1 WHAT IS ENVIRONMENTAL ECONOMICS?

Tell someone you study environmental economics and the usual response is a look of puzzlement and the query "Just what is that?" A natural reaction, particularly considering the common belief in some circles that economics is the root of the "environmental problem."

Environmental economics is concerned with the impact of the economy on the environment, the significance of the environment to the economy, and the appropriate way of regulating economic activity so that balance is achieved among environmental, economic, and other social goals. What distinguishes a morally neutral chemical such as sulfur dioxide from the pollutant sulfur dioxide is the economy. The polluters who emit sulfur dioxide do so because it is a by-product of producing some good the public wants; consumers want the good associated with sulfur dioxide but at the same time obtain disutility (damage) from the sulfur dioxide pollution. The essence of the environmental problem is the economy—producer behavior and consumer desires. Without the economy, most environmental issues are simply research questions of concern to chemists or biologists with no policy significance.

For most goods and services in a modern economy, we rely on markets to match producer costs with consumer demands to yield the "right" amount of pollution (and thus consumption). The problem with pollution is that markets do not work to yield the socially desirable amount of pollution. This illustrates the breadth of problems that need answers: What are the incentives for the generation of pollution? What are the costs of cleaning up pollution? What are the societal gains from pollution control? What is the right balance between costs of control and gains from control? What regulatory mechanisms can be designed to ensure the right balance between costs and gains? Sometimes these issues are straightforward; othertimes they are exceedingly complex.

Although the field of environmental economics probably dates to the late 1950s and early 1960s with the important contributions emerging from the "think tank" Resources for the Future,[1] the field really took off in the 1970s and has been booming ever since. In the 1990s the payoff is beginning to be seen in terms of influence on environmental policy. Marketable permits for pollution control are now widely embraced, valuation methods are an integral part of environmental prevention, environmental valuation is being

used to make decisions concerning major public projects with environmental impacts, and environmental economics is playing a major role in the current climate change debate.

In the sections that follow we will develop more fully several of these dimensions of environmental economics. We first consider how environmental economics relates to environmental policy. Next, we examine how environmental economics meshes with the larger discipline of economics. We then discuss two related terms that have emerged in the academic and policy world—ecological economics and environmental economics. How do they differ? Environmental economics is also closely related to resource economics. What is the connection and what are the distinctions between them? Finally, we consider several important issues, currently the subject of much research and debate, that confront the field of environmental economics.

I. ENVIRONMENTAL ECONOMICS AND ENVIRONMENTAL POLICY

Concern with the environment is not a passing fad but a deep-seated concern, brought on in large part by the coincidence of high incomes and high population density. If there were few people in the world, the earth's environment would be very forgiving and capable of absorbing most that humans throws at it, cleansing itself automatically. The days of low population on the earth have passed; the total number of people on the planet and particularly the density of people in some parts of the planet magnify the size of environmental insults, overloading the capacity of the earth for self-cleansing. Income is also important, not only because rich people tend to consume more and thus generate more pollution, but also because the environment is often viewed as a luxury good. For the poor who struggle to keep food on the table, environmental issues often take a backseat to other more pressing needs related to survival. As people become wealthier, they turn their attention increasingly to the quality of their living environment, which ultimately is the planet. Thus if recent trends toward increasing wealth for the people of the world continue, we can expect concern for the environment to increase over time.

What are the typical issues facing most countries of the world with regard to environmental policy? In developed countries, pollution and the preservation of natural environments (e.g., wilderness areas) are major concerns. Pollution problems usually involve two major issues—what is the right amount of pollution and how can we get polluters to control their emissions?

Determining the right amount of pollution is not easy. Pollution is generated as a by-product of producing goods. To determine the costs of pollution control it is necessary to understand the structure of goods production and how costs will differ for different levels of pollution. Contrary to what most people might think, this is not an engineering question. Although it is easy to find out how much it would cost for a piece of equipment that is placed on a smokestack to reduce pollutants in the smoke (a "scrubber"), to an economist that is only the tip of the cost iceberg. Faced with the prospect of having to reduce pollution levels, the firm has many options. These include end-of-pipe treatment, modifying the production process, modifying the characteristics of the product, relocating the productive activity to reduce damage, and investing in research and de-

velopment to find new ways of controlling pollution. Consumers can also reduce consumption of the polluting good. Thus characterizing costs at a conceptual level, as well as measuring these costs empirically, is a complex question without easy answers. It is also the domain of environmental economics.

Determining the right amount of pollution also involves determining damages from pollution. The words "damages from pollution" deceptively suggest that this is a natural science question, such as counting the dead fish on a polluted lake or determining the level of pollution at which people begin to get sick. This is an oversimplification of the multitude of ways pollution affects people and the relative seriousness of these effects to people. Air pollution in an urban area can cause physical irritation (itchy eyes, running nose), reduced visibility, degraded visibility (a brown pale), soiled clothes, decreased lung capacity, worry about adverse effects, increased susceptibility to illness, and of course illness itself. Some of these effects are tangible, others are very intangible. Economics is accustomed to condensing this variety of effects into a single measure—the willingness to pay to reduce pollution. If pollution is bad, people are willing to devote some of their resources to eliminating the pollution. Leaving aside the fact that most people think the polluter should pay, one way of measuring the overall magnitude or importance of pollution reduction to a person is through his or her willingness to give up something valuable in exchange for improved personal environmental quality. Measuring this willingness to pay is not easy and is the subject of much research in environmental economics.

Having characterized the importance of pollution reduction to individuals (their willingness to pay), it is possible to sum up individual preferences to obtain a societal willingness to pay to reduce pollution. It is then easy to combine this with the cost of pollution control to determine the socially optimal amount of pollution reduction. But how to obtain this? The government could tell each polluter how much to emit; but this would be analogous to central planning in the old Soviet Union—we know it works up to a point but has severe problems, particularly when there are many firms and polluters involved. It is difficult to determine the best way for the government to intervene in the economy ("regulate") to yield the right amount of pollution control without excessive administrative costs or control costs while at the same time providing the right incentives to undertake research to reduce costs for the future.

So the "simple" job of fixing the problem of pollution is not so easy at the policy level and can involve hard-to-solve problems, many in the domain of environmental economics. The examples we have used are from developed economies but a very similar analysis could apply to a developing country. Air pollution is a big problem in many cities of the developing world. Water pollution is probably the most severe environmental problem in many developing countries: water contaminated by human waste kills millions of people annually. The same issues of costs, demand for clean-up, and how to regulate apply equally to this question.

Another important type of policy question is the preservation of natural environments, broadly defined. This could involve preserving wild and scenic areas from development or protecting animal and plant species from extinction. Here the primary issue is providing balance between the forces of development that threaten these environmental resources and the social value of preservation. How can both sides of this equation be quantified to help policymakers when they are confronted with very specific decisions (such as whether to allow logging in a virgin forest)?

These examples could go on and on. The point is that environmental protection usually involves the intervention of governments in the economy and it is often difficult to decide on the proper extent and nature of that intervention. Environmental economics as it is applied to real environmental problems can be invaluable in helping make those important decisions.

II. ENVIRONMENTAL ECONOMICS AND ECONOMICS

Economics is a well-developed discipline with an extensive body of theory, a paradigm associated with how the economic world works, and a number of branches, or fields of study, associated with pieces of the economy.

The fundamental building blocks of economics are contained in microeconomics—the theory of the consumer, the theory of the firm, and the theory of market interaction. This forms the basis for nearly all of economics. Related to microeconomics is the branch of statistics applied to economic phenomena—econometrics. Microeconomics permeates all of economics and econometrics permeates all of applied economics.

Branching out from basic microeconomic theory are the several fundamental fields of economics. These would include macroeconomics (the study of aggregate as opposed to individual phenomena), public finance (the study of goods not provided by the market and the study of taxation), industrial organization (the in-depth study of how firms interact with each other and with consumers and organize themselves into industries), and international trade (concerned with how distinct and independent economies interact). Each of these major fields is concerned with major portions of economic activity and each has unique contributions to make to the overall study of economics.

There are a number of applied fields of economics that draw on all of the basic fields as well as microeconomics. These would include labor economics, health economics, monetary economics, experimental economics, development economics, international finance, law and economics, and environmental economics. Each of these applied fields draws heavily on microeconomics and the basic fields of economics. For the most part, each of these fields has contributed in some way to understanding economics outside of its own narrow set of interests. For instance, labor economics has been the source for many innovations in econometrics that have found application across economics. The primary contribution of environmental economics has been in the area of nonmarket valuation, i.e., methods for measuring demand curves for goods when there is no market. Other important components of environmental economics involve adapting tools developed in other parts of economics to questions regarding the environment.

The categorization above is by no means unequivocal. I would expect many economists in one or another of the fields mentioned above to dispute how their field has been categorized and placed in relation to other fields. To an extent they would be right: there are many different ways of summarizing the different fields of economics. The point that is being made is that environmental economics is an applied field, like many other applied fields in economics. Much of environmental economics involves adapting concepts developed in other branches of economics (particularly public finance and industrial organization) and applying them to environmental problems. Some aspects of environmen-

tal economics are unique to the field (such as valuation, mentioned above) and have potential use in economics outside of the environmental economics field.

III. ENVIRONMENTAL ECONOMICS AND ECOLOGICAL ECONOMICS

This book is concerned with environmental economics. There is another discipline that largely has grown out of systems ecology called "ecological economics." These two fields take quite different perspectives, but are ultimately concerned with helping make social decisions about environmental problems. Unfortunately, in many non-English speaking countries the distinction between the two fields is lost in the translation because of the similarities between the words "environmental" and "ecological."

A simple distinction between the two fields arises from the fact that environmental economics tends to involve economists who have extended their discipline and paradigm to consider the environment, whereas ecological economics tends to involve ecologists who have extended their discipline and paradigm to consider humans and the economy. But this is history; the appropriate question to ask is how do the two fields approach environmental problems and how do they differ?

Ecological economics (as well as conventional economics) is difficult to succinctly define. One of the leading ecological economists defines the subject as a "field of study that addresses the relationships between ecosystems and economic systems in the broadest sense."[2] The emphasis is on the very long-term health of the ecosystem, broadly defined (i.e., with humans as part of it).

One major distinction between the two fields is associated with value and thus the way in which social decisions are made that depend on measures of value of the environment. Conventional economists believe that value to society derives from the individual values held by human members of society. Ecological economists take a more biophysical view of value. For instance, some ecological economists measure value in terms of embodied energy content. Thus in comparing a typewriter to a computer, the appropriate question is which took more energy to create? Less energy is better. This is a direct extension of ecological theories that ecosystems operate to minimize the throughput of energy. To these researchers, minimizing the energy content of delivered goods and services should drive public policy. The criticism leveled at this "energy theory of value" by environmental economists is that there are many resources in short supply, including land and skilled people. Reducing the value of a good to the embodied content of any factor is an oversimplification. Environmental economists believe the value of a good stems from its embodied content of multiple scarce factors (including energy) as well as how much value individual people place on the final good. In other words, value cannot be reduced to a simple physical metric.

However, the greatest distinction between the fields emerges when considering environmental problems with very long-time horizons, such as global warming or disposal of nuclear wastes. As some environmental economists will readily admit, economics has a difficult time analyzing problems in which costs and benefits span long time horizons. For instance, storing nuclear wastes can involve potential risks that extend for a quarter

of a million years. The benefits of the storage are reaped by the present consumers of nuclear power; the costs, if any, are borne by future generations that must live with the nuclear repositories. The conventional economic approach to this is to add up all of the costs and benefits, whenever they may occur, but to apply a discount factor to reduce the importance of future costs in the sum. Inevitably, this means that what happens a century from now has very little effect on the decisions that are made today. To many people, this is disquieting. Ecological economists have proposed other ways of dealing with the intertemporal decision problem, particularly the notion of sustainability. They argue that we should never undertake any action that is not sustainable in the long run. In the nuclear waste example, they would ask: Can we continue to bury waste forever and ever and be satisfied with the world that results? If the answer is no, then the action is not sustainable. It is not a matter of balancing costs and benefits. There is some intuitive appeal to such a philosophy.

To a large extent, the problem of making decisions over the very long run will not arise in this book. For the most part, we are concerned with static issues. Questions of long-run tradeoffs and dynamics are the purview of resource economics, to which we now turn.

IV. ENVIRONMENTAL ECONOMICS AND RESOURCE ECONOMICS

Nearly all textbooks combine the treatment of environmental and resource economics. In fact, most graduate programs that have a specialization in the area combine environmental and resource economics into one field. Undoubtedly this is because both concern the natural world. Environmental economics involves questions of excessive production of pollution by the market or insufficient protection of the natural world, due to market failure. Resource economics, on the other hand, is concerned with the production and use of natural resources, both renewable and exhaustible. Renewable resources would include fisheries and forests. Nonrenewables would include minerals and energy as well as natural assets such as the Alps and species of plants and animals.

So we see the distinction between the two areas but we also see the overlap. Typically, environmental economics is concerned with static questions of resource allocation. Time is not really an issue in deciding on the right amount of air pollution in London. Resource economics on the other hand is concerned with dynamics. Time is what makes renewable and exhaustible resource questions interesting. If we log a forest slowly enough, the forest can regenerate itself and we can continue logging indefinitely. How fast we extract an exhaustible resource will determine its scarcity in the future, and thus its price in the future. In both of these cases, market failure is not the essence of the problem (though poorly functioning markets can be important).

There are overlaps between environmental and resource economics. Global warming is an example of a pollution problem with a very long time frame. There are other overlaps, primarily in the preservation of natural environments. These issues involve time so they could be relegated to resource economics. On the other hand, damage to natural environments is often the incidental result of economic activity with a different primary purpose. Species loss is usually the result of conversion of habitat to human use.

Perhaps the best division between environmental and resource economics is between static issues related to the natural world and dynamic issues. For the most part this book concerns problems in resource and environmental economics that are static. Typically, we are concerned with pollution.[3]

V. POSITIVE VERSUS NORMATIVE PERSPECTIVES

There are two fundamental uses of economics. One is to try to explain what we see in the economy around us. Another is to try to explain how we would wish the economy to allocate and distribute goods and services. The terms positive and normative are used to distinguish these two perspectives. Positive economics is more value free, aiming to explain why markets and institutions have evolved as they have and how they work. Examples are understanding why the price of gasoline increases when OPEC meets to restrict output and how the spatial distribution of pollution emissions changes when a marketable permit system is established to regulate sulfur emissions.

Normative economics, on the other hand, attempts to use economic tools to design government policies to intervene in the marketplace. Inevitably the question arises as to the "best" way of intervening in the marketplace. Clearly, this requires a way of defining what is best—a much more value-laden process than merely explaining why the economy works as it does.

Unfortunately, when working with environmental problems it is not possible to restrict attention solely to positive economics. Fundamental to environmental economics is the notion of market failure. Repairing that market failure typically requires government intervention. What kind of government intervention? That is a normative question. And that is often the question that environmental economists are asked to help answer. In developing the normative theory of regulation to correct market failure or the public provision of nonmarket goods, we will try to make clear when value judgments enter the process of policy formulation. The practicing environmental economist should always be aware of the problems of venturing into the territory of normative analysis. This is one reason we turn in Chapter 3 to the question of social choice—the process of making societal decisions.

VI. IMPORTANT ISSUES IN ENVIRONMENTAL ECONOMICS

This is truly an exciting time in the field of environmental economics. There are relatively few economists who call themselves environmental economists while there are many basic problems that need addressing. We will suggest a few here.[4]

One of the most important contributions of environmental economics to economics generally has been in the area of measuring the demand for nonmarket goods. Measuring this demand has become central to many public debates over environmental quality. However, some methods for measuring demand have been the subject of great controversy. Stated preference methods involve directly asking people how they value the environ-

ment. Such methods have come under strenuous attack by some as at best biased and at worst vacuous. Others argue they are valid and of tremendous importance. A very active area of current research is the theory underlying methods for measuring the demand for environmental goods as well as empirical methods for doing so.

There is another set of issues surrounding regulation of environmental goods. Some of the unanswered questions are detailed more fully in Chapter 8. The basic problem is that economic incentives need significant refining before they can be relied on to solve many real environmental problems. These difficulties have to do with incentives, different amounts of information possessed by polluters and the government, and the role of technological change in determining future levels of pollution control. This work takes place at various levels, including institutional design, determining empircal properties of different regulatory mechanisms, and theoretical issues of regulatory design.

There are a number of international issues of environmental regulation that are not fully resolved. Some of these are discussed in Chapter 13. One major problem is in understandng how environmental regulations interact with trade restrictions (or lack thereof). Are differential environmental regulations compatible with free trade? Can environmental regulations be used effectively as barriers to trade? Does free trade tend to exploit the environments of developing countries due to their less well-developed institutions for environmental protection?

These few paragraphs are meant to suggest the menu of research questions that is being examined by environmental economists. As we travel through the book, it is my sincere hope that the reader identifies other interesting problems for further exploration.

NOTES

1. Resources for the Future (RfF), a Washington, DC environmental and resource economics research organization, was set up in the early 1950s by the Ford Foundation to address problems of materials shortages. A number of very important works emerged from researchers at RfF in the 1950s and 1960s. One contribution was the development of methods for measuring recreation demand (Clawson and Knetsch, 1966). Another was the reinvigoration of the use of emission fees by Alan Kneese. This culminated in the still-impressive study of regulation of water pollution in the Delaware River system (Kneese and Bower, 1968). Another was the analysis of scarcity of natural resources by Barnett and Morse (1963). John Krutilla forged the basis for how we view natural environments by expanding the notion of value beyond simple use (Krutilla, 1967). RfF remains today at the forefront of environmental economics research.
2. Costanza (1991), p. 3.
3. Cropper and Oates (1992), in their excellent survey of the field of environmental economics, make just this distinction between environmental and resource economics.
4. See Deacon et al. (1998) for a discussion of current research issues in environmental and resource economics.