Introduction: Economics *for* the Environment

Welcome! The title of this chapter is 'Economics *for* the Environment'. Why? Because we believe that economics has an important contribution to make in helping us understand and solve the many environmental problems facing people throughout the world today. People often equate 'economics' with 'financial and commercial', yet economics is as much about Main Street as it is about Wall Street. Economic arguments can often be used to help protect the environment, rather than harm it. In Part I of this book, we set out the principal insights that economics has to offer. Then, in Part II, we take a range of important environmental problems, and show how these insights can improve how people respond to these problems. We believe strongly that an environmental policy that does not address the economic behaviour of consumers and firms is likely to get things badly wrong. Often, economic actors can be induced to take account of their impacts on the environment, by getting prices on environmental goods and services right. Economic and environmental systems are closely interlinked: by not addressing economic insights, we are unlikely to produce cost-effective outcomes for either system.

People are paying more attention to the environmental consequences of economic activity, and to the economic value of the environment. Partly, this is due to greater public awareness of environmental issues such as climate change or the loss of treasured local landscapes. Partly, it is a consequence of the increasing interest of policy-makers to understand the benefits and costs of environmental regulation. People have started to care and know more about environmental degradation and the benefits of ecosystem services. Sustainable development and green growth have become key concepts within many public policy pronouncements, yet the usefulness of these concepts is unclear—whilst predictions of impending doom due to world population increases and climate change continue to circulate. Given our belief that economics has an important, indeed vital, contribution to make in understanding these issues and the trade-offs that lie behind them, we think that a book that tries to get the basic ideas across to a wide audience seems a good idea.

This is the second edition of a book first published in 2001. Since then, public debates over climate change (the evidence for it, and what to do about it) have greatly increased, whilst there has been a growing awareness since the Millennium Ecosystem Assessment of the benefits that ecosystems provide to people. Many countries have greatly expanded their renewable energy capacities, whilst global targets on reducing biodiversity losses have not

been achieved. The links between the increasing scale of global economic activity, trade, and environmental quality continue to be debated. We thus felt that there was still a need for an introductory-level textbook that explains the contributions that economics can make to understanding and resolving these problems. In revising the text, we have taken account of both the evolution of environmental issues and the advances in environmental economics since the first edition appeared. We have also tried to take into account feedback from people who have used our textbook, both students and faculty.

In the rest of this chapter, we:

- Discuss the connections between the economy and the environment.
- Review ten key insights from environmental and resource economics that environmental scientists, managers, and politicians ought to be aware of.
- Explain how this book is best used.
- Provide an overview of what happens in the rest of the book.

1.1 The Economy and the Environment

This book explores why economics matters more to environmental and natural resource policy than many people think. To begin with, it is important to say that economics is not just about financial comings and goings within markets: the 'unpriced' or non-market services that the natural environment provides us with are equally its concern. The value of protecting wetlands for their biodiversity, flood defence, and pollution treatment functions is just as much an economic value as this week's production of oil from a Texas oilfield.

Next, people can benefit from a better appreciation of how the economy and the environment are interlinked. The economy operates from inside the environmental system, with conditions in the two systems being simultaneously determined in an evolving, dynamic way. By 'the economy', we mean all the firms that make up industry; households (people) in their twin roles as consumers and suppliers of labour; governments; the institutions that govern interactions between these groups, such as markets; the state of technology; and our stocks of produced capital (such as roads and space stations). By 'the environment', we mean all natural resources found in the biosphere, including land, land cover, and ecosystems (flora and fauna); resource deposits under the land surface; the world's oceans and atmosphere; and the natural climate and nutrient cycles. As Figure 1.1 shows, there are many links between these two systems.

First, the environment provides the economic system with *inputs* of raw material and energy resources, including minerals, metals, food, hydrocarbons, and fibres such as wood and cotton. These resources may be either non-renewable—such as coal or iron ore—or renewable, such as fisheries or forests. Inputs are transformed by the economic system into outputs that consumers demand—wood into paper and oil into petrol, for example.

Second, the economy uses the environment as a *waste sink*. Wastes may originate from either production processes, such as CO_2 from electricity generation; or from consumption activities, for instance, when households put out the garbage for collection and disposal. Wastes come in a number of basic types—solid, air-, or water borne—and the environment has a limited assimilative capacity to absorb and transform some wastes into harmless

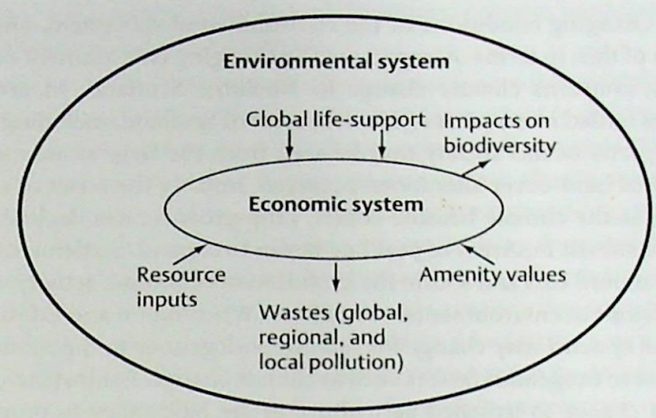

Figure 1.1 Economy–environment interactions.

substances. Pollution is said to occur when emissions exceed assimilative capacity, and produce some undesirable impact.

Third, the environment provides households with a direct source of *amenity*. People derive utility (happiness, satisfaction) from the contemplation of scenic beauty and wildlife, and from hiking and fishing. As Chapter 3 makes clear, these direct utility impacts are both important and relevant from an economics viewpoint.

Finally, the environment provides the economic system with basic life-support services. Since the Millennium Ecosystem Assessment, these services have increasingly been referred to as *ecosystem services*. These include climate regulation, the operation of the water cycle, the regulation of atmospheric composition, and nutrient cycling.

One obvious point is that if the economy increases its demand on the environment with regard to any one of these four service flows, this can impact on the environment's ability to provide other services. For example:

- An increase in the use of the environment as a waste sink due to increased emissions of pollutants may reduce the environment's ability to supply basic life-support by interfering with climate regulation; or may reduce the amenity value of the environment by degrading wildlife populations.
- An increase in demand on the environment for resource inputs may mean a reduction in amenity flows; for example, if quarries are developed in national parks or as logging reduces the area of rainforest.
- We also show a link in Figure 1.1 between the economy and *biodiversity*. This shows that economic activity can affect natural diversity, most notably by taking over habitats (e.g. when a rainforest is turned into a gold mine). Diversity is thought to be an important property of natural systems, especially with regard to their ability to withstand shocks such as drought and fire (this property is sometimes known as *resilience*). Thus, ultimately, reductions in biodiversity can have direct and indirect effects on human well-being.

An important feature of the interdependent economic–environmental system is co-evolution. This means that the way in which the economic subsystem evolves over time

depends on the changing conditions of the environmental subsystem, and vice versa. A good illustration of this, in terms of impacts of the changing environment on the evolution of the economy, concerns climate change in Neolithic Scotland. In around 4000 BC, Neolithic farmers settled many parts of the west coast of Scotland, including islands such as Arran. The prosperity of this society may be seen from the large stone monuments they erected. Substantial land-cover alterations occurred, notably the onset of clearing land of trees.[1] However, as the climate became cooler, crop growth rates declined and the land became harder to subsist in. Areas of peat bog began to expand. Settlements became abandoned as people moved east and south: the evolution of economic activity was changed by exogenous alterations in environmental conditions (Whittington and Edwards, 1997).

Environmental systems may change for reasons endogenous to the economic system as well as in response to exogenous factors such as climate change. For instance, in nineteenth-century Egypt, a change to irrigated agriculture in the Nile valley to produce cotton for exporting, away from the system of natural flooding that had been in use since 5000 BC, resulted in the increasing salinity of farmland, and its eventual abandonment. Overexploitation of farmlands in areas as diverse as Mesopotamia, Easter Island, the Indus valley, and the Mayan civilization of Central America caused food production crashes that changed the course of the development of entire societies (Ponting, 1991).

Economic changes also impact on ecosystem evolution. Examples include the following:

- *Introductions of invasive species.* For instance, the introduction of possums from Australia to New Zealand, and earlier introductions of rats and stoats, have changed the types and abundance of flora and fauna there. Zebra mussels invading the Great Lakes of the United States have transformed the basic nature of freshwater ecosystem services.
- *Changes in aquatic ecosystems.* Changes took place as the Industrial Revolution unfolded in nineteenth-century Britain. The resultant increased sulphur deposition via acid rain reduced pH values in lakes and lochs, changing the composition of vertebrate and invertebrate fauna over time.

1.2 Key Insights from Economics of which Environmental Scientists, Environmental Managers, and Politicians Should be Aware

The previous section set out the interactions between the economy and the environment. What do economists have to say about these interactions? In the rest of this book, we will explain the contribution that economics can make to understanding and solving environmental problems. But suppose someone was too busy to read the rest of this book. What, at a minimum, would we wish to leave them with? The following list is one possibility:

1. Economic and environmental systems are determined simultaneously. This means that to fully understand these systems, economics must incorporate the mechanical

[1] There were in fact many phases of change in the woodland area up to 2,000 years ago, whilst the exact causes of change are still much debated. See Whittington and Edwards (1997).

underpinnings of the natural sciences, and the natural sciences must incorporate the behavioural underpinnings of economics.

2. The behavioural underpinnings of economics matter for environmental policy. First, people respond to incentives, as do firms. The most important incentives tend to be prices. Second, people make decisions 'at the margin': in other words, they try to balance out the costs and benefits of going one step further. Finally, expect firms and households to usually act in their own best interests. For firms, this typically means maximizing profits and for households it means maximizing their well-being (their *utility*). This implies that we should not be surprised when either behaves strategically: for example, when someone free-rides when asked to make a donation for an environmental good cause, or when a farmer threatens to destroy a wetland in return for a compensation payment not to do so. Institutions need to be designed that take these kinds of responses into account. Recent advances in mainstream economics that take a broader view of the motivations behind human behaviour than the standard model of 'rational choice' have become increasingly important within environmental economics (Shogren and Taylor, 2008).
3. Environmental resources are scarce, and using them in one way has an opportunity cost. By 'scarce', we mean that there are not enough environmental resources around to simultaneously meet every possible demand on them. By 'opportunity cost', we mean the net benefits forgone from the next-best use. For example, suppose that a piece of land has three possible uses, namely agriculture, forestry, and recreation, which have returns of £2,000/ha, £3,000/ha, and £4,000/ha. These activities we will assume to be mutually exclusive, in that the land cannot be used for more than one purpose at the same time. Deciding to use the land for recreation purposes forgoes a return from either agriculture or forestry, and the opportunity cost is the next-best return forgone, namely £3,000/ha. This cost should be taken into account when evaluating the net benefits of using the land for recreation.
4. The free market system can generate the 'wrong' level of environmental quality. Too many environmental bads (e.g. too much pollution) and too few environmental goods (such as beautiful landscapes) will result from the point of view of social optimality. Why should this be?—Because the system of property rights in existence means that no market price exists either to discourage economic agents from polluting or to encourage them to produce environmental benefits. This problem is known in economics as market failure: Chapter 2 investigates this issue in detail, and suggests alternative ways of solving such problems. Another way of thinking about this is to say that the environment is valuable in many ways, but not all of these show up in market values or prices. For example, it is hard for a private landowner to charge for the landscape benefits that his farm 'produces', and no market price exists for many aspects of landscape beauty.
5. However, markets have proved to be the best way of allocating a vast range of resources: Adam Smith's 'invisible hand' still has much to recommend it. Markets are good at coordinating actions and at transmitting information. For many resources, the market system is also good at responding to changes in relative scarcity. For example, the significant hikes in oil prices in the 1970s produced automatic adjustments in supply and demand. Finally, markets allow people the opportunity to trade, which turns out to

be a good way of increasing social welfare on the whole. Markets can also be made to work for the environment: see, for example, the discussion of the idea of tradable pollution permits in Chapter 2.

6. Government intervention does not always make things better, and can make things worse. The Common Agricultural Policy of the European Union (EU) has been frequently criticized as having given farmers an incentive to damage the environment: this might be called 'government failure'. When governments interfere with the free operation of markets, they need to be aware that they are likely to bring about coordination and information problems. Government intervention may well hinder the responsiveness of markets to changes in relative scarcity; for example, if they keep prices at levels other than the market clearing rate (Chapter 2).
7. Environmental protection costs money. Scarcity means that opportunity costs exist for all choices, even those driven by moral imperatives. Protecting endangered species costs money, both directly (e.g. in monitoring) and indirectly (in that land can no longer be used for development). Spending more public money on public transport systems to reduce air pollution may mean that less money is available to spend on schools. What is more, the costs of protecting the environment typically increase at the margin. As emissions from industrial sources are progressively cleaned up, each extra reduction gets more and more expensive to achieve.
8. When managing renewable resources such as fish and forests, choosing the maximum sustainable yield as the best level at which to harvest is rarely optimal. This is because this rule ignores the economic costs and benefits of renewable resource management. Catching at the maximum sustainable yield usually means too many boats chasing too few fish.
9. Whilst economic growth may contribute to current environmental problems, few people would swap their position today with their equivalent 200 years ago, due to the huge increases in real incomes per capita and improvements in life expectancy. It is hard to think of economic growth as a bad thing, but it is something that gives rise to a series of environmental consequences that need to be dealt with.
10. Many of the world's most serious environmental problems are global in nature; however, economics predicts that getting countries to agree to do something about these problems together is going to be tough (Chapter 7). This is because game theory shows us that countries have an incentive to 'free-ride' on the actions of others and so, for example, to avoid signing up for international agreements to cut global pollutant emissions. However, economists can help in designing institutional arrangements to reduce these problems.

1.3 The Rest of this Book: An Overview

We divide the book into two parts. Part I explores some important concepts in economics, and illustrates why they matter for environmental issues. Chapter 2 explores the role of markets in determining the level of environmental quality, what 'market failure' means, and

how markets can be used to work for the environment. The practice of placing monetary values on the environment has become controversial, but is an important component of the economist's toolbox: Chapters 3 and 4 deal with this issue, and with the methodology of cost–benefit analysis. Many environmental decision-making problems are characterized by high levels of risk and uncertainty, so Chapter 5 introduces economic approaches to these issues. Sustainable development and green growth are fashionable buzzwords in environmental and development debates at present: Chapter 6 investigates what economics has to contribute to this debate, and to understanding the relationship between growth and indicators of environmental quality. In Chapter 7, game theory techniques are introduced as a useful tool to help understand situations in which people behave strategically, be they countries arguing over climate change conventions or fishermen competing over harvests. Finally, Chapter 8 lays out some basic economics of the debate over free trade: Does free trade always increase people's well-being? Can trade restrictions be justified on environmental grounds?

In Part II, we explore how economics can help us understand the causes of a series of important environmental problems and, more importantly, provide more environmental protection at lower cost. The issues studied are:

- Climate change
- Forests and forest loss
- Water pollution
- Biodiversity loss
- Energy policy

These chapters are brief considerations of these important and complex issues, so we only have space to highlight how economics can be useful in thinking about our impacts on the natural world. Yet the material in Part II does show (we hope!) the richness of analysis that economics can bring to these problems.

1.4 Using this Book for Teaching and Learning

This book is aimed at a wide audience. Little economics background is assumed, and the use of mathematical explanations is downplayed as much as possible. The book is suitable for introductory courses in environmental and natural resource economics, both for economics students and non-economists. It should also be suitable for undergraduate- and MSc-level interdisciplinary courses in which many students lack a background in economics.

Instructors will see that we do not follow a traditional path in explaining the subject: for example, there is no chapter on the economics of renewable resources *per se*, nor on the economics of the mine. The key ideas may all be found either in Part I (e.g. in Chapter 7 on game theory, for renewables) or in the case studies in Part II (e.g. in the energy chapter for non-renewables and the forest chapter for forestry economics). We recognize that there are costs to presenting things this way, but we feel these are outweighed by the benefits: an initial introduction to important economic concepts; and then a look at important environmental issues, which draws on these concepts and develops others. At the end of each

chapter, we include a list of suggested questions for use in tutorials or seminars, and a glossary of key terms. References are provided at the end of each chapter, rather than being collected together at the end of the book.

References and Additional Readings

Ponting, C. (1991). *A Green History of the World* (London: Penguin).

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Whittington, G., and Edwards, K. (1997). 'Climate change', in K. Edwards and I. Ralston (eds.), *Scotland: Environment and Archaeology, 8000 BC–AD 1000* (Chichester: Wiley).