Applied Environmental Economics

The complex real-world interactions between the economy and the environment form both the focus of and the main barrier to applied research within the field of environmental economics. However, geographical information systems (GIS) allow economists to tackle such complexity head on by directly incorporating diverse datasets into applied research rather than resorting to simplifying and often unrealistic assumptions. This innovative book applies GIS techniques to spatial cost-benefit analysis of a complex and topical land use change problem – the conversion of agricultural land to multipurpose woodland – looking in detail at issues such as opportunity costs, timber yield, recreation, carbon storage, etc., and embracing cross-cutting themes such as the evaluation of environmental preferences and the spatial transfer of benefit functions.

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APPLIED ENVIRONMENTAL ECONOMICS

A GIS Approach to Cost-Benefit Analysis

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For Fiona, Ben, Freya and Natasha: my world. With love, Ian.

For Mum and Dad. With love and many thanks, Andrew.

For Isabel, Dan and John. Con cariño, Julii.

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Foreword

Much of environmental change is driven by land use change. To some, the whole history of economic and social development reflects the exchange of one form of asset – 'natural' landscape – for another form of asset – man-made capital. Certainly, viewed from a global perspective, there is a one-to-one relationship between the decline of forested land and the increase in land devoted to crops and pasture. The factors giving rise to land use change are many and varied. But one of the most powerful is the comparative economic returns to 'converted' land relative to the economic returns to 'natural' land. In short, the issue is conservation versus conversion, and this is a conflict that is invariably resolved in the favour of conversion. This systematic erosion of the natural capital base is what worries environmentalists, a term I take to embrace anyone with the slightest modicum of concern about what humankind is doing to its own environment and its fellow species. Acting on that concern takes several forms, as everyone knows. Some want to lie down in front of the bulldozers, protest to their Members of Parliament, write to the newspapers, appeal to some moral principle or other. For the most part quietly, environmental economists have sought a different route. First, they observe that the bias towards conversion arises from all kinds of incentive systems, including, for example, subsidies to agriculture or monocultural forestry. Second, some of those incentive systems are far more subtle, and arise from the fact that many of the functions and services provided by natural systems have no market. At the end of the day, and like it or not, the financial balance sheet drives land conversion. It pays to convert land because the financial returns from conversion exceed those from conservation. The same bias works in reverse: existing land is not converted back to, say, woodland because some of the woodland benefits have no market.

But this is a result that derives from a perversion of economics – markets 'fail' to allocate resources properly because many of those resources have no price, even though they have potentially substantial economic value. Markets are the medium through which prices materialise. If there is no market in the carbon stored in forest

biomass, then markets will ignore the fact that the carbon has an economic value. In turn, that value derives from carbon dioxide being 'fixed' by growing biomass or from the fact that it is stored rather than released as carbon dioxide, the main greenhouse gas.

These observations define the first stage of the economic argument for correcting the economic system's biases. This stage consists of 'demonstrating' that economic value resides in natural systems and estimating how much it is. The second stage is partly addressed in this volume, but it involves the redesign of institutions so that the 'missing' economic value is captured and represented as a financial flow. There are many examples of such capture mechanisms – environmental taxes, tradable pollution and resource permits, payments for ecological services, and so on. If there is an encouraging trend in the environmental world it is that, gradually, these capture mechanisms are expanding. Sometimes aided by policy initiatives, and sometimes spontaneous, they help shift the bias of conversion back towards more conservation than would otherwise be the case. In terms of this volume, Ian Bateman and his colleagues look at how farm incomes would change if only the non-market value of land (e.g. stored carbon, recreation) was 'monetised' and added to some of the market values from changed land use (e.g. timber).

Determining economic values has become 'big business' for environmental economists, and few can match the authors of this volume for ingenuity and application of the various techniques that have evolved for finding these values. But 'valuation' is expensive, or, at least, that's how policy-makers like to see it. Millions may be spent on engineering design and legal fees in the context of policy or investment projects. A few tens of thousands of pounds on a valuation study often produces the cry that it is 'too expensive'. In the absence of a saner approach, environmental economists have to live with the very limited resources allocated to valuation. That means that short-cuts are unavoidable. Results from one study have to be 'borrowed' and applied to another study area. But a much understudied issue is the reliability of making these 'transfers'. Transferability requires that the conditions at the 'new' site should at least be similar to the conditions at the previously studied site. Often they are not. A few attempts have been made in the past to adapt transferred values to account for different site characteristics. With hindsight, it seems almost obvious that the logical way to handle variability in site characteristics is through geographical information systems (GIS). But it wasn't done, and the dominant attraction of this volume is that it shows how to do it in the context of a detailed case study. The final analysis is a mix of 'transfer' estimates, modulated by the GIS, and validation of those transfers against actual data for their geographical focus, Wales.

Ian Bateman and his colleagues have successfully pushed back the frontiers in several ways. First, they have 'married' economic valuation with GIS. Second,

they have taken a very broad area for their application – the whole of Wales. Third, they have hypothetically reconfigured land use in Wales under the assumption that currently non-market land services and changed market values are integrated into farm incomes. This amounts to a cost-benefit analysis because they compare the costs of this change with its benefits. They are far more modest than I would be about the power and importance of cost-benefit analysis. It is fashionable to criticise the economic approach for all kinds of supposed ethical aberrations, but it has an ethical force of its own. It is democratic in that it allows individuals' preferences to rule rather than those of unelected 'stakeholders' and experts. It reminds us all the time that all decisions involve costs as well as benefits. While these may seem small claims, the reality is that actual decision-making all too often reduces to choices by an elite with little reference to cost. It is worth remembering that cost always reduces to a taxpayer's burden: there is no such thing as 'government money'. Finally, cost-benefit analysis is itself changing. Recent work on valuing the long distant future and on allowing for irreversibility and uncertainty (effectively making rigorous sense of the otherwise ill-defined 'precautionary principle') means that it is time to rewrite the cost-benefit textbooks. In so doing, we would overcome many of the criticisms advanced against it.

So, I would make greater claims for the approach adopted in this book than the authors make for it themselves! But what cannot be disputed is that we have a fine example here of economic valuation being put to an imaginative and unique use by some of the most exciting practitioners of the art of economic valuation.

David W. Pearce

Preface

This book concerns the application of environmental economic analysis to real-world decision-making. In particular it seeks to demonstrate a number of ways in which geographical information systems (GIS) can be employed to enhance such analyses. We have written it because, in our opinion, GIS techniques can considerably improve the way in which the complexities of the real world can be brought into economic cost-benefit analyses (CBA)[1], so reducing the reliance upon simplifying assumptions for which economists are infamous.

As we are primarily interested in demonstrating the flexibility and applicability of GIS techniques to a diversity of situations, we assume no prior knowledge of such techniques and avoid unnecessary technicalities wherever possible by referring the interested reader to related academic papers throughout. In so doing it is our objective to appeal to students, researchers, academics and, in particular, decision-makers and analysts across a broad spectrum of disciplines including economics (especially environmental, agricultural and resource economics), geography, land use planning and management, environmental science and related policy studies.

The application of GIS to environmental economic analyses is introduced gradually through the use of a diverse land use change case study. This concerns the potential for converting surplus agricultural land to multipurpose woodland in Wales. However, neither the specifics of this case study nor its location need be of particular interest to the reader as the study is designed primarily to demonstrate the flexibility of the underlying approach. The book opens by reviewing some basic economic ideas concerning value and CBA (Chapter 1), focusing in particular upon methods for valuing individuals' preferences for non-market goods such as those provided by the environment (Chapter 2). Previous studies of the recreational value of open-access woodland are reviewed and some new applications presented (Chapter 3) through which we first introduce the use of GIS techniques as a means

[1] Or benefit-cost analysis, depending upon which side of the Atlantic/Pacific you reside.

of enhancing valuation methods. This approach is then extended to the estimation of the numbers of visitors arriving at existing or potential future woodland recreation sites (Chapter 4). We then turn to consider certain other forest benefits starting with the value of timber (Chapter 5). Again GIS techniques are used to bring together a host of diverse datasets to permit modelling of timber yield and its net value (Chapter 6). These techniques are then extended to conduct an analysis of the carbon sequestration value of woodland, combining models of carbon flux in live trees, timber products and forest soils (Chapter 7). The opportunity cost of converting agricultural land to woodland is then examined, with GIS providing the medium for undertaking assessments of the principal farming sectors in the case study area (Chapter 8). All of these sub-analyses are synthesised through our GIS to undertake a spatial CBA considering, for each location across our entire study area, what the consequences of land use change from agriculture to woodland would be (Chapter 9). Finally we summarise the strengths and weaknesses of our particular application and consider the wider conclusions to be drawn from the approach set out in this volume (Chapter 10).

We hope that readers will find this book interesting and enjoyable and that it might contribute to what we believe would be a timely infusion of realism into economic analyses.

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