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0521809568 - Applied Environmental Economics: A GIS Approach to Cost-Benefit Analysis

Ian J. Bateman, Andrew A. Lovett and Julii S. Brainard

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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

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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.

Contents

<i>List of plates</i>	<i>page</i> ix
<i>List of figures</i>	x
<i>List of tables</i>	xii
<i>Foreword by David W. Pearce</i>	xv
<i>Preface</i>	xix
<i>Acknowledgements</i>	xxi
1 Introduction	1
2 Recreation: valuation methods	15
3 Recreation: predicting values	43
4 Recreation: predicting visits	91
5 Timber valuation	111
6 Modelling and mapping timber yield and its value	158
7 Modelling and valuing carbon sequestration in trees, timber products and forest soils	184
8 Modelling opportunity cost: agricultural output values	219
9 Cost-benefit analysis using GIS	250
10 Conclusions and future directions	285
<i>References</i>	293
<i>Index</i>	332

Plates

between pages 266 and 267

- 1 Predicted timber yield class (YC): (a) Sitka spruce; (b) beech
- 2 (a) Predicted farm-gate income for sheep farms; (b) Predicted shadow value for sheep farms; (c) Predicted farm-gate income for milk farms; (d) Predicted shadow value for milk farms
- 3a The farm-gate net benefit of retaining sheep farming as opposed to conversion to conifer woodland (defined as timber plus grants only, i.e. present situation): 6% discount rate
- 3b The social net benefit of retaining sheep farming as opposed to conversion to conifer woodland (defined as timber, carbon storage and recreation, the latter measured using contingent valuation): 6% discount rate
- 3c The farm-gate net benefit of retaining milk farming as opposed to conversion to conifer woodland (defined as timber plus grants only, i.e. present situation): 6% discount rate
- 3d The social net benefit of retaining milk farming as opposed to conversion to conifer woodland (defined as timber, carbon storage and recreation, the latter measured using contingent valuation): 6% discount rate
- 3e The farm-gate net benefit value of retaining sheep farming as opposed to conversion to broadleaf woodland (defined as timber, carbon storage and recreation, the latter valued using the ITC measure): 6% discount rate
- 3f The social net benefit of retaining sheep farming as opposed to conversion to broadleaf woodland (defined as timber, carbon storage and recreation, the latter valued using the ITC measure): 6% discount rate
- 3g The farm-gate net benefit of retaining sheep farming as opposed to conversion to conifer woodland (defined as timber plus grants only, i.e. present situation): 3% discount rate

Figures

1.1	The total economic value of woodland	<i>page</i> 2
1.2	Representing real-world phenomena as raster or vector data layers	6
1.3	Costs and benefits of woodland	8
2.1	Methods for the monetary assessment of non-market and environmental goods	16
2.2	The value formation process	21
3.1	Graph of the ratio of stated to GIS-calculated distance against calculated distance	79
3.2	Comparison of 1 km grid reference with county centroid trip origins	86
4.1	Travel time zones for the Thetford Forest study	93
4.2	Digital road network for Wales and the English Midlands	98
4.3	Population density surface for Wales and the English Midlands	99
4.4	5 km grid points used to generate the predicted woodland visitors surface	101
4.5	Woodland recreation demand in Wales: predicted annual total party visits per site	103
4.6	Woodland recreation demand in north-western Wales: predicted annual total party visits per site	103
4.7	Predicted value of total annual woodland recreation demand per site using two valuation estimates: (a) lower-bound values based on cross-study analysis of CV values; (b) upper-bound values based on ITC study	104
5.1	Forestry Commission, private sector and total annual forestry planting, Great Britain 1946–2000	114
5.2	Price–size curve for conifers in England and Wales	131
5.3	Discount factor curves	133
5.4	Price–size curves for beech in Great Britain	135
5.5	Farmers’ private timber values for Sitka spruce (annualised equivalents of a perpetual series of optimal rotations: $r = 3\%$). Various yield classes and subsidy types	149
5.6	Farmers’ private timber values for beech (annualised equivalents of a perpetual series of optimal rotations: $r = 3\%$). Various yield classes and subsidy types	150

<i>List of figures</i>		xi
5.7	Social value for Sitka spruce (annualised equivalent of a perpetual series of optimal rotations). Various yield classes and discount rates	156
5.8	Social value for beech (annualised equivalent of a perpetual series of optimal rotations). Various yield classes and discount rates	156
6.1	Aspect effects for Sitka spruce and beech in differing locations	173
6.2	Predicted timber social NPV sums for perpetually replanted Sitka spruce: 3% discount rate	180
7.1	Total carbon storage curves for unthinned and thinned Sitka spruce: 5% discount rate	190
7.2	Longevity of Sitka spruce timber when put to different uses	192
7.3	Thinning factor for beech	205
7.4	Annual carbon liberation distributions for products and waste expressed as a proportion of total carbon sequestration in wood from one rotation of Sitka spruce	206
7.5	Annual carbon liberation distributions for products and waste expressed as a proportion of total carbon sequestration in wood from one rotation of beech	207
7.6	NPV of net carbon storage in live wood, products and waste from an optimal first rotation of Sitka spruce: 3% discount rate	213
7.7	NPV of net carbon storage in live wood, products and waste from an optimal first rotation of beech: 3% discount rate	214
7.8	NPV of net carbon flux (live wood, products, waste and soils), Sitka spruce: 3% discount rate	217
8.1	Model of a typical CAP price support system	221
8.2	Sheep stocking intensity in Wales, 1972 to 1997	227
9.1	Location of Forestry Commission sub-compartments of Sitka spruce in Wales (superimposed upon elevation)	283

Tables

1.1	Typical questions that a GIS can be used to answer	<i>page 6</i>
2.1	Welfare change measures obtained from expressed preference measures	18
2.2	WTP for preservation of the Norfolk Broads using various elicitation methods	27
2.3	Payment vehicle analysis results	28
2.4	ZTC/ITC consumer surplus estimates for six UK forests	32
3.1	Forest users' per person per visit recreation values from ZTC studies	45
3.2	Forest users' per person per visit recreation values from CV studies	46
3.3	Woodland recreation values from a cross-study analysis of CV estimates	51
3.4	Summary WTP responses for the Thetford 1 CV study	53
3.5	Thetford 1 TC study: consumer surplus estimates for three functional forms	56
3.6	Summary WTP results: per annum (WTPpa) and per visit (WTPfee) formats	58
3.7	Stepwise regression of lnWTPpa on significant predictors	60
3.8	Farm characteristics and farmers' willingness to accept compensation for transferring from present output to woodland	62
3.9	Mean WTP (tax) per annum and 95 per cent confidence intervals for each subsample (including payment principle refusals as zeros)	68
3.10	Mean WTP (fee) per visit and 95 per cent confidence intervals for each subsample (including payment principle refusals as zeros)	69
3.11	Average road speed estimates	77
3.12	Sensitivity analysis: ML models (best-fitting model shown in italics)	82
3.13	Sensitivity analysis: OLS models (best-fitting model shown in italics)	84
3.14	Sensitivity analysis: effects of varying outset origin on TC benefit estimates	87
3.15	Valuing recreational visits to woodland: a synthesis of studies	88
4.1	Observed and predicted visitor rates	94
4.2	Official recreational visit numbers, predictions of arrivals and consumer surplus estimates for twenty-seven English woodlands	106

	<i>List of tables</i>	xiii
5.1	Forestry Commission holdings: Great Britain 1978–2000 (’000 ha)	116
5.2	High forest by general species: Forestry Commission and private woodland in Great Britain 1947–2000 (’000 ha)	121
5.3	Woodland Grant Scheme payments (£/ha)	125
5.4	Woodland Management Grants	125
5.5	Payments under the Farm Woodland Premium Scheme (£/ha per annum)	127
5.6	Optimal felling age for various discount rates: Sitka spruce, YC6–24	134
5.7	Optimal felling age for various discount rates: beech, YC4–10	136
5.8	Agricultural nominal rate of return (RoR) on tenants’ capital: Wales 1987/88–1991/92	140
5.9	Farmers’ private timber values for high-output Sitka spruce and beech across various discount rates (annualised equivalents of a perpetual series of optimal rotations)	150
6.1	Variables obtained from the SCDB	164
6.2	Variables obtained from LandIS	166
6.3	Comparing actual with predicted YC for Sitka spruce (cell contents are counts)	171
6.4	Comparing actual with predicted YC for beech (cell contents are counts)	173
6.5	Predicted Sitka spruce YC under three scenarios	176
6.6	Predicted beech YC under two scenarios	177
6.7	NPV sums for perpetually replanted Sitka spruce timber across various discount rates	181
6.8	Annuity values for perpetually replanted Sitka spruce timber across various discount rates	182
6.9	NPV sums for perpetually replanted beech timber across various discount rates	182
6.10	Annuity values for perpetually replanted beech timber across various discount rates	183
7.1	The social costs of CO ₂ emissions (\$/tC): comparison across studies	188
7.2	Softwood and hardwood end uses for UK domestic production 1991/92	193
7.3	Post-afforestation changes in equilibrium soil carbon storage levels for various soils previously under grass (tC/ha): upland and lowland sites	196
7.4	Date of first thinning (TD1) for Sitka spruce yield models ($r = 0.05$ throughout)	201
7.5	Thinning factor for Sitka spruce ($TF_{SS,t}$): YC12	202
7.6	Date of first thinning (TD1) for beech yield models ($r = 0.05$ throughout)	204
7.7	NPV of net carbon flux (sequestration in live wood and liberation from products and waste) for an optimal rotation of Sitka spruce: various yield classes and discount rates (£, 1990)	210
7.8	NPV of net carbon flux (sequestration in live wood and liberation from products and waste) for an optimal rotation of beech: various yield classes and discount rates (£, 1990)	212

xiv	<i>List of tables</i>	
7.9	NPV of carbon in live wood, waste and products from an optimal rotation of Sitka spruce and beech: linear predictive equations with yield class as the single explanatory variable: various discount rates	212
7.10	NPV of Sitka spruce and beech carbon flux for live wood, waste and products: various discount rates (<i>r</i>)	215
7.11	NPV perpetuity sums for soil carbon flux: all tree species (£/ha)	216
7.12	Number of 1 km land cells at differing levels of NPV for net carbon flux (live wood, waste, products and soils): Sitka spruce, various discount rates (<i>r</i>)	216
8.1	Change in Welsh agriculture 1990 to 2000	226
8.2	FBSW annual farm account data: example of a typical farm record	232
8.3	Agroclimatic variables obtained from LandIS	234
8.4	Farm cluster characteristics: average income and mean percentage of total revenue from specified activities in each cluster of farms	236
8.5	Best-fitting stage 1 models of farm surplus/ha on sheep (cluster 1) and milk (cluster 2) farms	240
8.6	Best-fitting stage 2 models for sheep farms	242
8.7	Best-fitting stage 2 models for milk farms	244
8.8	Predicted farm surplus values for sheep and milk farms	247
8.9	Predicted farm-gate income and shadow values for sheep and milk farms	248
9.1	Distribution of the net benefits of retaining sheep farming in Wales as opposed to conversion to conifer (Sitka spruce) woodland: 6% discount rate	254
9.2	Distribution of the net benefits of retaining milk farming in Wales as opposed to conversion to conifer (Sitka spruce) woodland: 6% discount rate	260
9.3	Distribution of the net benefits of retaining sheep farming in Wales as opposed to conversion to broadleaf (beech) woodland: 6% discount rate	264
9.4	Distribution of the net benefits of retaining milk farming in Wales as opposed to conversion to broadleaf (beech) woodland: 6% discount rate	268
9.5	Distribution of the net benefits of retaining sheep farming in Wales as opposed to conversion to conifer (Sitka spruce) woodland: 3% discount rate	270
9.6	Distribution of the net benefits of retaining milk farming in Wales as opposed to conversion to conifer (Sitka spruce) woodland: 3% discount rate	274
9.7	Distribution of the net benefits of retaining sheep farming in Wales as opposed to conversion to broadleaf (beech) woodland: 3% discount rate	276
9.8	Distribution of the net benefits of retaining milk farming in Wales as opposed to conversion to broadleaf (beech) woodland: 3% discount rate	278

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

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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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