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Title	Cost-benefit analysis of Irish forest policy
Authors(s)	Clinch, J. Peter
Publication date	2006
Publication information	Clinch, J. Peter. "Cost-Benefit Analysis of Irish Forest Policy." Edward Elgar, 2006.
Publisher	Edward Elgar
Item record/more information	http://hdl.handle.net/10197/805

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2. Cost–benefit analysis of Irish forest policy¹

J. Peter Clinch

INTRODUCTION

The literature on the non-market costs and benefits of forestry varies in its quality. Pearce (1999) states that the results are a 'mixture of legitimate and illegitimate valuation procedures'. A large number of studies of the total economic value of forestry have been undertaken in developing countries. According to Pearce, most of these have been concerned with the destruction of indigenous forests and the associated loss of non-timber benefits rather than by any concern regarding the supply of timber. Thus, a large body of research has focused upon tropical forests and their provision of such external benefits as bush meat, firewood, nuts and berries, and medicinal plants. Despite much of the work on forestry valuation being concerned with tropical forests, there is an extensive literature focused on woodland in developed countries. Summaries of this research can be found in Wibe (1995) and Prins et al. (1990) and a collection of papers on the non-market benefits of forestry is contained in Roper and Park (1999). Most of the research has been carried out in North America although there is a considerable body of literature from the Nordic countries and the United Kingdom including, for the latter, the comprehensive study by Willis et al. (2003).

In general, while there is a substantial literature on the economic value of forestry, much of the research is related to deforestation and the associated loss of non-timber benefits. Temperate commercial afforestation brings with it quite different externalities and the consideration of external costs is most important. This chapter presents the results of an *ex ante* cost–benefit analysis of the Irish government's Forestry Plan. In doing so, a range of externalities is examined using, *inter alia*, contingent valuation and production function approaches. The study provides insights into the methodological difficulties and solutions for assessing the social efficiency of large-scale environmental projects.

IRISH FORESTRY AND FOREST POLICY

Forestry as a land use in Ireland involves a paradox: the rate of tree growth is among the fastest in Europe² and neighbouring Great Britain is a significant importer of wood, yet forests comprise less than 10 per cent of the state's land area, the lowest proportion in the European Union. The reasons for this are as follows: once the indigenous forests were cleared towards the end of the seventeenth century, those who controlled the cleared land rarely felt that the financial and other returns from tree planting justified the cost. Only for a relatively short time towards the end of the eighteenth century and the first half of the nineteenth century were the conditions met for making the long-term investments required to expand the forest estate, and then only on the part of a small number of landowners who developed some estate. However, most of these forest estates did not survive the transfer of the estates from landlord to tenant. Indeed, forestry was sometimes identified as an avocation of the 'landlord class', a group regarded by many as symbolic of a suppressive past rather than as models to be emulated!

In the twentieth century, the new Irish state took the lead in restoring forests as a land use. There was a steady increase in forest area, concentrated mainly on relatively high elevation and poor nutrient sites, which were not perceived as being of value for farming, with much of the expansion concentrated in the western counties. In the years immediately following membership of the European Community in 1973, the boom in farming resulted in an escalation in the real price of land, and forestry could not compete with highly-subsidized farming alternatives. However, the 1990s saw very striking changes in forestry in Ireland and they were driven by the country's membership of the EU. Reform of the Common Agricultural Policy made forestry an obvious target for structural fund support under two Forestry Operational Programmes. Generous planting grants, tax-free timber revenues and annual payments for farmers combined with growth rates of timber among the fastest in Europe to make investments in forestry seem most attractive. Today's grants are worth between €2000 and €5000 per hectare with a tax-free annual premium of between €200 and €500 per hectare for 15 to 20 years.

Current Irish Forest Policy at a macro level is set out in the Strategic Plan for the Development of the Forestry Sector in Ireland (Department of Agriculture, Food and Forestry, 1996). This envisages a doubling of the Irish forest estate by 2030 at a cost of over €3.9 billion. This involves increasing the forest area from 570 000 hectares (in 1996, the year of publication of the Strategic Plan) to 1.29 million hectares by 2030. The €3.9 billion would finance the grant and premium schemes necessary to encourage such a large increase in afforestation, 75 per cent of the funds

coming from the EU. It is clear that this plan would involve a major land-use change, which would have significant effects on the environment. It is generally thought that planting trees is good for the environment in that they provide recreational areas, sequester and store carbon, improve the landscape scenery and provide wildlife habitats. However, in Ireland, where planting consists of predominantly commercial forests, 80 per cent of which are non-indigenous conifers, there is considerable apprehension regarding the external costs of afforestation. Of particular concern are the potential negative effects of forestry on landscape, water and wildlife. The objective of the research presented here is to assess the social efficiency of the Strategic Plan for forestry.

METHODOLOGY

An *ex ante* assessment of the social efficiency of the Irish government's Forestry Plan was carried out using cost-benefit analysis (CBA). The Kaldor-Hicks (potential Pareto optimality) efficiency criterion was used. The total economic value of the plan was measured using both market and non-market valuation methods, the former involving shadow pricing where appropriate, and the latter comprising production function approaches and contingent valuation. The components of the economic value of the forestry plan and the method of valuation are presented in Table 2.1.

Table 2.1 *Components of the total economic value of the Forestry Plan and valuation method*

Function	Category	Valuation Method
Timber production	Benefit	Shadow pricing
Inputs (land, labour, capital)	Cost	Shadow pricing
Carbon sequestration	Benefit	Damage costs/ Opportunity cost
Water impacts	Cost	Replacement cost
Recreation	Benefit or cost	Contingent valuation
Habitat	Benefit or cost	Contingent valuation
Landscape impacts	Benefit or cost	Contingent valuation
Community stability	Benefit or cost	Not valued
Archaeological impact	Cost	Not valued

Discount rates were used to enable the comparison of costs and benefits that arise in different time periods. The choice of discount rate

is of particular importance in forestry as it is assumed that the land is reforested after felling and so the rotation is considered to be perpetual. There is a huge literature on discounting and space does not permit an in-depth discussion of appropriate measures. Suffice to say that there is no agreement on which particular number is appropriate. In practice, the discount rate used to evaluate public projects is chosen via the political system. The Irish government recommends a rate of 5 per cent be used to reflect the opportunity cost of capital (Department of Finance, 1994). For the purposes of this research, a range of discount rates varying between 0 per cent and 10 per cent were used with 5 per cent being considered the key rate for the purposes of drawing implications for government policy.

COMPONENTS OF THE TOTAL ECONOMIC VALUE OF THE FORESTRY PLAN

A brief outline of the procedure used for calculating each of the components of the economic value of the Forestry Plan and the results obtained are presented below. A comprehensive sensitivity analysis was carried out for each component but space does not permit a full outline of the analyses and results. The results are rounded to the nearest million euro (€).

Inputs

The inputs required for afforestation consist of land, labour and other inputs such as plants, fertilizer and pesticides, and materials for roads.

Land

Under the EU Common Agricultural Policy, farming in Ireland has been heavily subsidized. Similarly, afforestation has been in receipt of major subsidies under the EU Operational Programmes for forestry. Since land is in relatively fixed supply, this has resulted in the distortion of the price of land such that it no longer provides an adequate measure of the opportunity cost of its use in the absence of subsidies. The opportunity cost of using land for forestry can be measured by the agricultural output forgone valued at world prices. However, due to the existence of subsidies and trade restrictions, when calculating the value of the agricultural output lost, shadow pricing must be used.

Fitzgerald and Johnson (1996) estimate the social value of agricultural output on an average forestry site to be approximately €100 per hectare. This figure can then be capitalized at the test discount rates to give estimates of the opportunity cost of keeping land under forestry. At the 5 per cent

discount rate, the shadow price of land is €2007 per hectare and the cost of the land required for the targets of the Forestry Plan to be reached is calculated to be €701 million in present value terms.

Labour

If labour markets clear, the shadow price of labour will equal the market wage. Any increase in employment in one sector of the economy will merely reduce the availability of labour to another sector. However, in a country with a high unemployment rate, it could be argued that an increase in the demand for labour in one sector of the economy will not necessarily displace a job in another sector, that is, there may be employment additionality whereby if the new job is filled by a person who was previously unemployed, no cost in terms of output forgone is imposed upon society.³ In this case, the shadow price of labour would equal zero. It has been the practice of Irish government cost-benefit analyses to assume a shadow price of labour of zero. However, this is against the international practice of setting the shadow price of labour at most a fraction below the market wage. For example, in Canada the shadow wage is 95 per cent of the market wage and in the UK the shadow wage is set equal to the market wage (Honohan, 1998).

Honohan argues that it is hard to justify a shadow wage far below the going market wage in Ireland. He bases his conclusions on the recognition that migration responds so readily to job creation such that when the economy is in recession, there is net emigration as people travel abroad (mostly to the UK) in search of employment. The present boom in the economy has resulted in net immigration resulting in a rate of growth of the labour force much more rapid than the rate of decline of unemployment. At present it would seem that it is not justified to use a shadow wage of less than the market wage given that the economy is close to full employment and it is unlikely that the emergence of forests on the landscape will reduce the stock of long-term unemployed. Therefore, the shadow price of labour is considered to be equal to the market price of labour (net of taxes and social insurance). At a 5 per cent discount rate, the present value of the labour required under the Forestry Plan amounts to €173 million.

Other inputs

Input costs other than labour and land include costs associated with cultivation and drainage, plants and planting, fertilization and weeding, fencing, brashing, roads and roads repair, and marking and measuring. The total cost of these inputs amounts to €215 million at a 5 per cent discount rate. The total cost of inputs into the Forestry Plan therefore amounts to €1089 million – Table 2.2.

Table 2.2 *Cost of inputs into the Forestry Plan (€ million)*

Discount Rate (%)	Land	Labour	Other Inputs	Total
0	21 822	3 943	3 416	29 181
3	1 515	328	414	2 257
5	701	173	215	1 089
8	318	94	173	585
10	212	70	123	405

Timber

The principal marketed output of the Forestry Plan will be timber. The plan involves afforesting 725 000 hectares of trees. Prior to calculating the value of the timber, appropriate assumptions were made regarding timber prices based on a survey of timber markets and prices. The state forestry company, Coillte, produces 97 per cent of total roundwood in the state and 87 per cent of total production on the island of Ireland (Competition Authority, 1998). The importation of untreated timber is prohibited by law for pest control reasons and, unlike many state forestry companies, Coillte has a commercial brief. For these reasons, the potential exists for it to act as a monopoly supplier and thereby inflate prices. However, there is also market power on the demand-side, where ten wood processing firms consume approximately 80 per cent of the roundwood (Competition Authority, 1998). It is unclear at this point whether, and in what direction, prices are being distorted by this monopoly power in the wood market. However, given that price distortion may occur, Irish prices are an unreliable indicator of the social value of Irish timber. Border prices are normally considered to be the most appropriate (Pearce, 1998) but, because of the import restrictions, they are not suitable in this case. Therefore, British prices were used, as they provide a good indicator of the likely value of Irish timber in a competitive market due to Britain's reliance upon imports and the similarity of British and Irish wood.

A perpetual rotation was assumed when calculating the timber benefits of the Forestry Plan.⁴ The present value of timber output over one rotation at the five test discount rate was first calculated. A spreadsheet model was then created to simulate a perpetual rotation and to calculate its net present value. The timber value under varying price and discount rate assumptions is presented in Table 2.3.

If 5 per cent is taken to be the social rate of discount and average historical prices are expected to prevail, it is reasonable to conclude that the (discounted) timber value of the Forestry Plan is €1126 million. As expected, the rate of discount used has a major effect on the result due to

the bulk of the timber benefits arising at the end of the forest rotation. A 10 per cent rate gives a value of just €107 million compared with a value of over €3.8 billion at a 3 per cent discount rate. The expansion of the EU from 12 to 15 member states and the consequent shrinking of the timber deficit rendered the economic security value (the strategic value of growing timber in Ireland rather than importing it from abroad) close to zero.

Table 2.3 Timber value of the Forestry Plan under various price assumptions (€ million)

Discount Rate (%)	Low Prices	Average Prices	High Prices
0	102 686	114 096	125 505
3	3 504	3 893	4 282
5	1 013	1 126	1 240
8	234	259	284
10	97	107	117

Carbon Sequestration

Trees absorb (sequester) carbon dioxide (CO₂) and store it in the wood. The carbon is released when the wood, or the products that have been made from the wood, decay. In this way forests delay the release of CO₂ to the atmosphere. There are three approaches to placing a monetary value on this reduction in CO₂ emissions. The damage-avoided approach values a tonne of carbon sequestered by the cost of the damage that would have been done by global warming in the event that it had been emitted. The offset approach measures the value of not emitting a tonne of carbon using one method, by the next cheapest alternative method; the tonne of carbon sequestered is valued by the cost of substituting a non-carbon fuel for a fossil fuel at the margin. The avoided-cost-of-compliance approach measures the tonne of sequestered carbon by the avoided cost of compliance with a global or regional CO₂ emissions' reduction agreement (a form of 'offset').

There are three possible policy scenarios. Under the scenario of a fixed emissions quota, the measurement is, essentially, the same as the offset approach. Under the scenario of a carbon tax, the value of a tonne of carbon not emitted is measured by the tax that would have been paid had the carbon been emitted. With an emissions trading system, the value of not emitting carbon is equal to the cost of the permit(s) that would have been purchased if the carbon had been emitted, or, by the income received from the selling of those permits that are not required. This study uses the damage-avoided approach with a mid-range value for the marginal benefit of a tonne of carbon sequestered of €19 (from Fankhauser, 1995).

The simplest approach to converting a carbon price into a forest value is to approximate the cycle of carbon sequestration by a simple curve, rising asymptotically to a mean level of carbon fixed. However, this implies that the uptake rate is fastest at the beginning of the rotation. Price (1997) points out that, while this formulation gives a reasonable estimate of the carbon sequestered, on average, by a forest and its products, with discounting it is likely to be inaccurate, for example, using a 6 per cent discount rate, the overestimation of benefits at the beginning of the rotation leads to a three-fold overvaluation of discounted benefits. This study used the CARBMOD model developed by Colin Price and Rob Willis of the University of Wales at Bangor. This is a computer simulation that models the temporal sequestration of carbon for different yield classes of a range of species of tree based on Forestry Commission yield tables and carbon sequestration figures. For each species type, the model includes assumptions regarding the end uses of the timber to give a complete profile of the carbon dynamics of afforestation.

A further consideration is that peat soils emit methane and CO_2 when disturbed but the net sequestration effect of forests on peat soils in Ireland is still unclear.⁵ A conservative estimate of total sequestration benefits can be calculated by assuming peat oxidation rates are fast, such that there are no net sequestration benefits on peat soils. Results for a variety of discount rates, assumptions regarding the annual growth in the marginal benefit of sequestering carbon (ΔP) and the rate of oxidation of peat upon which forests are planted are provided in Table 2.4. Using a 5 per cent discount rate, a zero growth rate in the marginal benefit of sequestration, and fast peat oxidation gives a total value of carbon sequestration benefits of the Forestry Plan of €58 million.

Table 2.4 Carbon sequestration value of the Forestry Plan (€ million)

	Discount Rate (%)				
	0	3	5	8	10
ΔP (%)	Slow peat oxidation				
-3	145	46	23	10	6
0	375	145	66	23	13
3	-	375	220	66	32
ΔP (%)	Fast peat oxidation				
-3	128	41	20	9	6
0	331	128	58	20	11
3	-	331	193	58	28

Water

Plantation forestry can have a number of effects on the water supply. Acidification may occur in poorly buffered areas as a result of 'scavenging', whereby trees 'trap' pollutants and release them into the local water supply. In areas prone to acidification, this can increase the acid content of rivers and lakes, which may result in damage to fisheries. Pollution from fertilizers and/or pesticides can also have damaging effects on the water supply. Finally, forests tend to reduce stream flow.

The effects of forestry on water are some of the most difficult externalities to value as they tend to be very localized. There have been relatively few attempts to value the impact of forestry on water quality and quantity. Price (1997) quotes a study by Collet (1970), which established a technique for evaluating runoff loss and the effects of sedimentation on reservoir life in the UK based on the cost of replacement. It is thought that HM Treasury's (1972) study, which suggested a cost of £5 per acre afforested (1972 prices) in North Wales, was based upon Collet's method. Barrow et al. (1986) surmise from studies in Wales and Scotland that afforestation in upland sites is unlikely to be justifiable given the effect of water loss on hydroelectric power. Stretton (1984) suggested that cultivation of a 100-hectare plantation in South Wales imposed extra water treatment costs of £400 000 due to increased sediment while Milner and Varallo (1990) estimate that forestry-induced acidification of waters had a potential cost to Welsh Fisheries of £25 million (Price, 1997). Whiteman (1991) estimates the cost of replacement of the water restricted by forests in East England to be £0.5 million per year. In addition, he estimates the discounted cost of forgoing the use of fertilizers in afforestation to be between £50 and £80 per hectare. However, he suggests that the cost of environmental damage is much lower than the cost of abatement and suggests an average figure of £20 per hectare.

In terms of stream-flow reduction, in general, Ireland has a very generous supply of water as a result of a low population density and high rainfall levels. However, the lowest rainfall levels and the highest population levels occur on the east coast, specifically in the Greater Dublin Area. Thus, while increased afforestation in other parts of Ireland is unlikely to impose a significant cost in terms of reduced water supply, the Greater Dublin Area is an exception. Using Whiteman's (1991) method, it is possible to calculate the cost of reduced water supply from the existing forest estate. Most of the water supply comes from sources in Wicklow, Kildare and Dublin. These counties combined have an average forest cover of 8.33 per cent such that the non-afforested area is 91.67 per cent. Total water supply in the Greater Dublin Area is 442 mega litres per day. The actual water supply will equal

the potential supply in the non-afforested area plus the potential supply in forested area reduced by the percentage rate by which evapotranspiration is above normal.

Table 2.5 gives the potential water supply and the probable loss due to afforestation for five possible rates by which evapotranspiration is above normal. Taking a study on interception loss due to forestry by Johnson (1990), which suggests the loss is 28 per cent, this indicates that the probable loss in the Greater Dublin Area is approximately 11 mega litres per day. If we assume that the forest estate of the three counties from which water is supplied doubles in line with the Forestry Plan, this would suggest a further reduction in the water supply of 11 mega litres per day when the forest matures. The cheapest way of replacing this water would be to repair leaks at a cost of €7 million (M.C. O'Sullivan Ltd, 1996). At a 5 per cent discount rate, the cost amounts to approximately €3 million.

Table 2.5 Potential water supply in the Greater Dublin area and the probable loss due to the Forestry Plan

Evapotranspiration Above Normal (%)	Potential Water Supply (mega litres per day)	Probable Loss due to Afforestation (mega litres per day)
10	446	4
20	450	8
30	453	11
40	457	15
50	461	19

Due to the site-specific nature of the effects of forestry on water it is extremely difficult to predict the likely costs of future afforestation. This is particularly the case in relation to water quality. The magnitude of the cost will depend in a large part on the effectiveness of the Irish Forest Service guidelines with regard to fisheries. In relation to acidification, Allott and Brennan (1993) suggest that the guidelines will be unable to prevent acidification in poorly buffered catchments exposed to an atmosphere charged with acidifying acids (pollutant or otherwise) nor will they protect the soil from organic acids resulting from the drainage and afforestation of peats. However, the Forestry Plan restricts grant aid to areas of yield class 14 and above. In addition, it is expected that conventional afforestation will not be permitted in EU-designated Natural Heritage Areas (NHAs). There is a high correlation between areas designated by the Environmental Protection Agency as sensitive to acidification, areas of below yield class 14 and the

NHAs. It seems reasonable to assume, therefore, that the cost imposed by acidification from forests planted under the Forestry Plan will be minimal. The extent of eutrophication from fertilizers and pollution from biocides will depend upon the extent to which forestry contractors comply with the guidelines and the extent of consultation with the fisheries boards.

It is most difficult to value the likely cost of pollution from an increase in the forest estate. The actual cost can depend very much on particular events, for example, there may be only one or two pollution incidents in a year involving forestry but the costs would be very high if they happened to occur, for example, in areas of great value to angling. The magnitude of the cost will also depend upon the former land use. Given that most of the land that is likely to be planted is currently being used for grazing, it is predicted that there will be a net increase in the use of fertilizers, particularly at establishment phase. While it is not possible to predict the cost of pollution very accurately, Whiteman's (1991) figure of an average net (of the cost imposed by the former land use) discounted cost of £20 per hectare gives an indication of the likely order of magnitude of this cost. At a 5 per cent discount rate, total water pollution costs (assuming an acidification cost of zero) amount to €10 million. The total costs imposed by the effect of the Forestry Plan on the water supply at the five test discount rates are given in Table 2.6. At a 5 per cent discount rate, the total cost amounts to €13 million.

Table 2.6 Cost of water supply effects of the Forestry Plan

Discount Rate (%)	Present Value (€ million)
0	121
3	19
5	13
8	8
10	6

Recreation, Biodiversity and Landscape

Forests often are of value for recreation even if they are not specifically designed for such a purpose. In addition, afforestation alters the character of the landscape and has implications for biodiversity. The visual impact of afforestation is probably the most controversial external effect of afforestation in Ireland. This is primarily the result of the predominance of coniferous forestry and the non-native Sitka spruce species in particular (this species is favoured because of its rapid growth in Irish damp weather conditions).

In addition, afforestation has the potential to destroy valuable habitats if planting takes place in 'sensitive' areas. However, if planting is kept out of NHAs and sensitive areas as designated by local authorities, the threat to biodiversity is low, such that one rather limited diversity will be replaced by another limited diversity. The valuation of biodiversity is extremely difficult when existence values are thought to be significant. This is because there is often a lack of knowledge of the precise effects a proposed development will have on an ecosystem and there is also the difficulty of describing these effects in a contingent valuation questionnaire. Nevertheless, contingent valuation was considered to be the only appropriate way to calculate the landscape, wildlife and recreational benefits of the trees to be planted under the Forestry Plan.

A feature of many private goods is that only a subset of all consumers buy them even at a zero price and there is no reason why this should not also be the case for public goods (Kriström, 1997). If one is indifferent about consuming a good and not consuming it, whether it is marketed or otherwise, one's willingness to pay for the good will be zero. Moreover, depending on one's tastes etc, the consumption of a good may increase or decrease one's utility, for example, some individuals enjoy a trip on a rollercoaster while others would find such a trip thoroughly unpleasant. The same can be said for public goods, for example, the reintroduction of wolves in an area would increase the utility of those who like wolves but decrease the utility of farmers whose sheep fall prey to the wolves (all else being equal). However, while an individual can choose not to consume a private good they cannot choose to avoid consuming a public bad.

It had been ascertained in a survey of public attitudes to afforestation that the views of the Irish public differ regarding the environmental impact of forestry in Ireland. When valuing an increase in the quality of a public good, the appropriate measure is Hicksian compensating variation, that is, the respondent's willingness to pay (WTP) for the improvement is elicited. However, if the public good also exhibits features of a public bad, an appropriate consumer's surplus measure must be chosen that can measure the loss of welfare as a result of an increase in its provision. The most appropriate measure would be willingness to accept compensation (WTA). However, since the study of Hammack and Brown (1974), which showed that WTA amounts were over four times greater than WTP amounts for the same amenity, there has been some concern about the practical difficulties of eliciting willingness to accept in contingent valuation surveys. Given these difficulties, the question arises as to whether WTP to avoid a public bad is an appropriate proxy for WTA.

From the work of Hanemann (1991), we can say that WTP will be a valid proxy for WTA when the public good/bad is not unique and irreplaceable

and when WTP is unlikely to be a large proportion of income. This is likely the case in relation to the Forestry Plan. The agricultural land that would be replaced is not unique and the damage is not irreversible such that the elasticity of substitution is unlikely to be very low. WTP is not likely to be a large proportion of income. Therefore, a questionnaire was designed that 'filtered' respondents into two separate contingent markets based on their responses to questions regarding their preferences for forestry. Those who 'liked' afforestation were asked to 'bid' for a specific increase in the forest estate (the Forestry Plan) while those who 'disliked' forestry were asked to 'bid' to preserve the present land use and thereby avoid forestry (an environmental protection scheme).

A dichotomous choice elicitation format was used and the questionnaire had the usual checks as recommended by the best practice guidelines of Arrow et al. (1993) and others. The survey was mixed mode (personal interview and telephone) and was carried out in two parts to allow for consistency checks. A 78 per cent response rate was achieved resulting in a total effective sample of 2895 households. The results show that mean willingness to pay to avoid forests is significantly higher than mean willingness to pay for forests, suggesting that, as a result of an expansion in the forest estate, those who dislike forestry will, on average, endure a greater welfare loss than the average increase in welfare experienced by those who like forestry. Nevertheless, a majority were willing to pay for more forestry. At a 5 per cent discount rate, the net present value to the Irish population of the landscape, wildlife and recreational benefits of the Forestry Plan amounts to €164 million.

Other Considerations

Community stability

A potential benefit of an expansion in forestry is what is known as 'community stability' or 'community integrity'. Community stability relates to the value that society puts on the conservation of rural communities (Pearce, 1998).⁶ The contribution of forestry to community stability is measured by the increase in the welfare of society that results from the conservation of rural communities as a direct consequence of an expansion in the forest estate. One aspect of community stability is captured by the willingness to pay on the part of individuals, in terms of reduced salaries, to return from a job in a foreign location to their home town. Theoretically, this could be measured using contingent valuation by eliciting the maximum salary reduction that individuals would be willing to accept in order to take a forestry job in their home town. Those who, it is adjudged, would be forced to migrate in the absence of employment created by forestry could be asked

for the minimum salary increase they would be willing to accept in order to move away from their home town. However, it would also be necessary to measure the extra utility that relatives and friends gain by the presence of these individuals in their hometown. It is likely that the assessment of these values using contingent valuation would prove rather difficult. To complete the valuation of community stability it would be necessary to measure the increase in the welfare of the rest of society from the contribution that forestry makes to conserving rural communities. This would also prove to be difficult in practice.

If the Forestry Plan does not create more rural jobs than it displaces, the community stability value will be zero. If it displaces more than it creates it will have a negative effect. While there have been studies on the contribution of the US Forest Service to the stability of rural communities (Boyd and Hyde, 1989), there have been no such studies in Ireland and, therefore, the community stability value of the Forestry Plan has not been included in this CBA.

Archaeology

Ireland is fortunate to be endowed with a rich archaeological resource that is of value in terms of its direct use for tourism, both domestic and overseas, and for education and research. In addition it is likely to have both option and existence value. However, none of these values has been assessed to date. The difficulty with most archaeological sites is that their recognition requires specialized archaeological techniques and skills. Thus, two potential problems arise. First, an individual may recognize a feature on their land to be of archaeological importance but may destroy it to avoid interference with his or her desired activity (an individual is not compensated for the external benefit of preservation) and second, the individual may not recognize it as of archaeological value and destroy it by accident. Therefore, a change in land use as a result of increased afforestation might result in damage to the archaeological heritage. However, given the gaps in knowledge regarding the location of archaeological artefacts and the absence of any valuation of such artefacts, it is not possible to estimate the likely cost of increased afforestation in Ireland in terms of its impact on archaeology.

Cost of public funds

Due recognition must be made of the fact that the provision of subsidies to forestry will create distortions in the economy. These funds have to be raised through taxation or, if money is allocated to this project, there is an opportunity cost since funds for other projects must be paid from taxation. When distortions are created through revenue raising, the cost of raising such funds will be higher than the size of the funds raised. In 1997 the

marginal cost of public funds was estimated to be 1.5 (Honohan, 1996) such that the marginal excess burden equals 0.5, that is, the total cost of raising €1 via the tax system equals €1.50. Multiplying the subsidy by the marginal excess burden gives the excess burden of the forestry subsidies. This equals €808 million at a 5 per cent discount rate. However, this assumes that, were the 75 per cent funding from the EU not to go to forestry, the funds would be available for an alternative use in Ireland.

OVERALL RESULTS

Bringing together the various components of the total economic value of the Irish government's Forestry Plan shows that it passes a cost-benefit test if the discount rate is 4 per cent or below. At rates of 5 per cent and above, net social benefit is negative (Table 2.7). If the government's test rate of 5 per cent is considered appropriate, the results would suggest that the Forestry Plan should not proceed as it is not socially efficient. Timber is the dominant benefit at €1,126 million with net external benefits (amounting to €209 million) being equivalent to just 19 per cent of the timber value.

Table 2.7 Costs and benefits of the Forestry Plan (€ million)

	Discount Rate (%)				
	0	3	5	8	10
Timber	114096	3893	1126	259	107
Land	-21822	-1515	-701	-318	-212
Labour	-3943	-328	-173	-94	-70
Other inputs	-3416	-414	-215	-173	-123
Carbon	331	128	58	20	11
Water	-121	-19	-13	-8	-6
Landscape, wildlife, recreation	213	182	164	142	131
Excess burden	-1979	-1119	-808	-532	-420
Net social benefit	83359	808	-560	-702	-583

AGGREGATION ISSUES

Randall (1991) has pointed out the risks in independent valuation summation (IVS) particularly when using different valuation methods. However, it is important to use the most appropriate valuation method. Therefore, there is a trade-off between the possibility of inaccuracy from double counting

and the possibility of inaccuracy from using an inappropriate valuation method. Bergland (1998) recommends that simpler methods be used where possible and that revealed preference methods are widely accepted valuation methods, which provide valid, and often reliable, estimates of use values. However, in this study, it was necessary to use a stated preference method in order to assess the value of future planting in relation to, for example, landscape impacts. Therefore, if just one valuation method were to be used, it would have to be a stated preference method. Describing all the possible costs and benefits of the Forestry Plan in a contingent valuation questionnaire would be hard enough but, even if this could be achieved, it seems unreasonable to expect a respondent to place a value on, for example, the reduction in streamflow that would result in the Greater Dublin area.

In this study, it was considered that the implications of double counting were likely to be less of a concern than the inaccuracies that would result from using inappropriate valuation methods. Survey research into the preferences of the Irish public regarding forestry has shown that there is little awareness of the benefits of forestry in terms of carbon sequestration and virtually no awareness of the impact of forestry on water amongst the general public (Clinch et al., 2000). There was no mention of these impacts in the contingent valuation questionnaire and the preference surveys suggest that the public was unlikely to have these impacts in mind when answering. Therefore, it is hoped that double counting has been minimized. In any case, if double counting has occurred, it, most likely, has resulted in an overestimation of the benefits of the Forestry Plan. Therefore, the overall result of the CBA should be adjusted down and it would still return a negative net social benefit so the policy implications remain the same.

GOVERNMENT SUBSIDIES

If the Forestry Plan is implemented, there will be a massive transfer of public funds to afforestation in order to fund the forest subsidy schemes, namely €3.9 billion over 35 years. The CBA suggests that, even before subsidies are considered, the Strategic Plan for the Forestry Sector in Ireland should not be implemented as it will not improve the welfare of society as it returns a negative net social benefit. However, if, for illustrative purposes, a rate of return of 4 per cent is considered to be acceptable, then the Forestry Plan would be socially efficient and consideration would have to be given to whether and to what extent the plan should be subsidized from public funds. Conventionally, since transfers are omitted from cost-benefit analyses, the results of such studies do not give any indication of

the appropriate size of the subsidy. Further discussion of this topic can be found in Clinch (2002).

ASSESSING THE ECONOMIC VALUE OF MARGINAL CHANGES IN THE STRATEGIC PLAN

Environmental valuation, in many cases, is limited to providing point estimates of the value of externalities of a project or policy. It is often difficult to assess the overall impact on net present value of a change in project or policy specification. For example, the study presented above merely tells us whether the Irish government's Strategic Plan for forestry passes a cost-benefit test; it does not tell us the consequences of modifying the plan itself. As discussed previously, one of the most controversial aspects of Irish forest policy is the planting of non-native coniferous trees. Using a contingent valuation methodology as part of a face-to-face survey of 1202 Irish adults, Clinch et al. (2000) examine the environmental value of increasing the percentage of broadleaf planting from 20 per cent to 50 per cent of the total in the Strategic Plan. The results suggest that the environmental value of the plan would increase by €65 million. However, one should not infer that this change in species mix would necessarily increase the NSB of the plan. Given the dominance of the 'market values' of commercial afforestation shown above, reducing the percentage of fast-growing coniferous trees would likely reduce the NSB of the plan under all but the lowest discount rates.

DISCUSSION

The research summarized in this chapter has endeavoured to build on existing research on forest valuation by providing a template for undertaking comprehensive cost-benefit analyses of large-scale temperate plantation forestry programmes. Given the comprehensive range of externalities evaluated, this study provides some insights into the nature of the economic value of temperate plantation forestry and its assessment. The results of the study show that the private benefits of commercial forests dominate. Net external benefits, while significant, are only equivalent to 19 per cent of the timber value. This can be explained by the type of forestry under consideration. The primary purpose of plantation forestry is timber production. Therefore, the external benefits are likely to be lower than estimates from old forests that are likely to have greater landscape and

amenity value. This study devoted considerable effort to considering external costs as well as benefits. Temperate plantation forestry can produce negative externalities such as water restriction and negative landscape impacts. These reduce the overall net external benefit figure to below what might be expected given the figures from studies of non-commercial or old forests. This highlights the fact that figures from valuation studies of such forests may not be applicable to plantation forestry and this should be taken into account when using benefits transfer. It is also interesting to note that this study suggests that EU subvention of afforestation in Ireland constitutes an intervention failure.

The limitations of the study are typical of CBAs of large-scale projects. Ideally, a number of projects would have been evaluated to see which project would give the greatest return, whereas the results of this CBA merely answer a binary question, that is, whether or not the project provides a net benefit to society. Therefore, it does not tell us whether the money would be better spent elsewhere and so, in practice, one often relies on government test discount rates. In addition, despite a large range of externalities being evaluated, a number of impacts remain unvalued. The physical impact of plantation forestry on community stability is difficult to assess; it is even harder to value. An interesting area for research is the assessment of the willingness to pay of individuals to avoid emigrating from their home town. However, to capture the full value of community stability it is necessary to find ways of evaluating the benefits to others from that individual staying at home. This will prove more difficult. The inability of this study to value the impact of increased afforestation on the archaeological heritage points to the problem of information gaps and uncertainty. Many environmental impacts that we value now were ignored in the past because of lack of knowledge. There are likely to be benefits and costs of which we are, as yet, unaware.

Ex ante assessments make it necessary to use techniques such as contingent valuation in order to ask people what benefit they think a proposed project will bring. However, the respondents must work with what limited information can be provided to them in a questionnaire and there may be considerable uncertainty about the actual impact a project will have. In addition, if respondents do not have much experience of the good in question (in this case, Ireland is the least forested country in the EU), their ex post valuation of that good may be quite different from their ex ante bid. Some Irish foresters suggest that people will grow to like plantation forests, that is, they merely need to experience them. A related and equally important issue is that preferences may change with time. This contingent valuation study showed that older people were less favourably disposed to forestry, which could mean either that, by the time the forests develop, more

of the population will be favourably disposed to forestry, or, by that time, the formerly young people, having aged, will have changed their minds!

A further difficulty in trying to assess the total economic value of a project that has multiple inputs and outputs is that it usually requires a number of valuation methods. Thus, it is necessary to engage in independent valuation summation (IVS). As pointed out earlier, there is a trade-off between the risk of double counting from IVS and the risk of inaccurate results from using inappropriate valuation techniques.

CONCLUSION

In conclusion, this chapter has presented techniques for valuing a range of externalities, both positive and negative, from plantation forestry programmes. However, the study shows that problems still remain in assessing some costs and benefits and there is considerable uncertainty regarding how costs and benefits change over time. Large-scale environmental projects that necessitate a range of externalities to be valued will generally require more than one valuation technique and therefore run the risk of double counting. CBAs such as this merely say whether or not the project being considered is socially beneficial, that is, it is a binary choice and the difficulty of calculating the marginal benefits and costs of projects makes calculation of the optimal subsidy difficult. This highlights the need for more research on the use of environmental valuation in setting targets for environmental policy.

NOTES

1. This chapter is a modified and extended version of a paper that first appeared in *Forest Policy and Economics*, 1 (3-4), 2000.
2. Average growth rates for Sitka spruce (*Picea sitchensis*) are nearly four times the European average.
3. For this to be the case, involuntary leisure time must have no value.
4. In practice, any benefits accruing after 300 years can be ignored. In the case of a zero discount rate, timber values would be infinite so a 300-year life is also assumed for illustrative purposes.
5. See Byrne (1999) for the most comprehensive work.
6. Pearce (1998) also notes that this should not be confused with the benefits of creating rural employment, which, if they are adjudged to exist, are adjusted for using a shadow price.

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