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**Environmental  
Economics & Management**

Theory, Policy and Applications

**环境经济学与环境管理**

理论、政策和应用

第④版



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# 环境经济学与环境管理：理论、政策和应用

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Environmental Economics & Management: Theory, Policy, and Applications, 4e

Scott J. Callan & Janet M. Thomas

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# **Environmental Economics & Management**



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**Theory, Policy and Applications**

**(Fourth Edition)**

**Scott J. Callan Janet M. Thomas**

**Bentley College**

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# PREFACE

In the ten years since the first edition of this book was published, the world has changed in ways we never thought possible. This past decade has been marked by international conflict, acts of terrorism, and economic challenges. But society also has witnessed achievements and positive change—great strides in medical technology, advances in telecommunication, computing, and digitization, and measurable progress toward achieving a cleaner environment. During the last decade, Earth Day celebrated its 35th anniversary, and the Rio Summit its 10th, with the latter marked by the World Summit on Sustainable Development in Johannesburg. At the start of the new century, the European Union banned leaded gasoline, the Kyoto Protocol was ratified, hybrid SUVs were introduced, and important trends are evolving toward sustainable development, pollution prevention, and market-based solutions.

Of course, there have been setbacks and more than a few difficult compromises. The rapid economic growth in China, for example, has placed that country's natural resources at risk. This giant nation along with other countries faces serious water shortages, and urban areas around the world continue to struggle with poor air quality. Beyond national issues are transboundary environmental concerns, including global warming and ozone depletion. Without question, there is still much to be done. But the good news is that on balance, society has grown more cognizant of environmental risks and more receptive to the notion of integrating environmental issues into virtually every aspect of private and public decision making.

Few would debate the influence of environmental concerns on all facets of contemporary living—consumer behavior, corporate strategy, and public policy development. In the last several decades, we have witnessed significant change in product design, capital investment practices, tax and accounting policies, product packaging, and technology. New industries have emerged in environmental products and services. National and international policies have been implemented to preserve natural resources and ecosystems. Firms have redefined their business strategies in response to new regulations and the changing demands of more environmentally conscious consumers. Many companies now produce an environmental report to stockholders along with their financial annual report. As a society, we have come to recognize that economic activity and the natural environment are inexorably linked, and this profound relationship is at the core of environmental economics and management.

Arguably, environmental economics is a dynamic field. Hence, we continue to work diligently to keep the content of this text current and, at the same time, accessible to students and lively. In this fourth edition of our book, we again have had the opportunity to integrate suggestions offered by our review panel, insightful comments made by our adopters, plus some new ideas of our own. We continue to believe that teaching environmental economics is an exciting opportunity to show students the broad applicability of economic thinking. Students are more environmentally literate than ever before, and most are eager to understand how the market process can help explain and even solve environmental problems. It is, to say the least, an energizing challenge to present this evolving field to what typically is a diverse audience of students.



What hasn't changed over the years is our underlying purpose in writing this textbook. We wrote *Environmental Economics and Management* to offer undergraduate students and certain first-year graduate students a clear perspective of the relationship between market activity and the environment. Although we generally assume that students have been exposed to principles of microeconomics, we offer a good review of basic microeconomic fundamentals in Chapter 2 and the major concepts of public goods and externality theory in Chapter 3. Both chapters should provide students with the necessary foundation for the course.

As with previous editions, our general approach is to illustrate in a practical manner how economic tools such as market models and benefit-cost analysis can be used to assess environmental problems and to evaluate policy solutions. Along with traditional discussions, we incorporate contemporary examples of business and consumer practices that are part of environmental decision making. The presentation does not compromise economic theoretical concepts. Instead, it complements the theory with timely, real-world applications. In so doing, seemingly abstract concepts are given relevance through actual cases about consumers, industry, and public policy.

## CONTENT: A MODULAR APPROACH

Organizing the vast amount of material that an environmental economics course attempts to cover is a challenge at best. Mindful of the usual time constraint in a one-semester course and the fact that the student audience can be highly varied, we devised a **modular structure** for the text. This approach not only organizes the presentation by major topic but also provides a format that facilitates customizing the material to suit a variety of course objectives. At the instructor's discretion, certain chapters within a given module can be omitted or covered less thoroughly without loss of continuity in the overall presentation. Likewise, the order in which the modules are covered can be varied to suit instructor preferences or student interests.

The first three modules form the foundation for the course. These are:

- **Module 1. Modeling Environmental Problems:** a three-chapter module illustrating how environmental problems are modeled from an economic perspective. Primary topics are the materials balance model, a review of market theory and price determination in an environmental context, and the market failure of pollution using both a public goods model and externality theory.
- **Module 2. Modeling Solutions to Environmental Problems:** a two-chapter module on environmental regulatory approaches—one on the command-and-control approach and one on the market approach. Allocative efficiency and cost-effectiveness are used to analyze these, and models are developed to study various control instruments such as technology-based standards, pollution charges, deposit/refund systems, and tradeable pollution permits.
- **Module 3. Analytical Tools for Environmental Planning:** a four-chapter module introduced by an in-depth investigation of risk assessment, risk management, and benefit-cost analysis. Included is a thorough presentation of benefit estimation procedures such as the contingent valuation method and the averting expenditure approach.

Following these are three media-specific modules, which are actually comprehensive case studies of major environmental problems and policy solutions. Using economic modeling and analytical tools, each module assesses the associated environmental risk, evaluates the policy response, and presents a benefit-cost analysis of major legislation and international agreements. These three modules can be covered in any sequence following the foundational material covered in the first half of the text. Some instructors might elect to focus on only one or two of these modules.



- **Module 4. The Case of Air:** a four-chapter module assessing major air pollution problems and the policy initiatives aimed at controlling them. The first chapter lays the groundwork by discussing air quality policy in general and the standard-setting process. The next two chapters cover policy implementation—one aimed at mobile sources and the other at stationary sources, with accompanying discussions of urban smog and acid rain. The last chapter in this module deals with global air quality, specifically ozone depletion and climate change, as well as domestic and international policies that address these problems.
- **Module 5. The Case of Water:** a three-chapter module covering the problems of groundwater and surface water contamination and specific policies aimed at point and nonpoint polluting sources. Two chapters are devoted to an economic analysis of controls on point and nonpoint sources under the Clean Water Act, and a third conducts an analogous investigation of safe drinking water policy.
- **Module 6. The Case of Solid Wastes and Toxic Substances:** a three-chapter module analyzing the solid waste cycle and the use of pesticides and other toxic substances. Among the primary topics discussed are risk management of the hazardous waste stream, the Superfund controversy, market solutions to controlling municipal solid waste, and risk-benefit analysis in pesticide control.

Each of these media modules utilizes the analytical tools presented in Modules 1 through 3, such as economic models, risk management, and benefit-cost analysis.

The concluding module covers topics in global environmental management. While international issues are integrated throughout the text, this module concentrates on environmental objectives, policies, and strategies that involve the global community. We focus here on sustainable development, international trade and environmental protection, industrial ecology, and pollution prevention.

- **Module 7. Global Environmental Management:** a two-chapter module examining sustainable development as a worldwide objective and various efforts underway to achieve it. The first chapter in the module addresses the effect of economic growth on environmental quality, international agreements aimed at trans-boundary pollution, and the effect of environmental protection on international trade. In the second chapter, the focus is on approaches, specifically industrial ecology and pollution prevention. Beyond explaining these concepts at a fundamental level, we also illustrate how these ideas are put into practice through various programs and partnerships in nations around the world.

In essence, this module “closes the loop” of the text by revisiting the materials balance model introduced originally in Chapter 1. Here, we use this model to illustrate the importance of long-run environmental planning and global policy initiatives that go beyond command-and-control abatement efforts.

## NEW TO THE FOURTH EDITION

Because our adopters have been pleased with the organization and writing of the text, we have maintained its basic style, structure, and underlying motivation. This allows current adopters to face minimal adjustment in transitioning from the third edition to the fourth edition. The overall content and completeness of each module has been maintained as well as the mobility among them. We also continue to offer supporting examples and data that are as current as possible and to emphasize the important connections between theory and reality through our boxed applications. That said, we did make some important

changes in response to policy changes, news events, and suggestions offered by reviewers and adopters.

### **New Topics, New Applications, and Other Updates**

As in previous editions, we searched diligently for **updates** on all the policies, data, applications, and examples used in the book to ensure that instructors and students have access to the most current information.

Wherever data are presented in tables or within the text content, we looked for more recent values to update the presentation. For example, new abatement cost data and compliance cost data have been added to Chapter 8, *Assessing Costs for Environmental Decision Making*, updated emissions data have been added to all the chapters comprising Module 4, *The Case of Air*, and new trend data on community water systems appears in Chapter 16, *Protecting Drinking Water*. We also checked examples used in the text to ensure that they continue to be relevant, and we revised or replaced them as needed. Every URL quoted for a relevant Web site has been tested and updated as necessary. We researched every major environmental policy and program to determine if any revisions had been passed or new initiatives launched so that we could include these changes in the new edition.

We also added **new topics** and offered **expanded coverage** of others in this edition. Among these are the following:

- The Clear Skies Act
- The watershed management approach
- Ratification of the Kyoto Protocol
- Environmental justice in air quality policy
- Updated benefit-cost analysis of U.S. air quality policy
- The NO<sub>x</sub> Budget Trading Plan
- 1996 Protocol to the LDC
- The pollution haven effect
- Doha Ministerial Conference
- Airline drinking water quality
- China's water shortage
- European Union Greenhouse Gas Emissions Trading Scheme (EU ETS)
- The Packaging Recovery Organisation Europe (PRO EUROPE)
- Proposed mercury emissions trading
- New hybrid vehicles
- Expanded coverage of brownfield sites

All boxed applications, which have been well received by adopters and their students, were reviewed, updated, and in some cases replaced with more current cases. Overall, we added about 10 new applications, deleted a fair number, and updated the remainder for a total of nearly 50 applications placed throughout the text. The **new applications** deal with recent issues that have affected, or are continuing to influence, policy decisions or business practices. Among the new titles are:

- *The High Price of China's Economic Advance*
- *Building Cleaner Cars: What Is the Cost of Abating Tailpipe Emissions?*
- *Benefit-Cost Analysis in Practice: The RIA for Reducing Lead in Gasoline*
- *Clean School Bus USA: Air Quality and Environmental Justice*
- *China's Automobile Demand*
- *The Hybrid Car Market: U.S. Firms Play Catch-Up*
- *Scrapping Old Cars for Credit*
- *Mercury Contamination and Fish Advisories*
- *Aircraft Drinking Water Fails to Meet Standards*

## A More Streamlined, Accessible Presentation

As in past revisions, we were struck by the fact that, while most of our reviewers recommended at least one or two topics to be added to the text, many also suggested that we try to make the content more concise and more accessible to students. Based on our own work in environmental economics, we fully understood the spirit of these comments. Environmental economics is a multi-disciplinary, extensive, and growing field. We, too, want to offer as much as possible to our students, but we also know that a one-semester course is limiting.

Striving to achieve a balance of these seemingly mutually exclusive ideas, we arrived at what we believe is a workable solution: a **topic-rich text with a more streamlined presentation**. Making the book more concise called for careful (and sometimes painful) editing. And while we believe this change was worthwhile, it did not take precedence over the integrity of content and the text's attention to economic theory and public policy.

We conducted a careful review of the text, noting places where we could simplify the presentation without loss of continuity or proper treatment of key issues. Cuts were made selectively and, we hope, seamlessly. Some noncritical content was deleted, such as detailed discussions of policy evolution in the media modules and the text appendix of ancillary tables and charts. However, important content elements and economic analyses remain. Yet, even in these instances, we made judicious edits to present the material as efficiently as possible and to make the analytical findings accessible to students. A brief overview of the major revisions follows, which will help guide existing adopters through these changes.

Starting with the first three foundation modules, demand data in Chapter 2, *Modeling the Market Process*, and Chapter 3, *Modeling Market Failure*, have been revised to avoid deriving a market demand function with a kink. In the benefit-cost chapters (Chapters 7, 8, and 9), we converted all magnitudes to 2003 dollars so that the values could be more easily understood by today's students. New abatement cost data in Chapter 8, *Assessing Costs for Environmental Decision Making*, are presented in easy-to-read histograms. In Chapter 9, *Benefit-Cost Analysis*, the detailed steps of deriving present values of benefits and costs have been moved from the text to a table, where they can be easily located without interrupting the text discussion.

Similar revisions were done in the media modules. In Chapter 10, *Defining Air Quality*, the benefit-cost analysis centers on the more recent study of the current law, i.e., the 1990 Amendments, referring only where necessary to the earlier study of pre-1990 legislation. We also converted all the values in this chapter to 2003 dollars for consistency and accessibility to students. Chapter 12, *Controlling Stationary Sources*, was reorganized to be symmetric with Chapter 11, *Controlling Mobile Sources*. Each chapter now opens with the relevant pollution problem, then moves to the policy response, and concludes with the economic analysis. Chapter 13, *Global Air Quality*, was made more concise to allow a clearer focus on current policy, including the recently ratified Kyoto Protocol, the U.S. response to the protocol, and the Chicago Climate Exchange.

In Chapter 14, *Defining Water Quality*, we made analogous changes to those done in Chapter 10. Specifically, we deleted the discussion of the benefit-cost analysis of the 1972 water quality legislation, calling attention to the more recent analysis that uses the contingent valuation method. Chapter 17, *Managing Hazardous Solid Waste and Waste Sites*, was reorganized to present the material more efficiently and in an easier-to-follow format, which comprises two distinct and symmetric discussions—one on hazardous waste and one on hazardous waste sites. A similar reorganization was done in Chapter 19, *Controlling Pesticides and Toxic Chemicals*.

Lastly, we simplified all structural elements of the book to achieve a **trimmer look**. Instructors should notice more succinct graph legends, more concise definitions, shorter chapter headings, and fewer footnotes. In those cases where detailed quantitative values are not critical, we replaced data tables with easier-to-read histograms or pie charts.

We believe the overall result is a positive one. The goal was to preserve the careful exploration of environmental issues and economic analysis that is the hallmark of our text, while integrating revisions that make the material more accessible to students and more accommodative of instructor time constraints. The table of contents attests to the topic-rich character of the text, but the presentation is markedly more concise. On average, each chapter is 20 percent shorter than it was in the third edition.

### **More Graphs and Quantitative Problems**

Based on input from adopters and our review panel, the new edition offers more **quantitative problems and models** for student use. More graphs and figures have been integrated throughout the text to reinforce the economics and the analytical tools introduced in the first three modules. A few examples will illustrate.

Chapter 13, *Global Air Quality*, now includes two additional graphical models—one on the negative externality of producing CFC-generating products and another on using an excise tax on ozone-depleting substances. In Chapter 17, *Managing Hazardous Solid Waste and Waste Sites*, a model of a waste-end charge has been added. Chapter 19, *Controlling Pesticides and Toxic Chemicals*, adds a graphical model of incremental benefits of pesticide use and another on using a product charge in chemical markets. And Chapter 20, *Sustainable Development*, presents a new graph of an international externality of transboundary pollution.

Where relevant and appropriate, algebraic models continue to be integrated in the text, and most are accompanied by graphical figures. This allows students to link graphs to simple quantitative models more readily. Not only does this help students develop good quantitative skills, but it also gives them two avenues to pursue when studying key concepts in the discipline. In some cases, we have edited existing models to make the set-up and the solution more explicit.

Lastly, at the end of virtually every chapter, the Review Questions now include at least one problem using algebra and/or a graphical analysis. As in past editions, solutions to all questions are found in the available Instructor's Manual.

### **Current International Coverage**

Reviewers and adopters have responded positively to Module 7, *Global Environmental Management*, which was essentially new to the third edition. We made certain to retain the focus of this module, adding new information and data where available. This module gives instructors the option of devoting a class or two strictly to **international issues** in environmental economics. A quick scan of the table of contents will convey the depth of coverage and the interesting content in supporting applications. Of course, as in previous editions, we continue to offer an integration of international issues throughout the text.

To keep this module relevant, we felt it was important to carefully research any new policy changes and incorporate them along with any available supporting data. Instructors and students will find new information on the recently ratified Kyoto Protocol and its flexible mechanisms, the Johannesburg Summit and its accomplishments, the Border 2012 Program between Mexico and the United States, and the status of the 1996 Protocol to the London Dumping Conventions. We also made best efforts to update such issues as the ratification status of major international agreements, international funding commitments, and corporate accomplishments in pollution prevention.

### **Updated Internet Links and Icons**

As in the prior edition, we continue to offer students and instructors **Internet links** to Web sites that support or enhance the text presentation. Every effort has been made to update all URLs and to add new Web sites that have come to our attention. These links are integrated within the text and in footnotes. To facilitate using the Internet as a complement to

instruction and study, an icon has been placed next to each link within the main text, which points them out more clearly to instructors and students.

## PEDAGOGICAL FEATURES

Our text continues to use a number of features designed to help instructors prepare lectures and class materials and to make the material interesting and accessible to students. There are both end-of-chapter and end-of-text pedagogical tools, including chapter summaries, review questions, a comprehensive glossary, and an extensive list of references. In every chapter, important definitions are given in the margins, key concepts are shown in boldface, and an extensive offering of real-world applications are provided in shaded boxes.

### Applications

Nearly **50 boxed applications** complement the text presentation by illustrating the relevance of economic theory, environmental risk, and public policy. The content has been drawn from many sources, including the business press, government reports, economic research, and the environmental science literature. Topics range from corporate strategies to international policy formulation. These real-world cases motivate learning because they illustrate fundamental concepts in relevant, contemporary settings. They also may stimulate more in-depth study in a term paper or course project. In addition to the new applications listed previously, other titles include:

- *BMW Group's Sustainable Decisions and Design for Recycling*
- *Taxing Gasoline Consumption: An International Comparison*
- *Fighting Acid Rain with Pollution Rights: The First Annual Auction*
- *The Endangered Species Act*
- *Incremental Environmental Costs of the September 11, 2001, Terrorist Attacks*
- *Why the United States Is Not Participating in the Kyoto Protocol*
- *Using the Market to Control Hazardous Wastes*
- *The Green Dot Program in Europe*
- *Bag-and-Tag Systems*
- *The Environmental Kuznets Curve*
- *ISO 14000 International Standards on Environmental Management*
- *Industrial Symbiosis in Kalundborg, Denmark: When a Bad Becomes a Good*

### Margin Definitions

In each chapter, **Margin Definitions** of terms and relationships are placed adjacent to the associated text presentation. This feature calls attention to important points in the text, helps familiarize students with new terminology, and assists them in reviewing and self-testing their comprehension. Each of these terms is repeated in the end-of-text glossary for easy reference.

### End-of-Chapter Learning Tools

Each chapter concludes with a **Summary** to help students review and assimilate what they have read. Instructors also may find these summaries valuable in organizing the course and in preparing lectures. We also provide both conceptual and analytical **Review Questions** that can be used for regular assignments, in-class discussions, or sample test questions. Solutions are provided in an Instructor's Manual available online through the publisher. We also offer a selection of **Additional Readings** (beyond those cited in the chapter), which are useful for supplementing reading assignments or supporting student projects. As in prior editions, these readings lists have been revised to include a sample of recently published journal articles and books. We also provide a reference list of commonly used **Acronyms** at the end of the chapters in the media-specific modules, i.e., Modules 4, 5, and 6.

**End-of-Text Learning Tools**

At the end of the text is a list of **References**, which gives complete information on all sources cited in short form throughout the book. Both instructors and students should find this collection of resources helpful in conducting independent investigations of selected topics. Some of these include URLs to facilitate online access. There is also a convenient **Glossary** of all defined terms given in the chapters.

**Text Ancillaries**

The following ancillary materials are available to users of the text:

- An **Instructor's Manual** is available online only to instructors and includes quantitative solutions and suggested responses to all end-of-chapter Review Questions.
- A newly developed collection of **PowerPoint<sup>®</sup> slides** with animated graphs is available on the text Web site to facilitate classroom presentations.

The text Web site at [www.thomsonedu.com/economics/callan](http://www.thomsonedu.com/economics/callan) contains links to Internet addresses from the text, PowerPoint<sup>®</sup> slides, the Instructor's Manual, and more.



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Scott J. Callan  
Janet M. Thomas

# ABOUT THE AUTHORS

**Professor Scott J. Callan** is a professor of economics at Bentley College. Professor Callan received his M.S. and Ph.D. degrees from Texas A & M University in 1985. Prior to joining the Bentley College faculty in 1987, Professor Callan was a member of the business faculty at Clarkson University in Potsdam, New York. His teaching areas of interest focus on quantitative methods and applied microeconomic topics, such as environmental economics and managerial economics. He has taught courses in environmental economics and the economics of natural resources at both the undergraduate and graduate levels.

In addition to his textbook, Professor Callan is the author of numerous applied microeconomic articles that have been published in a variety of economic journals, including the *Southern Economic Journal*, *Advances in the Economics of Energy and Resources*, *The Review of Industrial Organization*, and *The Journal of Business and Economic Statistics*. His recent environmental economics research investigates the demand and supply characteristics associated with the market for municipal solid waste (MSW). Demand-side topics examined include the impact of pay-as-you-throw programs on waste generation, disposal, and recycling activities. Supply-side issues have focused on the extent of economies of scale and scope in the provision of MSW services. His research findings have appeared in *Land Economics* and *Environmental and Resource Economics*, among other academic journals. In addition to his many publications, Professor Callan has reviewed numerous scholarly articles for academic publications as well as research grant proposals for the U.S. Environmental Protection Agency. Professor Callan is a member of several professional organizations, including the American Economic Association and the Southern Economic Association.

**Professor Janet M. Thomas** earned her M.A. and Ph.D. degrees in economics at Boston College. After completing her doctorate, she was appointed to the faculty of Bentley College in 1987. She is currently a full professor at Bentley, teaching at both the undergraduate and graduate levels. In addition to environmental economics, Professor Thomas teaches intermediate microeconomics, industrial organization, principles of microeconomics, and principles of macroeconomics. She has been actively involved in course and curriculum development in environmental economics and served as coordinator of the MBA, Environmental Management Concentration Program at Bentley.

Professor Thomas also is an active researcher in environmental economics, industrial organization, and other fields in applied microeconomics. Based upon data provided by the Massachusetts Department of Environmental Protection, her present environmental economics research centers on municipal solid waste markets, studying such issues as economies of scale and scope, demand determinants, unit pricing, and the influence of policy on recycling efforts. In addition to her textbook, she has published her research results in such academic journals as *Land Economics*, *Southern Economic Journal*, *Environmental and Resource Economics*, *Review of Industrial Organization*, *Eastern Economic Journal*, and the *Journal of Transport Economics and Policy*. She is a member of the American Economic Association and the Industrial Organization Society and has served as a reviewer for a number of academic journals and textbook publishers. Professor Thomas was named Faculty Member of the Year by Bentley's Student Government Organization in 1991. In 1993, she received the Gregory H. Adamian Award for Teaching Excellence, and in 1996, she received the Bentley College Scholar of the Year Award.