7e *Environmental* Economics

An Introduction

Barry C. Field | Martha K. Field

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An Introduction Seventh Edition

Barry C. Field
Department of Resource Economics
University of Massachusetts Amherst

Martha K. Field
Department of Business and
Information Technology
Greenfield Community College

Mc Graw Hill Education

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To Leslie, Sidney, and Tory

About the Authors

Barry C. Field is Professor Emeritus of Resource Economics at the University of Massachusetts Amherst. Previously he taught at the University of Miami and The George Washington University. He received his B.S. and M.S. degrees from Cornell University and his Ph.D. from the University of California at Berkeley.

At the University of Massachusetts he has devoted many years to teaching environmental economics to students at all levels and has worked to develop an undergraduate major in environmental and resource economics.

Martha K. Field is Professor of Economics at Greenfield Community College, where she has taught environmental economics for many years. She has taught at the University of Massachusetts, Mount Holyoke College, Westfield State College, Holyoke Community College, and the Consumer Cooperative at Gomel, Belarus. She received a B.S. and M.S. from the University of Massachusetts and holds a Ph.D. from the University of Connecticut.

They reside in Leverett, Massachusetts.

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Preface

When our descendants look back at the last part of the 20th century, and now at the beginning of the 21st, we want them to be able to say: "That's when they began to take the degradation of the natural environment, with its threats to human life and the life of the planet, seriously." Furthermore, we would like them to be able to see that around this time we took serious steps to halt and reverse this process. This book is an introduction to environmental economics, one way of approaching the steps that need to be taken. It's about the way human decisions affect the quality of the environment, how human values and institutions shape our demands for improvement in the quality of that environment, and, most especially, about how to design effective public policies to bring about these improvements.

Problems of environmental quality are not something new; in fact, history is filled with bleak examples of environmental degradation, from deforestation by ancient peoples to mountains of horse manure in urban areas in the days before automobiles. But today's world is different. For one thing, many people in economically developed countries, having reached high levels of material well-being, are beginning to ask questions: What good is great material wealth if it comes at the cost of large-scale disruptions of the ecosystem by which we are nourished? More fundamental, perhaps, is the fact that with contemporary economic, demographic, and technological developments around the world, the associated environmental repercussions are becoming much more widespread and lethal. What once were localized environmental impacts, easily rectified, have now become widespread effects that may very well turn out to be irreversible. Indeed some of our most worrisome concerns today are about global environmental impacts.

It is no wonder, then, that the quality of the natural environment has become a major focus of public concern. As we would expect, people have responded in many ways. Environmental interest groups and advocates have become vocal at every political level, especially in those countries with open political systems. Politicians have taken environmental issues into their agendas; some have sought to become environmental statespersons. Environmental law has burgeoned, becoming a specialty in many law schools. Thousands of environmental agencies have appeared in the public sector, from local conservation commissions to environmental agencies at the United Nations. At the scientific level, environmental problems have become a focus for chemists, biologists, engineers, and many others. And within economics there has developed ***environmental economics***, the subject of this book.

Environmental economics focuses on all the different facets of the connection between environmental quality and the economic behavior of individuals and groups of people. There is the fundamental question of how the economic system shapes economic incentives in ways that lead to environmental degradation

as well as improvement. There are major problems in measuring the benefits and costs of environmental quality changes, especially intangible ones. There is a set of complicated macroeconomic questions: for example, the connection between economic growth and environmental impacts and the feedback effects of environmental laws on growth. And there are the critical issues of designing environmental policies that are both effective and equitable.

The strength of environmental economics lies in the fact that it is analytical and deals with concepts such as efficiency, trade-offs, costs, and benefits. Many believe strongly that the times call for more direct political action, more consciousness-raising, more political-organizing, and, especially, more representation and influence of environmental interests on the political scene. Nobody can doubt this. We live in a complicated world, however, where human problems abound; domestically we have health care, drugs, education, violence, and other critical issues, all competing for attention and public resources. Throughout the world, vast numbers of people struggle to alter their political and economic institutions, develop their economies, and raise their material standards of living and well-being.

In these settings, just raising the political heat for environmental issues is necessary but not sufficient. We have to get hard scientific results on how people value environmental quality and how they are hurt when this quality is degraded. We also have to put together environmental policy initiatives that get the maximum impact for the economic and political resources spent. This is where environmental economics comes in. It is a way of examining the difficult trade-off types of questions that all environmental issues entail; it is also a valuable means of inquiring why people behave as they do toward the natural environment, and how we might restructure the current system to rectify harmful practices and inspire favorable behavior.

In fact, the subject is important enough to deserve to be widely available to the nonspecialist. Economics is a discipline that has developed a sophisticated body of theory and applied knowledge. Courses in economics now follow a hierarchy of introductory- and intermediate-level principles that are designed to lead students along and prepare them for the more advanced applications courses. But these run the risk of closing off the subject, making it inaccessible to those who do not want to become specialists. This book is intended, instead, for people who have not necessarily had any economics courses, at least not yet. It was written on the assumption that it's possible to present the major principles of economics in a fairly commonsensical, although rigorous, way and then apply them to questions of environmental quality.

This book is an introduction to the basic principles of environmental economics as they have been developed in the past and as they continue to evolve. The real world, certainly the real world of environmental policy, is much more complicated than these principles would often seem to imply. The examples discussed represent only a sample of the full range of issues that actually exists. If and when you confront that real world of environmental politics and policy, you will find it necessary to adapt these principles

to all the details and nuances of reality. Unfortunately, there is not enough space in one book to look at all the ways that environmental economists have found to make the basic concepts and models more specific and relevant to concrete environmental issues. So we stick to the basic ideas and hope they excite your interest enough to make you want to pursue the refinements and adaptations of these ideas as they relate to a subject of growing relevance and importance.

When the first edition was published, there was no way of knowing how many others might be teaching a course similar to the one from which the book sprang: a course in environmental economics for people who have not necessarily had a course in economics. The reception that the previous editions have had, therefore, is gratifying. The comments received, sometimes directly and sometimes via the grapevine, have in general been quite positive. We hope the seventh edition will be as well received.

The basic structure and sequence of chapters in this edition are unchanged although we have reorganized and updated the last section on global issues. The first section of the book is an introduction, beginning with a chapter on what environmental economics is about, followed by one on the basic relationships between the economy and the environment. The next section is devoted to studying the "tools" of analysis, the principles of demand and cost, and the elements of economic efficiency both in market and nonmarket activities. These chapters are not meant to be completely thorough treatments of these theoretical topics; however, given the objective of the book, the introductory chapters are essential. Even those who have had a course in microeconomic principles might find them valuable for purposes of review. Section 2 also contains a chapter in which these economic principles are applied to a simple model of environmental pollution control. In these chapters, as well as the others, we have tried to leaven the presentation with examples taken from current sources, such as in the news media.

Section 3 is on environmental analysis. Here we look closely at some of the techniques that have been developed by environmental economists to answer some of the fundamental value questions that underlie environmental decision making. We focus especially on the principles of benefit–cost analysis. After this we move to Section 4, on the principles of environmental policy design. It begins with a short chapter dealing with the criteria we might use to evaluate policies, then moves on to chapters on the main approaches to environmental quality management.

Sections 5 and 6 contain policy chapters, where we examine current developments in environmental policy with the analytical tools developed earlier. Section 5 is devoted to environmental policy in the United States, covering federal policy on water, air, and toxic materials. It also contains a chapter on environmental issues at the state and local levels, including recycling. Finally, the last section looks at international environmental issues: global climate change, the economics of international environmental agreements, globalization, and economic development and the environment.

The seventh edition contains much new material, including new exhibits and updated figures and tables. It also contains new materials on:

• Carbon taxes	Chapters 1 and 12
• Pollution and GDP in India	Chapter 1
• Oil spills from pipelines and trains	Chapter 2
• Regulatory flexibility	Chapter 9
• European emissions taxes	Chapter 12
• Offset trading	Chapter 13
• Emission rate trading	Chapter 13
• Carbon market in California	Chapter 13
• Controlling greenhouse gas emissions	Chapter 15
• Energy-efficiency gap	Chapter 15
• Burden of proof in toxic testing	Chapter 15
• Social cost of carbon	Chapter 18
• Globalization and the environment	Chapter 18
• Clean Air Act updates	Chapter 5

A collection of relevant web links and additional sources is available on the Web site. Also available is a tutorial for working with graphs. For instructors, the Web site offers an Instructor's Manual available for easy download. To access the Web site associated with this book, please see **www.mhhe.com/field7e.**

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Barry C. Field

Martha K. Field

Section 1

Introduction

This first section contains two introductory chapters. The first is a brief, nontechnical review of some of the main topics and ideas of environmental economics. The second contains a general discussion of the interactions that exist between the economy and the environment, and introduces some fundamental concepts and definitions that are used throughout the book.

Chapter 1

What Is Environmental Economics?

Economics is the study of how and why individuals and groups make decisions about the use and distribution of valuable human and nonhuman resources. It is not solely the study of profit-making businesses making decisions in a capitalist economy. It is much broader than this; it provides a set of analytical tools that can be used to study any situation in which the scarcity of means requires the balancing of competing objectives. It includes, for example, important questions in the behavior of nonprofit organizations, government agencies, and consumers.

Environmental economics is the application of the principles of economics to the study of how environmental resources are managed. Economics is divided into **microeconomics,** the study of the behavior of individuals and small groups, and **macroeconomics,** the study of the economic performance of economies as a whole. Environmental economics draws from both sides, although more from microeconomics than from macroeconomics. It focuses primarily on how and why people make decisions that have consequences for the natural environment. It is concerned also with how economic institutions and policies can be changed to bring these environmental impacts more into balance with human desires and the needs of the ecosystem itself.

One of our first jobs, therefore, is to become acquainted with some of the basic ideas and analytical tools of microeconomics. To do this at the very beginning, however, would risk giving the impression that the tools are more important than their uses. The tools of analysis are not interesting in themselves, but for the understanding, they can give us about why the natural environment becomes degraded, what the consequences of this are, and what can be done effectively to reduce this degradation. For this reason, the first chapter is devoted to sketching out, in commonsense terms, the kinds of questions environmental economists ask and the kinds of answers they seek. After a brief discussion of some general issues, we look at a series of examples of some of the problems addressed in environmental economics.

Economic Analysis

To study economics is to study the way an economy and its institutions are set up, and how individuals and groups make decisions about transforming and managing scarce resources to increase human wealth, in its broadest sense. Environmental economics focuses on a society's natural and environmental resources, and examines the way people make decisions that lead to environmental destruction and environmental improvements.

Environmental economics is an **analytical subject.** We want not only to describe the state of the environment and changes in it, but also to understand why these conditions exist and how we might bring about improvements in environmental quality. This means we will have to introduce a specialized set of concepts and vocabulary. We will also have to use specialized means of expressing connections between important factors that are involved in the environmental quality issues we explore. To do this, economists use what are called **analytical models.** A model is a simplified representation of reality, in the sense that it isolates and focuses on the most important elements of a situation and neglects the others. The models we will use are graphical in nature, and they will be quite simple.[1]

It is important to distinguish between **positive economics** and **normative economics.** Positive economics is the study of what is; normative economics is the study of what ought to be. Positive economics seeks to understand how an economic system actually operates by looking at the way people make decisions in different types of circumstances. A study to show how the housing market reacts to changes in interest rates is an exercise in positive economics. A study to estimate how electric utilities would respond to a new tax on sulfur emissions is also an example of positive economics. However, a study to determine what kind of regulation we ought to adopt for a particular environmental problem is a case of normative economics because it involves more than just knowing how things work; it also involves value judgments. We make use of this distinction repeatedly throughout the book.

The economic approach to environmental issues is to be contrasted with what might be called the **moral approach.** According to the latter, environmental degradation is the result of human behavior that is unethical or immoral. Thus, for example, the reason people pollute is because they lack the moral and ethical strength to refrain from the type of behavior that causes environmental degradation. If this is true, then the way to get people to stop polluting is somehow to increase the general level of environmental morality in the society. In fact, the environmental movement has led a great many people to focus on questions of environmental ethics, exploring the moral dimensions of human impacts on the natural

[1] The Web page associated with the book contains a section on working with graphs. See **www.mhhe.com/economics/field7e.**

environment. These moral questions are obviously of fundamental concern to any civilized society. Certainly one of the main reasons environmental issues have been put on the front burner of social concern is the sense of moral responsibility that has led people to take their concerns into the political arena.

But there are practical difficulties with relying on moral reawakening as the main approach to combatting pollution. People don't necessarily have readily available moral buttons to push, and environmental problems are too important to wait for a long process of moral rebuilding. Nor does a sense of moral outrage, by itself, help us make decisions about all the other social goals that also have ethical dimensions: housing, health care, education, crime, and so on. In a world of competing objectives we have to worry about very practical questions: Are we targeting the right environmental objectives, can we really enforce certain policies, are we getting the most impact for the money, and so on. But the biggest problem with basing our approach to pollution control strictly on the moral argument is the basic assumption that people pollute because they are somehow morally underdeveloped. It is not moral underdevelopment that leads to environmental destruction; rather, it is the way the economic system, within which people make decisions about how to conduct their lives, has been arranged.

The Importance of Incentives

People pollute because it is the cheapest way they have of solving a certain, very practical problem. That problem is the disposal of the waste products remaining after consumers have finished using something, or after business firms have finished producing something. People make these decisions on production, consumption, and disposal within a certain set of economic and social institutions[2]; these institutions structure the **incentives** that lead people to make decisions in one direction rather than another. What needs to be studied is how this incentive process works and, especially, how it may be restructured so that people will be led to make decisions and develop lifestyles that have more benign environmental implications.

One simplistic incentive-type statement that one often hears is that pollution is a result of the **profit motive.** According to this view, in private enterprise economies such as the Western industrialized nations, people are rewarded for maximizing profits, the difference between the value of what is produced and the value of what is used up in the production process. Furthermore, the thinking goes, the profits that entrepreneurs try to maximize are strictly monetary profits. In this headlong pursuit of monetary profits, entrepreneurs give no thought to the environmental impacts of their actions

[2] By "institutions" we mean the fundamental set of public and private organizations, laws, and practices that a society uses to structure its economic activity. Markets are an economic institution, for example, as are corporations, a body of commercial law, public agencies, and so on.

because it "does not pay." Thus, in this uncontrolled striving for monetary profits, the only way to reduce environmental pollution is to weaken the strength of the profit motive.

There is substantial truth in this proposition, but also a degree of misunderstanding. It is certainly the case that if operators of private firms make decisions without taking environmental costs into account, excess pollution will result. But this is true of anybody: private firms, individuals, and public agencies. When individuals pour paint thinner down the sink drain or let their cars get seriously out of tune, they are making decisions without putting adequate weight on environmental consequences. Because individuals don't keep profit-and-loss statements, it can't be profits per se that lead people to pollute. The same can be said of government agencies, which have sometimes been serious polluters even though they are not profit motivated. But the most persuasive argument against the view that the search for profits causes pollution comes from looking at the history of Eastern Europe and the former USSR. With the collapse of these ex-Communist regimes, we became aware of the enormous environmental destruction that occurred in some of these regions—heavily polluted air and water resources in many areas, which have a major impact on human health and ecological systems. China is currently experiencing the same problem: headlong emphasis on economic development (by both public and private firms) with insufficient regard for the environmental consequences of this process. These examples show that it is not the profit motive itself that causes pollution, but any resource-using and waste-producing decisions that are made without exercising appropriate control over their environmental consequences.

In the sections and chapters that follow, we will place great stress on the importance of incentives in the functioning of an economic system. *Any* system will produce destructive environmental impacts if the incentives within the system are not structured to avoid them. We have to look more deeply into any economic system to understand how its incentive systems work and how they may be changed so that we can have a reasonably progressive economy without disastrous environmental effects.

Incentives: A Household Example

An incentive is something that attracts or repels people and leads them to modify their behavior in some way. An *economic incentive* is something in the economic world that leads people to channel their efforts at economic production and consumption in certain directions. We often think of economic incentives as consisting of payoffs in terms of material wealth; people have an incentive to behave in ways that provide them with increased wealth. But there are also nonmaterial incentives that lead people to modify their economic behavior; for example, self-esteem, the desire to preserve a beautiful visual environment, or the desire to set a good example for others.

Worcester Reduces Trash and Increases Recycling — EXHIBIT 1.1

"Pay-as-you-throw" (PAYT) works by putting a price on an activity that has an environmental cost: the disposal of household trash. Many cities and towns in the U.S. have adopted PAYT systems over the last few decades. One of the most successful has been the program in Worcester, Massachusetts. That program was started in 1993, as a result of a municipal budget crisis that forced the Department of Public Works to look for new ways of generating revenues. There was massive opposition to the idea at first. Why should people have to pay for a municipal service that had traditionally been free? But the system was installed over this opposition: $1.50 for a large, 30-gallon trash bag and $0.75 for a smaller, 15-gallon bag.

The data collected to monitor the program showed that within the first week the recycling rate was up from a meager 2% to 38%; so that Worcester residents throw out about 400 pounds of trash per capita per year compared to a national average of 900 pounds. The data show that over 400,000 pounds of trash that would have ended up in Worcester landfills was recycled instead. The program has saved Worcester an estimated $10 to $20 million over the last twenty years. Revenues from sales of the bags are primarily used to support a curbside recycling program and bulky waste collection. Worcester City Council Kathleen Toomey says, "While no one likes to pay for trash bags, it has truly made an enormous difference in the amount of recycling over the past two plus decades. People are more cognizant about what goes into their trash bags and make an effort to increase their recycling."

For added information see: Go Local Worcester, *Worcester's Pay-As-You-Throw Trash Removal Saves City $10 – 20M*, April 2014, **http://www.golocalworcester.com/news/worcesters-pay-as-you-throw-trash-removal-saves-city-10-20-M.**

For a simple first look at the importance of changing incentives to get improvements in environmental quality, consider the story shown in Exhibit 1.1. It is about the new ways of paying for trash disposal, focusing on the experience of Worcester, Massachusetts. Before the program, people in the city paid a flat annual fee to have their trash collected. This is a common practice in most communities. The problem with this approach is that there is simply no incentive for any individual family to limit its trash production, because the family will pay the same annual trash-collection fee no matter how much, or little, it produces. This might not be a problem if there were ample landfill space and if there were no danger that the landfill would contaminate the surrounding environment, such as a nearby groundwater system. But for most communities these conditions don't hold any more, if they ever did. Residents of Worcester were confronted by rapidly escalating trash-collection costs. They faced the problem of how to get a significant reduction in the quantity of solid waste handled by the city.

The response in this case was to introduce a system that gives people an incentive to search for ways to reduce the amount of solid waste they produce. This was done by charging people for each bag of trash they put on the curb. What this does is to give families the incentive to reduce the number of bags of trash they set out. They can do this by recycling, by switching to products that have less waste, by putting food scraps in a compost pile, and so on. These have led, according to the story, to a large increase in the amount of trash recycled and a reduction in the total amount of trash. There are many other communities around the country where this system has been adopted. Of course, no system is perfect. Increases in illegal dumping and difficulties with applying the plan to apartment houses are problems. Nevertheless, the new approach does illustrate in a very clear way the effects of a shift from a system where there were no incentives for people to reduce their solid waste to one where there are such incentives. The technical name for this approach is **unit pricing.**

Incentives and Global Warming

Municipal solid waste and other trash have traditionally been local problems, both because the possible environmental impacts are usually local, and because, policy-wise, local governments have had the primary responsibilities for dealing with them. Obviously, not all environmental problems are local: traditional air pollution is usually a regional or national issue, and sometimes it is an international problem because it crosses country borders. And some environmental problems are truly global in that they have causes and impacts that involve everyone around the world, though not necessarily in equal intensity.

Of course, the global issue that is thrusting itself into the world's consciousness is the greenhouse effect, the buildup of heat-trapping gases in the earth's atmosphere that is producing long-run changes in global climate. We will have much more to say about this issue in later chapters. A major focus of environmental economists is to try to identify the most effective policy approaches to combat the emissions of substances causing the greenhouse effect, especially carbon dioxide (CO_2), but also including many other gases, such as methane (CH_4).

One way to approach this is with conventional "command-and-control" policies. This relies on laws and regulations that directly or indirectly specify pollution-control technologies or practices that polluters should use. Then standard enforcement procedures are used (inspections, monitoring, fines, etc.) to produce acceptably high degrees of compliance. Although this approach still characterizes much of the environmental policy arena, there has been a lot of attention recently given to incentive-based policies. There are two basic types of incentive policies: emission charges or taxes, analogous to the trash-collection fees discussed in the previous section; and market-based trading programs. We

Carbon Taxes Around the World **EXHIBIT 1.2**

Country/Region	Year Started	Currency Rate/ton CO_2e
British Columbia	2012	CAD 30
Chile	2018	USD 5
Denmark	2014	USD 31
Finland	2013	EUR 35
France	2014	EUR 7
Iceland	2014	USD 10
Ireland	2013	EUR 20
Japan	2014	USD 2
Mexico	2014	MEX 10-50
Norway	2014	USD 4-69
South Africa	2016	R 120
Sweden	2014	USD 168
Switzerland	2014	USD 68
United Kingdom (U.K.)	2014	USD 15.75

Source: OECD, *Climate and Carbon-Aligning Prices and Policies*, Environmental Policy Paper No. 01, 2013.

will discuss each of these at length; trading programs in Chapter 13 and emission charges in Chapter 12.

Emission charges work essentially by putting a price on emissions. Many people have argued that this would be the most effective approach to getting reductions in greenhouse gas emissions. In many countries, such charges have been introduced. Exhibit 1.2 lists some of the charges currently in effect; they have become popular especially in Europe. They are generally charges per ton of CO_2e, that is, equivalent tons of CO_2.

The Design of Environmental Policy

Environmental economics has a major role to play in the design of **public policies** for environmental quality improvement. There are an enormous range and variety of public programs and policies devoted to environmental matters, at all levels of government: local, state, regional, federal, and international. They vary greatly in their efficiency and effectiveness. Some have been well designed and will no doubt have beneficial impacts. Others are not well designed. Not being cost-effective, they will end up achieving much less environmental improvement than they would have if they had been designed better.

The problem of designing efficient environmental policies is often not given the emphasis it deserves. It is easy to fall into the trap of thinking that any programs or policies that flow out of the rough and tumble of the

environmental political process are likely to be of some help, or that they certainly will be better than nothing. But history is full of cases where policymakers and public administrators have pursued policies that don't work; the public is frequently led to believe a policy will be effective even when any reasonable analysis could predict that it will not. All of this means that it is critically important to study how to design environmental policies that are effective and efficient.

In 2005, pollution control expenditures (including both capital and operating costs) amounted to about 1 percent of GDP, or about $130 billion. These are very large amounts of money, even though we could probably agree that they ought to be higher. A question of great importance, however, is whether we are getting the most improvement possible in environmental quality for the money spent. Former EPA director William Reilly is quoted as saying that "at this level of expenditure, there's a very large obligation to get it right." By "getting it right," he means having programs that get the maximum improvement in environmental quality for the resources spent. Everybody has an interest in this: environmentalists, for obvious reasons; public regulators, because they are tapping a limited supply of taxpayer resources and consumer tolerance; and the regulated polluters themselves, because matters of efficiency are critical to business success.

"Getting it right" means paying attention to the factors that affect the cost-effectiveness of environmental regulations, and especially to the way they create incentives for actions taken by polluters. An important problem in environmental policy is that of **perverse incentives**—that is, incentives created by a policy that actually work against the overall objectives of that policy. Environmental policies often created perverse incentives, because environmental policymakers have too often tried to legislate results directly, rather than establish the types of regulations that harness the self-interest of polluters to move toward efficient emission reductions. Exhibit 1.3 discusses perverse incentives in the federal program to control power plan emissions, specifically the incentive inherent in the decision to switch from old, highly polluting technology to newer, cleaner plants.

Issues related to the design of environmental policy are a major part of environmental economics. It is important to know how alternative policy approaches measure up in terms of cost-effectiveness, getting the most pollution reduction for the money spent, and, in terms of efficiency, appropriately balancing the benefits and costs of environmental improvements.

Macroeconomic Questions: Environment and Growth

The incentive issues discussed in the previous section are microeconomic problems; they deal with the behavior of individuals or small groups of consumers, polluting firms, and firms in the pollution-control industry. The macroeconomy, on the other hand, refers to the economic structure and