

高等学校经济类双语教学推荐教材

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经济学经典教材·专业主干课系列

Economics Classics

环境与自然资源经济学

Environmental &
Natural Resource

(第八版)

(Eighth Edition)

Economics

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中国人民大学出版社

图书在版编目 (CIP) 数据

环境与自然资源经济学：第 8 版：英文/蒂坦伯格，刘易斯著；安树民改编。—北京：中国人民大学出版社，2012.4
高等学校经济类双语教学推荐教材
经济学经典教材·专业主干课系列
ISBN 978-7-300-15522-7

I. ①环… II. ①蒂… ②刘… ③安… III. ①环境经济学-双语教学-高等学校-教材-英文②自然资源-资源经济学-双语教学-高等学校-教材-英文 IV. ①X196②F062.1

中国版本图书馆 CIP 数据核字 (2012) 第 056484 号

高等学校经济类双语教学推荐教材
经济学经典教材·专业主干课系列
环境与自然资源经济学 (第八版)

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Huanjing yu Ziran Ziyuan Jingjixue

出版发行	中国人民大学出版社		
社 址	北京中关村大街 31 号	邮政编码	100080
电 话	010-62511242 (总编室)		010-62511398 (质管部)
	010-82501766 (邮购部)		010-62514148 (门市部)
	010-62515195 (发行公司)		010-62515275 (盗版举报)
网 址	http://www.crup.com.cn		
	http://www.ttrnet.com (人大教研网)		
经 销	新华书店		
印 刷	涿州市星河印刷有限公司		
规 格	215 mm×275 mm 16 开本	版 次	2012 年 4 月第 1 版
印 张	28.5 插页 1	印 次	2012 年 4 月第 1 次印刷
字 数	662 000	定 价	55.00 元

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出 版 说 明

入世十年，我国已完全融入到经济全球化的浪潮中。党的十六大确立了“引进来，走出去”的发展战略，使得“国际化”复合型人才的需求不断增加。这就对我国一般本科院校多年来所采取的单一语言（母语）教学提出严峻挑战，经济类专业双语教学改革迫在眉睫。

为配合高校经济类专业双语教学改革，中国人民大学出版社携手培生、麦格劳-希尔、圣智等众多国际知名出版公司，倾情打造了该套“经济类双语系列教材”，本套教材包括：经济管理类专业开设的核心课程、经济学专业开设的主干课程以及财政金融专业和国际贸易专业的主要课程。所选教材均为国外最优秀的本科层次经济类教材。

我们在组织、引进和出版该系列教材的过程中，严把质量关。聘请国内著名经济学家、学者以及一线授课教师审核国外原版教材，广泛听取意见，努力做到把国外真正高水平的适合国内实际教学需求的优秀教材引进来，供国内广大师生参考、研究和学习。

本系列教材主要有以下特点：

第一，教材体系设计完整。本系列教材全部为国外知名出版公司的优秀教材，涵盖了经济类专业的所有主要课程。

第二，英文原版教材特色。本系列教材依据国内实际教学需要以及广泛适应性，部分对原版教材进行了全文影印，部分在保持原版教材体系结构和内容特色的基础上进行了适当删减。

第三，内容紧扣学科前沿。本系列教材在原著选择上紧扣国外教学前沿，基本上都是国外最流行教材的最新版本。

第四，篇幅合理、价格适中。本系列教材一方面在内容和篇幅上很好地适应了国内双语教学的实际需要，另一方面，低定价策略又避免了国外原版图书高额的学习费用。

第五，提供强大的教学支持。依托国外知名出版公司的资源，本系列教材为教师提供丰富的配套教辅资源，如教师手册、PPT课堂演示文稿、试题库等，并配有内容丰富的网络资源，使教学更为便利。

本系列教材既适合高等院校经济类专业的本科教学使用，也适合从事经济类工作和研究的广大从业者的阅读和学习。我们在选书、改编过程中虽然全面听取了专家、学者和教师的意见，努力做到满足广大读者的需求，但由于各教材的作者所处的政治、经济和文化背景不同，书中内容仍可能有不妥之处，我们真诚希望广大读者提出宝贵意见和建议，以便我们在以后的版本中不断改进和完善。

改 编 者 前 言

汤姆·蒂坦伯格和琳恩·刘易斯所著的《环境与自然资源经济学（第八版）》是环境与资源经济学方面的经典之作。它通过完整的理论分析和有力的经验证据，清楚地向人们阐述了当今世界面临的复杂环境和自然资源问题，并详细讨论了保护环境和自然资源、实现可持续发展的有关政策问题。本书是一部经济学著作，但又超越了单一的经济学科范畴，结合了经济学、生态学、政治学等多门学科的知识，并且几乎涉及了目前该领域的所有前沿问题。应中国人民大学出版社的要求，本人将原教材的部分内容进行了删减，形成一部精简版的《环境与自然资源经济学（第八版）》。

本书最大的特点就是作者以其开阔的视野，搜集了大量翔实且生动的例证，避免了大多数经济学书籍堆积较多经济理论与模型的编写方式。本书的每一章都针对环境与自然资源经济学中的一个论题，尽管具有相对的独立性，但通过用有限环境中的发展这一脉络来贯穿始终，使全书内容形成一个完整的主题。

正是由于原著的每一章具有相对的独立性，因此也为本书内容的删减提供了便利。原书的第2~5章比较深入地探究了传统经济学方法，为后续章节提供了基本的估值原则，予以保留。原书第6章论述了人口问题的经济分析，而在国内有专门独立的“人口经济学”的课程，因此为避免和人口经济学课程的内容重复，这里予以删除。原书第7~14章论述了传统自然资源经济学中的几个问题。其中第9章论述的是“可回收资源”，而在国内有专门独立的“循环经济”课程论述类似的问题，因此在精简版中予以删除。第11章论述了“土地资源利用的经济学分析”，而在国内有专门独立的“土地经济学”课程论述类似的问题，因此在精简版中予以删除。第12章论述了“农业经济”的问题，而在国内有专门独立的“农业经济学”课程论述类似的问题，因此在精简版中予以删除。原书第15章是概括性的一章，不仅强调了污染问题的多重本质，而且强调了解决问题的不同政策方法之间的差异。原书第16~20章分别论述的是本地大气污染的特殊性、区域和全球大气污染、机动车空气污染、水污染和有毒物质的控制。其中第20章关于“有毒物质”的论述中经济学分析的色彩相对较淡，而法律监管的论述相对多一些，因此在精简版中予以删除。原书第21章是关于“环境公正”的论述，类似内容在“环境伦理学”的课程中多有论述，为避免重复，精简版中予以删除。原书第22章是关于“发展、贫困与环境”的论述，这个话题非常重要也非常复杂，单单靠一个章节的内容难以将这一问题剖析清楚，基于此，精简版中予以删除，请对此问题感兴趣的读者寻求专门的论著。原书第23章是关于“可持续发展”的论述，

与前述内容紧密相关，予以保留。原书第 24 章是关于对未来展望的再思考，内容相对简单，在精简版中予以删除。

囿于改编者的学识与能力有限，所做删减不一定能满足各类读者的需求，望此领域的专家学者及各位读者不吝赐教，以为更正完善。

改编者 安树民

2012 年 3 月

Preface

A glance at any newspaper will confirm that environmental economics is now a major player in environmental policy. Concepts such as cap-and-trade, renewable portfolio standards, block pricing, renewable energy credits, development impact fees, conservation easements, carbon trading, the commons, congestion pricing, corporate average fuel economy standards, pay-as-you-throw, debt-for-nature swaps, extended producer responsibility, sprawl, leapfrogging, pollution havens, strategic petroleum reserves, and sustainable development have moved from the textbook to the legislative hearing room. As the large number of current examples in *Environmental & Natural Resource Economics* demonstrates, ideas that were once restricted to academic discussions are now not only part of the policy mix, but they are making a significant difference.

Reflecting this new role of environmental economics in policy, a number of journals are now devoted either exclusively or mostly to the topics covered in this book. One journal, *Ecological Economics*, is dedicated to bringing economists and ecologists closer together in a common search for appropriate solutions for environmental challenges. Interested readers can also find advanced work in the field in *Land Economics*, *Journal of Environmental Economics and Management*, *Environmental and Resource Economics*, *International Review of Environmental and National Resource Economics*, *Environment and Development Economics*, *Resource and Energy Economics*, and *Natural Resources Journal*, among others.

New resources for student research projects have been made available in response to the growing popularity of the field. Original research on topics related to international environmental and natural resource issues was formerly very difficult for students because of the paucity of data. A number of good sources now exist, including *World Resources* (Washington, DC: Oxford University Press, published annually), which has an extensive data appendix, and *OECD Environmental Data* (Paris: Organization for Economic Cooperation and Development, published periodically).

A few Internet sources are included because they are closely related to the focus of environmental and natural resource economics. Two discussion lists that involve material covered by this book are ResEcon and EcolEcon. The former is an academically inclined list focusing on problems related to natural resource management; the latter is a wider ranging discussion list dealing with sustainable development.

Services on the Internet change so rapidly that some of this information may become obsolete. To keep updated on the various Web options, visit the Companion Website of this text at <http://www.aw-bc.com/tietenberg>. The site has links to

other sites, including the site sponsored by the Association of Environmental and Resource Economists, which has information on graduate programs in the field.

Environmental & Natural Resource Economics attempts to bring those who are beginning the study of environmental and natural resource economics close to the frontiers of knowledge. Although it is designed to be accessible to students who have completed a two-semester introductory course in economics or a one-semester introductory microeconomics course, it has been used successfully in several institutions in lower-level and upper-level undergraduate courses as well as lower-level graduate courses.

Intertemporal optimization is handled within a discrete-time, mathematical programming framework, and all mathematics, other than simple algebra, are relegated to chapter appendixes. Graphs and numerical examples provide an intuitive understanding of the principles suggested by the math and the reasons for their validity. In the eighth edition, we have retained the strengths that are particularly valued by readers, while expanding the number of applications of economic principles, clarifying some of the more difficult arguments, and updating the material to include the very latest global developments.

The structure and topical coverage of this book facilitate its use in a variety of contexts. For a survey course in environmental and natural resource economics, all chapters are appropriate, although many of us find that the book contains somewhat more material than can be adequately covered in a quarter or even a semester. This surplus material provides flexibility for the instructor to choose those topics that best fit his or her course design.

New to This Edition

In this eighth edition, Lynne Lewis joins the author team as we examine many of these newly “popular” market mechanisms within the context of both theory and practice. Environmental and natural resource economics is a rapidly growing and changing field as many environmental issues become global in nature. In this text, we tackle some of the complex issues that face our globe and explore problems and potential solutions.

This edition retains a strong policy orientation. Although a great deal of theory and empirical evidence is discussed, their inclusion is motivated by the desire to increase understanding of intriguing policy problems, and these aspects are discussed in the context of those problems. This explicit integration of research and policy within each chapter avoids the problem frequently encountered in applied economics textbooks—that is, in such texts the theory developed in earlier chapters is often only loosely connected to the rest of the book.

This is an economics book, but it goes beyond economics. Insights from the natural and physical sciences, literature, political science, and other disciplines are scattered liberally throughout the text. In some cases these references raise outstanding issues that economic analysis can help resolve, while in other cases they affect the structure of the economic analysis or provide a contrasting point of view. They play an important role in overcoming the tendency to accept the material uncritically at

a superficial level by highlighting those characteristics that make the economics approach unique.

Supplements

For each chapter in the text, the *Online Instructor's Manual*, revised by Ana Espinola-Arredondo of the School of Economic Sciences, Washington State University, provides an overview, learning objectives, a chapter outline with key terms, common student difficulties, and suggested classroom exercises. *PowerPoint*® presentations, prepared by Hui Li of Eastern Illinois University, are available for instructors and include all art and figures from the text as well as lecture notes for each chapter. Professors can download the *Online Instructor's Manual* and the *PowerPoint* presentations at the Instructor Resource Center (www.pearsonhighered.com/irc).

The book's Companion Website, www.aw-bc.com/tietenberg, features chapter-by-chapter Web links to additional reading and economic data. The site also contains Excel-based models that can be used to solve common forest-harvest problems numerically. These models, developed by Arthur Caplan and John Gilbert of Utah State University, may be presented in lecture to accentuate the intuition provided in the text, or they may underlie specific questions on a homework assignment.

For the first time with this edition, the Companion Website also provides self-study quizzes for each chapter. Written by Elizabeth Wheaton of Southern Methodist University, these chapter quizzes contain 10 multiple choice questions for students to test what they have learned.

Tom Tietenberg
Lynne Lewis

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Visions of the Future

From the arch of the bridge to which his guide has carried him, Dante now sees the Diviners ... coming slowly along the bottom of the fourth Chasm. By help of their incantations and evil agents, they had endeavored to pry into the future which belongs to the almighty alone, and now their faces are painfully twisted the contrary way; and being unable to look before them, they are forced to walk backwards.

—Dante Alighieri, *Divine Comedy: The Inferno*, translated by Carlyle (1867)

Introduction

The Self-Extinction Premise

About the time the American colonies won independence, Edward Gibbon completed his monumental *The History of the Decline and Fall of the Roman Empire*. In a particularly poignant passage that opens the last chapter of his opus, he re-creates a scene in which the learned Poggius, a friend, and two servants ascend the Capitoline Hill after the fall of Rome. They are awed by the contrast between what Rome once was and what Rome has become:

In the time of the poet it was crowned with the golden roofs of the temple; the temple is overthrown, the gold has been pillaged, the wheel of fortune has accomplished her revolution, and the sacred ground is again disfigured with thorns and brambles. ... The forum of the Roman people, where they assembled to enact their laws and elect their magistrates is now enclosed for the cultivation of potherbs, or thrown open for the reception of swine and buffaloes. The public and private edifices, that were founded for eternity lie prostrate, naked, and broken, like the limbs of a mighty giant; and the ruin is the more visible, from the stupendous relics that have survived the injuries of time and fortune [Vol. 6, pp. 650–651].

What could cause the demise of such a grand and powerful society? Gibbon weaves a complex thesis to answer this question, suggesting ultimately that the seeds for Rome's destruction were sown by the Empire itself. Although Rome finally succumbed to such external forces as fires and invasions, its vulnerability was based upon internal weakness.

Some Historic Examples

The premise that societies could germinate the seeds of their own destruction has long fascinated scholars. In 1798 Thomas Malthus published his classic “An Essay on the Principle of Population,” in which he foresaw a time when the urge to reproduce would cause population growth to exceed the land’s potential to supply sufficient food and result in starvation and death. In his view, the adjustment mechanism would involve rising death rates caused by environmental constraints, rather than a recognition of impending scarcity followed by either innovation or self-restraint.

Actual historic examples suggest that the Malthus vision may have merit. Consider two specific cases: the Mayan civilization and Easter Island.

The Mayan civilization, a vibrant and highly cultured society that occupied parts of Central America, did not survive. One of the major settlements, Copán, has been studied in sufficient detail to reveal reasons for its collapse (Webster et al., 2000).

The Webster et al. study reports that the population growth began to bump into environmental constraints in the fifth century, specifically the agricultural carrying capacity of the land. The growing population depended heavily on a single, locally grown crop (maize) for food. By early in the sixth century, however, the carrying capacity of the most productive local lands was exceeded, and farmers began to depend upon more fragile parts of the ecosystem. The economic result was diminishing returns to agricultural labor, and the production of food failed to keep pace with the increasing population.

By the mid-eighth century, when the population was reaching its historic apex, widespread deforestation and erosion had set in, thereby intensifying the declining productivity problems associated with moving onto marginal lands. By the eighth and ninth centuries, the evidence reveals high levels of infant and adolescent mortality, as well as widespread malnutrition. The royal dynasty, an important source of leadership in this society, collapsed rather abruptly around A.D. 820–822.

The second case study, Easter Island, shares some remarkable similarities with both the Mayan case and the Malthusian vision. Easter Island lies some 2,000 miles off the coast of Chile. Current visitors note that it is distinguished by two features: (1) its enormous statues carved from volcanic rock and (2) a surprisingly sparse vegetation given the island’s favorable climate and volcanic conditions, which typically support fertile soil. Both the existence of the imposing statues and the fact that they were erected such a long way from the quarry suggest the presence of an advanced civilization, but to current observers it is nowhere in evidence. What happened to that society?

The short answer is that a rising population, coupled with a heavy reliance on wood for housing, canoe building, and statue transportation, decimated the forest (Brander and Taylor, 1998). The loss of the forest contributed to soil erosion, declining soil productivity, and, ultimately, diminished food production. How did the community react to impending scarcity? Apparently the social response was war and, ultimately, cannibalism.

We would like to believe that in the face of impending scarcity, societies would react by changing behavior to adapt to the diminishing resource supplies and that this benign response would follow automatically from a recognition of the problem. We

even have a cliché to capture this sentiment: “Necessity is the mother of invention.” While these stories do *not* imply that the cliché is always wrong (it isn’t), they do point out that nothing is automatic about a problem-solving response. Sometimes societal reactions not only fail to solve the problem, but also they make it worse.

Future Environmental Challenges

Future societies, like those just discussed, will be confronted by both resource scarcity and accumulating pollutants. Although many specific examples of these broad categories of problems are discussed in detail in the following chapters, this section provides a flavor of what is to come by illustrating the challenges posed by one pollution problem (climate change) and one resource scarcity problem (water accessibility).

Climate Change

Energy from the sun drives the earth’s weather and climate. Incoming rays heat the earth’s surface, radiating energy back into space. Atmospheric “greenhouse” gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy.

Without this natural “greenhouse effect,” temperatures on Earth would be much lower than they are now, and life as we know it would be impossible. It is possible, however, to have too much of a good thing. Problems arise when the concentration of greenhouse gases increases beyond normal levels, thus retaining excessive heat somewhat like a closed cabin in the summer.

Since the Industrial Revolution, greenhouse gas emissions have increased considerably. These increases have enhanced the heat-trapping capability of the earth’s atmosphere. According to the Committee on the Science of Climate Change (2001), the earth’s surface temperature has risen by about one degree Fahrenheit in the past century, with accelerated warming during the past two decades. That study concludes that most of the warming over the last 50 years is attributable to human activities.

As the earth warms, extreme heat conditions are expected to affect human health. Some damage is caused directly by increased heat, as shown by the heat waves that resulted in thousands of deaths in Europe in the summer of 2003. Human health can also be affected by pollutants, such as smog, that are exacerbated by warmer temperatures. Rising sea levels (as warmer water expands and previous frozen sources such as glaciers melt), coupled with an increase in storm intensity, are expected to flood coastal communities. Ecosystems will be subjected to unaccustomed temperatures; some will adapt by migrating to new areas, but others may not be able to adapt in time. While these processes have already begun, they will intensify slowly throughout the century.

Climate change also has an important moral dimension. Many developing countries that have produced relatively little greenhouse gases are expected to be the hardest hit as the climate changes due to their more limited adaptation capabilities.

Dealing with climate change will require a coordinated international response. That is a significant challenge to a world system where the nation-state reigns supreme and international organizations are relatively weak.

Water Accessibility

Another class of threats is posed by the interaction of a rising demand for resources in the face of a finite supply. Water provides a particularly interesting example because it is vital to life.

According to the United Nations, about 40 percent of the world's population lives in areas with moderate-to-high water stress. ("Moderate stress" is defined in the U.N. Assessment of Freshwater Resources as "human consumption of more than 20 percent of all accessible renewable freshwater resources," whereas "severe stress" denotes consumption greater than 40 percent.) By 2025 it is estimated that about two-thirds of the world's population—about 5.5 billion people—will live in areas facing either moderate or severe water stress.

This stress is not uniformly distributed around the globe. For example, in the United States, China, and India groundwater is being consumed faster than it is being replenished and aquifer levels are steadily falling. Some rivers, such as the Colorado in the western United States and the Yellow in China, often run dry before they reach the sea.

According to U.N. data, Africa and Asia suffer the most from the lack of water supply and sanitation in urban areas. Up to 50 percent of Africa's urban residents and 75 percent of Asians lack adequate access to a water supply.

The availability of potable water is further limited by human activities that contaminate the finite supplies. According to the United Nations, 90 percent of sewage and 70 percent of industrial wastes in developing countries are discharged without treatment.

Some arid areas have compensated for their lack of water by importing it via aqueducts from more richly endowed regions or by building large reservoirs. Regional and international political conflicts may result if the water transfer or the relocation of people living in the area to be flooded by the reservoir is resisted. Additionally, aqueducts and dams may be geologically vulnerable. For example, in California many of the aqueducts cross or lie on known earthquake-prone fault lines (Reisner, 2003).

Meeting the Challenges

If our ancestors had recognized that human activities could seriously impact environmental life-support systems and deny our generation the quality of life to which we have become accustomed, they might have chosen a different, more sustainable path for improving human welfare. Because they did not have that knowledge and, therefore, did not make sustainable choices years ago means that current generations are now faced with making more difficult choices with even fewer options.