted of Otto Davis, Allen Kneese and the Editor. The Editor is indebted to his colleagues for their work on these committees, and to all the participants in the conference.

Despite the outpouring of printed material on environmental problems in recent years, careful economic research on the subject is still a scarce commodity. It is therefore hoped that the research brought together in this volume will be particularly useful to scholars, students and public and private officials interested in the subject.

The papers and comments in this volume speak for themselves and need not be summarized here. Instead, this introduction will present a brief guided tour through economic issues related to the environment, pointing out niches into which the papers fit and some niches that are still empty or nearly empty.

The essence of economic activity is the removal of materials from the environment, their transformation by production and consumption, and their eventual return to the environment. With relatively unimportant exceptions, the mass of materials removed must equal the mass of materials returned during any substantial period of time. Resource economics is concerned with the kinds, amounts, and forms of materials removed, places from which materials are removed, and the institutions, markets and laws by which removal is governed. Environmental economics is con-

cerned with similar issues related to the return of materials to the environment.

It is natural to classify environmental studies in the ways that other economic studies are classified: micro, macro; theoretical, empirical; domestic, international; etc. The papers in this volume fall naturally into the three parts listed in the contents.

Of the five theoretical papers in part one, the first two, by Uzawa and Mäler, are macroeconomic. In the long run, the most important environmental issue is the relationship between environmental quality and economic growth in a finite world. Economic growth normally entails increases in the amounts of materials removed from and returned to the environment. In the absence of efforts to avoid it, environmental deterioration must result when materials returns exceed the absorptive capacity of the environment. This statement applies to a local or regional environment, such as a flowing stream, but it also applies to the global environment, especially to the earth's air mantle. Resources can be devoted to environmental protection in two ways: materials can be transformed by production, consumption and waste treatment in ways that make their return innocuous; and materials can be reused or recycled rather than returned to the environment. Failure to realize that resources can be devoted to environmental protection as well as to direct production of goods is a fatal defect of much popular environmental literature and technical environmental literature by noneconomists. This failure is the source of anti-growth bias in some of that literature. Both Uzawa and Mäler, by incorporating resource use for environmental protection in growth models, contribute to our understanding of their relationship. An important direction for future work on growth theory ought to be the incorporation of both resource and environmental considerations in long-run growth models.

Mäler's paper also discusses short run macro stabilization policy in a model with environmental considerations built in. He shows that effluent or discharge taxes may have quite different stabilization effects from income or other taxes. This must be one of the first attempts to include environmental variables in a short run macro stabilization model. Clearly, more such research is needed.

The last three theoretical papers are microeconomic. The most important microeconomic environmental issue is to understand the precise nature of the market failure that pollution entails. Economists have studied this issue since Pigou, and the recent research by, and inspired by, Coase has reopened the subject. The paper by Plott and Meyer explores fundamental aspects of the concept of market failure. The authors

consider in what sense and to what extent it is useful to characterize the reasons for market failure by the currently fashionable term "transaction costs." To the extent that it is useful, they discuss what can be said about the transaction costs of various government policies relative to the costs of private transactions.

The next theoretical issue considered is the measurement of costs and benefits of environmental protection. If it is accepted that there is market failure regarding the environment, how are the costs and benefits of measures to improve the environment to be appraised? Measuring costs of environmental protection raises few new theoretical issues, but calculating the benefit side involves important unanswered questions. Environmental quality differs from the usual economic goods in several ways and has several quite different kinds of benefits. Neither this volume, nor the profession has much to contribute on benefit measurement to date.

A third theoretical issue is the choice of public policy instruments for environmental protection. Most research in recent years has focused on the choice between direct regulation of materials returns or effluents, and the use of taxes or charges on effluents. In fact, a much broader range of policies is available to protect the environment. The papers by Oates and Baumol and by Tolley contribute to the evaluation of alternative public policies. It can be said that no environmental issue has been so well studied: The great American pollution paradox is that no serious economic study has concluded that discharge fees should not be a major tool of public policy, whereas no serious environmental measure has included them. The paradox is deep in a society in which almost everything else is taxed, including those areas opposed by powerful interest groups.

The empirical studies reported in part two are all microeconomic. One important kind of empirical environmental study can be termed industry studies. These include studies of the kinds, magnitudes and speeds of response to various public policies to protect the environment. The term industry here must be interpreted to include public institutions, such as municipal waste treatment plants, as well as private firms. Several earlier studies investigated responses of industry to effluent charges on waterborne wastes in particular river basins. The first two empirical studies in this volume are much more comprehensive industry studies. The paper by Spofford, Russell and Kelly reports a large-scale systems study of all discharges in the Delaware Basin. It includes air, water, and solid wastes and a large number of alternative ways of changing or reducing discharges. The paper by Kohn is an input-output study of air pollution control in the St. Louis metropolitan area. Both are optimization studies in that they compute least-cost combinations of ways to achieve given en-

vironmental standards. The third empirical paper is a different kind of industry study. In it, Bower reports on several studies undertaken at Resources for the Future of the process, product, and waste treatment changes that can be employed in several industries to reduce the amounts or harmfulness of waste discharges.

The paper by Lave and Seskin is the only paper in the volume on the benefits of pollution abatement. In it, the authors study health effects of episodes of severe air pollution in metropolitan areas. It is curious that we now have better and more comprehensive studies of benefits of air pollution abatement than of water pollution abatement. Many studies, some of the best of them by Lave and Seskin, have estimated effects of air pollutants on human health, and some have estimated property damage. There are only a few studies of benefits of water pollution abatement, mostly restricted to recreational benefits, despite the fact that basic physical, chemical and biological processes are better understood for water pollution than for air pollution. High priority should be attached to further studies of water pollution abatement benefits.

The final paper in part two is a study of the political process by which environmental issues are settled. In it, Jackson studies in detail the controversy surrounding the decision whether to build a second jetport in the Minneapolis-St. Paul metropolitan area. More such studies are needed, especially of the passage of major national environmental legislation.

Part three consists of two international environmental studies. Several kinds of international environmental studies might be undertaken. First and most obvious is environmental effects that spill over national boundaries. Examples most often quoted are airborne discharges that pollute the air over neighboring countries. Other possible examples pertain to the global environment, e.g., heating of the atmosphere or pollution of the oceans. However, no economic, e.g., benefit-cost, studies appear to have been published on global problems, probably because underlying technical relationships are not well understood. A second kind of international study is of the kinds of arrangements, institutions and policies that nations might adopt to deal with environmental effects that spill over national boundaries. The paper by d'Arge explores basic aspects of this problem. A third kind of international study would be effects of domestic environmental protection policies on a country's international trade and balance of payments. Environmental protection measures tend to make domestic goods expensive relative to foreign goods, hence increasing imports and decreasing exports. Unfortunately, we have no paper on the subject in this volume. The fourth kind of international study is a cross-country comparison of environmental protection policies. Wise men tell

us we do not learn the lessons of history. A generalization of the proposition is that we fail to learn from both time series and cross-sectional data. Hufschmidt's paper is a contribution to refuting the generalization. In it, he compares recent air and water pollution control programs in the United Kingdom and the United States.