Current debates on the cost-benefit analysis of transport projects in Great Britain*

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Abstract

Britain was one of the first countries to adopt cost-benefit analysis for use in transport projects, and now has a state of the art approach, which nests the cost-benefit analysis in a multi-criterion framework linked to the objectives of transport policy. But despite this a number of heated debates about the approach used continue. This paper outlines the current approach used and the debates going on.

Regarding valuation of benefits, despite decades of relevant research, the value of time savings remains controversial, particularly in the context of small time savings and of savings in working time, where the current approach is based on theoretical considerations rather than empirical evidence on willingness to pay. The other big uncertainty in measuring benefits is in relation to wider economic benefits. For many years the official position on these was that they were unlikely to be significant, but recent research has led to proposals to incorporate them into the standard analysis.

The current British approach to decision criteria relies on the calculation of benefit cost ratios, in which the benefits are the net impact on all other than the government budget and the costs are the cost to the public budget. However, there is a strong case for introducing an explicit shadow price of public funds into the appraisal. A further weakness in current British transport project appraisal is the lack of detailed attention to the distribution of costs and benefits. Overall, appraisal is seen too much as a purely technical analysis to obtain a single indicator of value for money rather than a consideration of the robustness of the project to alternative future scenarios.

JEL Classification**:** *G31, H40, H54.*

Keywords: *cost-benefit analysis, transport, Great Britain.*

Resumen

Gran Bretaña fue uno de los primeros países en adoptar el análisis coste-beneficio (ACB) para su uso en proyectos de transporte, y actualmente utiliza un enfoque que incorpora el ACB en un marco de decisión multi-criterio que está vinculado a los objetivos de la política de transportes. A pesar de la larga tradición del ACB, aún se mantienen abiertos varios intensos debates sobre la metodología utilizada. En este trabajo se describe este nuevo enfoque británico para aplicar el ACB y los debates en curso.

En cuanto a la valoración de los beneficios, a pesar de décadas de investigación, el valor de los ahorros de tiempo sigue siendo controvertido, particularmente en el contexto de pequeños ahorros de tiempo y de ahorros obtenidos en viajes por motivo de trabajo, ámbitos en los cuales el enfoque actual se apoya en desarrollos teóricos en lugar de sobre la evidencia empírica acerca de la disponibilidad a pagar. La otra gran incertidumbre en la medición de los impactos positivos de un proyecto está en los beneficios económicos generales que puedan atribuirse a su puesta en marcha. Durante muchos años, la posición oficial sobre estos beneficios fue que era poco probable que fueran significativos, pero la investigación reciente ha dado lugar a propuestas para incorporarlos en el análisis estándar.

El enfoque británico actual para los criterios de decisión se basa en el cálculo de ratios beneficio-coste, en los cuales los beneficios son todos aquellos efectos netos que se generan exceptuando los

* I am grateful to Gines de Rus and Peter Mackie for comments on an earlier draft of this paper, but responsibility for the views expressed is solely my own.

impactos sobre el presupuesto público, y los costes son todos aquellos impactos sobre el lado del gasto del presupuesto público. Sin embargo, hay razones importantes para la introducción de un precio-sombra explícito de los fondos públicos en la evaluación. Otro punto débil en el sistema británico actual de evaluación de proyectos de transporte es la escasa atención que se presta a la distribución de costes y beneficios. En general, la evaluación se considera como un análisis puramente técnico orientado a conseguir un indicador único del valor económico generado con los recursos públicos, más que a valorar la robustez de un proyecto frente a posibles escenarios futuros.

Palabras clave: *análisis coste-beneficio, transporte, Gran Bretaña.*

Clasificación JEL: *G31, H40, H54.*

1. Introducción

Cost-benefit analysis (CBA) is a way of providing evidence on the impacts of policies or projects which examines all the costs and benefits they give rise to and seeks to value them at what those impacted would be willing to pay for the benefits and what compensation they would require willingly to bear the costs. Britain was one of the first countries systematically to apply cost-benefit analysis to projects in the transport sector. As long ago as the 1960s, cost-benefit analysis was required of all road schemes funded by central government, and it also came to be applied to proposals to close rail services, and rail and other projects requiring central government grants. It had also been applied to major planning decisions such as where to build a third London airport.

In the revisions to the approach to CBA following the election of a new government in 1997, the government declared its intention to apply a consistent approach to cost-benefit analysis to all proposals requiring government spending, whether for investment or subsidies. Thus in addition to road and rail projects, cost-benefit analysis is routinely applied in other areas such as decisions about the level of service to specify in rail passenger franchising (albeit subject to the constraint that the government did not wish to see rail services completely close) and rail fares regulation. Since local authorities in Britain obtain much of their funding from central government, the use of CBA extended to all major projects proposed by local authorities as well. The new approach to appraisal (NATA for short) can be accessed via the WEBTAG website at *www.webtag.org.uk*. Because of devolution of responsability for some transport decisions, what follows strictly only applies to England or for decisions taken at the British government level, although broadly similar approaches are used in Scotland and Wales.

However, criticisms of this approach to appraisal have been widespread, and even before the change of government in May 2010, an update exercise known as 'NATA refresh' was underway. The new government has stressed its dissatisfaction with a number of aspects of the appraisal process, including the treatment of small time savings, taxation and greenhouse gases, so further revisions are anticipated.

In the next section, we give a broad overview of the current British approach to transport appraisal. We then outline the arguments currently taking place over the appraisal process. We first consider issues of valuation of costs and benefits (value

of time savings, accidents, treatment of taxation, the environment, option values and wider economic impacts), then aspects of the decision criteria (choice of discount rate, project life and uncertainty) and the treatment of the distribution of costs and benefits before reaching our conclusions.

2. The current British approach to appraisal.

The current approach to appraisal in Britain groups costs and benefits according to the five declared objectives of transport policy, namely:

- Environment
- Economy
- Safety
- Accessibility
- Integration

(note that these objectives have now been somewhat modified, and the appraisal process is in the course of revision to be compatible with the new objectives).

Standard tables of information relevant to teach of these objectives are produced, and the key results brought together in an appraisal summary table (Table 1).

TABLE 1

APPRAISAL SUMMARY TABLE

Environment	Noise
	Local Air Quality
	Greenhouse Gases
	Landscape
	Townscape
	Heritage of Historic Resources
	Biodiversity
	Water Environment
	Physical Fitness
Safety	Accidents
	Security
Economy	Public Accounts
	Transport Economic Efficiency
	Reliability
	Wider Economic Impacts
Accessibility	Option values
	Severance
	Access to the Transport System
Integration	Transport Interchange
	Land-Use Policy
	Other Government Policies

SOURCE: WEBTAG (2004): Unit 2.5: The Appraisal Process (*www.webtag.org.uk*).

The information is grouped according to the stakeholder group on whom the cost or benefit impacts (transport users, government, private sector, residents and other concerned individuals). Impacts valued in money terms are construction, maintenance and operating costs, travel time and accidents (which together form the 'transport economic efficiency' table), noise and greenhouse gas emissions. The public accounts table shows the net impact on public spending after allowing for changes in taxes as well as explicit expenditure items. There is also evidence on the value of quality of rolling stock, reliability, the requirement to change trains and crowding for rail services, which is allowed as supplementary evidence. However, a great deal of other information relevant to the goals of transport policy is presented in other tables in physical units or qualitative description. Thus NATA may really be regarded as a multi-criterion appraisal process rather than a pure cost-benefit analysis. Although non monetary impacts are rated on a seven point scale from highly beneficiary to highly detrimental, there is no formal process of weighting these and adding them together with the information in monetary values, so the ultimate decision is based on the decision maker's judgement.

3. Valuation of costs and benefits

In the early days of cost benefit analysis in Britain, the only costs and benefits included were the capital costs and operating costs of the project, time savings and the costs of death or injury in accidents. Provided that the economy is reasonably competitive, capital and operating costs will represent an estimate of the goods given up elsewhere in the economy through undertaking the project in question. There is however currently debate in Britain about the treatment of taxation. When traffic is diverted from the private car to public transport, part of the saving in cost is the tax that would have been paid on motoring. Whilst there is a cost saving to the user, to the extent that this is a saving in tax paid, there is an offsetting loss to the government, and ultimately to the beneficiaries from the spending it would have financed or the taxpayers who have to make it up in other taxes. Because the British approach identifies costs and benefits to different stakeholder groups separately, the benefit to the users appears gross of the tax, and separately the loss of the tax as a cost to government. This is consistent with one of the fundamental principles of cost benefit analysis, that transfers must either be excluded, or included both as a benefit to one group and a cost to another. However, to many non economists seeing the failure to pay a tax as a cost is incomprehensible, and the current government has said it will review this treatment of taxation.

Time savings tend to dominate transport appraisals, and have long been the source of much debate. Leisure time savings are valued according to the willingness to pay for them of recipients, valuations being derived from studies of choices between slower cheaper ways of travelling (routes or modes) and faster more expensive ones. In the early days of appraisal these values were based on observed behav-

iour, but now valuation is usually based on surveys in which respondents are given hypothetical choices, itself a cause of distrust, although there is a reasonable amount of evidence that well designed questionnaires can recover the same values as revealed by actual choices but much more economically in terms of sample size. (Hensher, 2001). The values currently used in Britain are shown in Table 2. Of more concern is the fact that these same valuations are applied to very small time savings (small road projects often yield benefits of less than a minute) even though there is evidence that such small time savings are valued at a lower rate per minute than larger savings, if indeed they are perceived at all. There are two counter arguments. Firstly, that where people or firms are subject to constraints such that, for example, only a ten minute time saving can be usefully employed, then some people will already have idle time. If this is evenly distributed between zero and ten minutes, then whilst nine people will be unable to use a one minute saving for the tenth ir will be worth ten minutes, so for the population as a whole the valuation will be correct. Secondly, even where there is no such constraint, in the long run such time savings may be aggregated with other time savings and losses from a wide variety of causes, transport and non transport, and thus the magnitude of the ultimate effect may be greater than the initial impact. Nevertheless, these arguments do not seem persuasive politically, and it must be accepted that in the short run such small time savings may not even be perceived let alone usefully employed.

A second argument is that there is evidence that a considerable proportion of time savings are in fact devoted to more travel, so that the result is not more time to devote to other activities, but rather a different set of locations of activities (home, work, leisure). The standard response is that if users choose to devote time savings to more travel, they must get benefits at least as great as if they had devoted the time savings to other activities, so the existing valuation method remains appropriate. Additional trips are valued at half the time and cost savings for existing trips, on the basis that they must be valued at something between the original and the new cost, and in the absence of more precise knowledge the valuation is taken to be halfway between the two (where a forecasting model is used which provides measures of consumer surplus a more precise valuation may be possible, and indeed it is needed if the changes in times and costs are large). However, to the extent that such changes in amounts of travel and location of activities have impacts on other members of society, for instance in terms of congestion and environmental costs, they must of course be forecasted and all the costs and benefits of them included in the appraisal,. An attempt to do this by allowing the trip matrix to vary in response to travel time and cost is a standard part of British appraisal processes, but explicit forecasting of land use changes and of any costs and benefits associated with these is difficult and rarely done.

In Britain, travel in working time is valued at the wage rate plus an allowance for the overhead costs of employing labour, on the basis that this represents the savings to the employer if travel time in working hours is saved. Again there are questions about whether very small time savings really do save the employer costs, especial-

ly in the short run. Moreover, in the case of 'briefcase' travel, such a simple approach was questioned many decades ago and an alternative provided (Hensher, 1977). Hensher's approach allows for the fact that business travellers often start and finish journeys in their own time, so that some of the time saved is actually leisure and not work, and that they are able to do some work whilst travelling by rail or air. On the other hand, time savings may have a more than proportionate value if they permit more meetings to be held in a day, and thus save the cost of overnight stays or of travelling again another day. Also, employers may be willing to pay something to avoid a very early start from home, on the basis that this will raise their productivity later in the day. It appear that the only way of resolving this debate is through empirical studies of what employers are willing to pay to save their employees' time, but whilst there are numerous studies of the value of leisure time, empirical studies of the value of business time are scarce and, to the extent that time savings may benefit both employer and employee, requires the results of studies of both values to be combined in a consistent manner. Such empirical evidence as exists does suggest values approaching or even exceeding the values currently in use (Wardman, 2001; Marks, Fowkes and Nash, 1986).

The values of time currently used in Britain are to be found in Table 2. Note the strong differences in the value imputed to working time according to the mean income of the users of different modes of transport. By contrast, there is no such differentiation for non working time, for equity reasons as discussed below. The only distinction is between commuting and pure leisure travel, on the basis of empirical evidence of a slightly higher value for the former.

TABLE 2

VALUES OF TIME
(£ per hour in 2002 market prices)

In working time	
Car driver	26.43
Car passenger	18.94
Rail passenger	36.96
Bus passenger	20.22
Walker	29.64
Cyclist	17.00
Out of working time	
Commuting	5.04
Leisure	4.46

SOURCE: DfT: WEBTAG Unit 3.5.6 (*www.webtag.org.uk*).

The early approach to valuing accident savings, as well including money costs such as health service costs and damage to property, valued death or injury in terms of lost production, and regarded the wage rate as a good estimate of this. When it

was realised that this meant valuing the lives of retired persons at zero, a politically determined so-called 'warm-blooded' cost of accidents was added. More recently, research on what people are willing to pay to reduce the risk of death or injury (estimated for instance by examining choices between different means of transport involving different risks) has been used as the basis for estimating this 'warm-blooded' cost of accidents.(Lindberg, 2005). Although it is translated into the so-called 'value of a statistical life' by dividing the valuation by the change in probability to which it refers, it is actually valuing changes in risk rather than deaths or injuries. Unless the entire output of the country is devoted to reducing risk, and nothing else, such trade-offs between cost and risk are inevitable.

For environmental costs, the strongest argument against the simple willingness to pay approach is that individuals often do not correctly perceive the costs of environmental impacts; for instance, that of air pollution on health, crops and buildings. Thus a straightforward willingness to pay approach is only used in the British appraisal process for amenity impacts such as noise and visual intrusion. Noise is already valued, based on the house price approach whereby the willingness to pay of residents to reduce noise nuisance is estimated from differentials in house prices between quiet and noisy environments, other things being equal, (Nellthorp, Bristow and Day, 2007). Research is also taking place using the willingness to pay approach to examine townscape and landscape, although the difficulty of classifying different landscapes in terms of their amenity value is a considerable barrier; unlike noise, landscape value is not easily measured. Air pollution is currently not valued at all, but rather described in physical terms. However, recent research has developed an approach using the so-called 'dose–response' method, in which the impact of the pollution on health, crops and buildings is first forecast, and then these damages valued, at market prices in the case of crops and buildings and according to the valuation of risk of death or injury in the case of health impacts (Bickel *et al.,* 2005). Although the approach is complex and demanding in information, it is widely used elsewhere in Europe.

Global warming is also an issue where the straightforward willingness to pay approach is inappropriate; the average person cannot know the best scientific evidence on which to base a judgement about its impacts. The «dose-response» approach appears more appropriate but is extremely difficult because of the problem of forecasting global effects up to a century ahead. But in any event the way in which governments take decisions on global warming is by committing themselves to particular reductions in greenhouse gas emissions by a certain date. Thus, if these constraints are binding, the effect of a change in emissions from transport is not a change in total greenhouse gas emissions but the need to reduce them elsewhere. For those sectors of the economy which are already part of the European emissions trading scheme (electricity generation, heavy industry), the cost of this is already included in the market price through the trading of permits. Elsewhere it is necessary to estimate the shadow price of carbon by looking at the most efficient way of achieving the targets in the economy as a whole.

It will be seen above that measures of accessibility, particularly for those without a car available, are included in the current appraisal process, although not valued in money terms. There has been a long debate in Britain over whether accessibility itself has any value over and above the benefits of trips actually made. There is limited evidence that people are prepared to pay something over and above the value of the expected benefits from it in order to have good quality public transport available, as a sort of insurance policy should they need it Laird *et al.,* 2009). This concept is already incorporated in the current approach to appraisal in Britain in the form of option values. Option values are likely to be significant where the future consequences of a lack of the facility could be severe. This of course is of particular relevance to the provision of public transport, as for those without a car available, the absence of a public transport link may render access to facilities very expensive (involving the use of taxis) or inconvenient (involving a slow roundabout route). Road schemes seldom have such a drastic impact on car users. But it is also likely that option values will only be significant where people may become heavily dependent on frequent use of the service in question, rendering the use of taxis prohibitively expensive; it does not make sense to pay a lot to preserve a service which at most would only be used very occasionally. The most obvious case where this might apply is where people might have to commute to the nearest large town or city; Table 3 shows values based on studies of such circumstances.

TABLE 3

WILLINGNESS TO PAY PER HOUSEHOLD PER ANNUM (£ 2002)

Mode	Option Value
Train	170
Bus	90
Train and bus	170

SOURCE: DfT: WEBTAG Unit 3.6.1 (*www.webtag.org.uk*).

Finally in this section we come to one of the longest standing debates of all. It has always been observed that politicians, and particularly local politicians, have little interest in the formal cost-benefit analysis of projects, but are very much more interested in their impact on employment and incomes. The NATA approach does not explicitly consider these at all, although implicitly the value of working time savings and other cost savings represent resources released to boost output elsewhere in the economy. In 2006, the Eddington enquiry was established to look into the issue of whether this adequately treated the issue of productivity impacts of transport schemes, and concluded it did not (Eddington, 2006). Three further

impacts of transport projects on productivity and output have been identified, in the form of agglomeration benefits, output increases under imperfect competition and labour market impacts (Venables, 2007). It is argued that the observed higher productivity of labour located in high density areas reflects an external benefit from access to a larger labour market with more scope for specialisation, from economies of scale in supplier industries and greater opportunities and pressure for innovation. Thus measures which increase the effective density of jobs by reducing the generalised cost of travelling between them will not just benefit the travellers themselves, but will have an external benefit of raising productivity of other workers in the area affected (Graham, 2007). Moreover, if more jobs move to the area in question, there will also be an external effect on productivity of other jobs in the area. However, the methods of quantifying this benefit remain a matter of dispute and the results uncertain. Less controversial is the point that if a project brings more people into the labour market, the benefit is not solely to themselves, but to other taxpayers in the form of additional tax revenues and a reduced need to pay unemployment benefits. Also, measures (such as reduced freight or business travel costs) which reduce the costs of firms producing in imperfect competition and induce them to expand output will lead to additional benefits in the form of the margin between price and marginal cost on that incremental output. There are now proposals to include all these forms of wider economic benefit in the standard approach to appraisal in Britain (DfT, 2009). The first occasion when these so-called wider economic benefits proved influential was that of the Crossrail project in London, which will provide a new tunnel under central London linking suburban lines in East and West London and thus both improve services and relieve overcrowding. Table 4 shows the cost-benefit analysis of this project and the major impact of the wider economic benefits on the benefit-cost ratio, forming nearly a third of the total benefits. By contrast, wider economic benefits are estimate to form only 10% of the proposed new high speed line from London to Birmingham (HS2), and even these result mainly from improved commuter services on the existing line as a result of capacity being freed by diversion of fast trains to the new line (High Speed 2 Limited, 2009).

TABLE 4

BENEFITS AND COSTS OF THE LONDON CROSSRAIL PROJECT

Time savings	12832
Crowding	2889
Other transport benefits	372
Wider economic benefits	7161
Total benefits	23254
Total costs	13902
Less revenues	-6149
Plus tax loss	1207
Cost to government	8960
BCR	2.6 (1.8 excl Wider economic benefits)

SOURCE: Cross London Rail Links Ltd. (2005).

4. Decision criteria

There are several inter related issues to resolve when considering decision criteria – choice of discount rate, project life, decision-rule and the treatment of uncertainty.

There are broadly two competing approaches to choosing the discount rate – opportunity cost and social time preference. The opportunity cost approach involves estimating the return that could have been earned on the investment elsewhere in the private or public sector. It used to be used in Britain, and at that time the discount rate used in CBA was 10%. But this approach essentially assumes that all future costs and benefits can be reinvested, so that it is the returns on that investment which determine the discount rate to use. When many of the costs and benefits in the appraisal do not take the form of cash flows, this is unrealistic. So the alternative approach, that of social time preference, is to be preferred. This approach bases the discount rate on the rate of decline of the marginal utility of income as incomes rise over time. This is the approach now used in Britain, with an assumption that incomes will grow at 2% per annum, that the marginal utility of income falls by 1% for every 1% growth in income, and that there is a «pure» time preference rate of 1.5%. This all adds up to a discount rate of 3.5%. The rate is assumed to fall to 3% after 30 years and thereafter to continue a steady decline.

With such a low discount rate, even benefits quite remote in time may be significant in the appraisal. Thus at the same time as the lower discount rate was introduced, the appraisal period for transport infrastructure projects was extended to 60 years. This obviously has two important repercussions. Firstly, the low discount rate and the long appraisal period mean that a lot of schemes have positive net present values, and particularly in times of acute financial difficulty for governments only a small proportion of them may be undertaken. Secondly, uncertainty becomes an acute issue. These are sometimes taken as arguments for reversing the former decisions on discount rates and appraisal periods. However, neither of these problems in itself justifies using a higher rate of discount or a shorter project life. Instead other solutions must be sought.

There is a strong argument in the literature (*e.g.* Dodgson and Topham, 1986) for adding a premium of, say 30%, to all costs and benefits that involve cash flows to or from the government, on the basis that for the government to raise funds involves the deadweight loss of the distorting effects of taxation, and indeed an even higher rate might be justified as a reflection of the opportunity cost of government funds. No such adjustment is made in the current British approach to appraisal, but this would be a better solution than raising the discount rate, with its attendant bias against the future.

Instead, the current approach in Britain is to rate schemes according to the ratio of net benefits to stakeholders other than the government per pound of government spending. A qualitative adjustment has to be made for elements not valued in money terms. At the present time, only projects for which this ratio exceeds 2 are regarded

as giving high value for money and having a strong case to go ahead. Even so, far more schemes pass this test than can be afforded and – particularly in the light of planned government spending cuts – there may be a case for tightening it further.

We have already noted the need to consider uncertainty in appraisal, particularly when that appraisal extends up to 60 year into the future. Despite many years of debate, the British appraisal process is unsophisticated in its treatment of uncertainty. It has taken note of the work of Flyvbjerg *et al*. (2003 and subsequent papers) who have shown that estimates of both capital costs and benefits of schemes are often grossly wrong, with a clear tendency to under estimate costs and to overestimate benefits. The approach taken to deal with this in Britain is to require costs to be adjusted for 'optimism bias', currently by adding 67% to the capital cost of rail schemes at the outline stage and 40% to road. These adjustments are reduced as the scheme is examined in more detail, but remain at 40% for rail and 15% for road at the option selection stage. There is a smaller adjustment for operating costs. There is no such blanket adjustment for benefits, but sensitivity testing is recommended. This approach is hardly a solution to the problem. To the extent that the problem is one of genuine errors in forecasting, it is obviously desirable to understand the reasons for these and to improve forecasts rather than adding a blanket adjustment. To the extent that it is actually strategic misrepresentation in order to achieve a desired outcome, then presumably those responsible will take the presence of this adjustment into account and seek to offset it by further misrepresentation of benefits and costs. The solution here must be to find institutional arrangements which reduce the incentive for such misrepresentation (the British system has endeavoured to do this, for instance, by requiring that the risk of cost overruns be borne by the budget of the sponsoring authority). In the case of operating costs and benefits, accurate forecasts up to sixty years ahead are simply not possible, so the emphasis on the use of complex forecasting methods to produce single point forecasts and benefit cost ratios is misguided. Of far more use is the preparation of long run forecasts from a range of scenarios, showing how robust the alternative is to alternative possible futures, with detailed forecasting being confined to the early years of the life span of the project.

In a world of constrained capital budgets, where many justified schemes are not progressed, often the most crucial decision is which schemes to do now rather than later. For this, the main emphasis is on the benefits foregone if the scheme is delayed, *i.e*. on the first five or ten years of the life of the asset. Forecasting for such a period is much more feasible. Thus it would make sense to place the emphasis of the detailed technical analysis on the costs and benefits of postponing the scheme say five or ten years, with the longer term appraisal concentrating on whether the scheme would still be justified under a range of alternative future scenarios.

5. Distribution of costs and benefits

There are two broad views of the basis of cost-benefit analysis to be found in the literature (Nash, Pearce, and Stanley, 1975). The first is that it seeks to test whether a project could potentially make everyone better off because the willingness to pay of the beneficiaries exceeds the compensation required by the losers. That is one rational for using money values based on willingness to pay or required compensation. If the compensation were actually paid, then of course going ahead with such a project would clearly be better than doing nothing. However, compensation is not usually paid, and if the present distribution of income is not seen as fair then a project which redistributes income in a fairer way may actually be favoured over one which makes everyone better off; a project which redistributes income to make it more unfair will obviously be seen as worse.

The alternative approach is to see CBA as measuring the change in social welfare according to a social welfare function with explicit weights attached to changes in welfare to different income groups, with measures of willingness to pay and willingness to accept compensation as indicators of the change in welfare to the group in question. This approach means that costs and benefits should be subdivided by income group, to permit the necessary weighting. It was explicitly adopted by the Treasury in the Green Book which sets out the rules for public sector appraisal in Britain when it was revised in 2003 (HM Treasury 2003), with the required weights being inversely proportional to income (*i.e.* assuming that the social marginal utility of income declines by 1% for every 1% rise in the level of income). But few appraisals in practice do this, and it must be accepted that it is not easy. A full distributive analysis requires the tracing through of the ultimate incidence of costs and benefits, which are often passed on in the market. For instance time savings may be passed on to property owners in the form of property values, or employers as reduced wage rates. Cost savings to freight operators may be passed on to shippers of goods, and ultimately to the purchasers of those goods in the shops. Yet an attempt at estimating this, however crude, is essential if we are to implement this approach to cost-benefit analysis.

The British approach, again like many others, attempts to allow for equity considerations by using common values of time, risk of accidents and environmental amenity regardless of income. This might have been reasonable at a time when appraisal was mainly applied to road schemes which were paid for by the government but gave time savings to users, but now that appraisal is often applied to schemes which trade off time savings against money cost (*e.g.* whether to replace buses with higher priced light rail services, or whether to reduce road congestion by means of road pricing), it may be highly misleading. It would be quite possible for the appraisal to conclude that the scheme was desirable on the basis of a standard value of time, when according to the actual values of the users it was not (or *vice versa*).

If the values in question rise roughly in proportion to income, then a standard value would be consistent with a weighting system which attached weights that were inversely proportional to income (as required by the British appraisal process according to the government 'green book' on appraisal). But it would then be necessary also to attach weights inversely proportional to income to money costs and benefits. Thus it is essential to estimate the incidence of money costs and benefits by income group. No attempt to do this is made in the standard approach in Britain; instead, distributional considerations are largely seen as an additional issue concerned with the impact on specific stakeholder groups or geographical areas rather than income groups (see for instance the study of the geographical distribution of the benefits of the Crossrail project in London, Crossrail, 2009). Yet if CBA is seen as an application of a social welfare function, then a measure of willingness to pay or cost that is not adjusted for differences in the marginal utility of income is meaningless.

In practice, in the case of the Crossrail project, the distribution of benefits became a contentious issue. Evidence that previous investment in transport in the Docklands area of London, in the form of the Jubilee line extension, had raised property values by some £2b (University of Westminster, 2004) led to concern that taxpayers' contributions to the cost of construction of Crossrail would simply be passed on to wealthy property owners and developers through the property market. Alternative ways of recouping this were investigated, and ultimately legislation was introduced permitting part of the cost of the line to be met from a supplementary rate on business in the area. But such explicit concern with the distributive effects of transport projects is rare in Britain.

6. Conclusions

We have seen a wide range of criticisms of the current appraisal process in Britain. In terms of valuation procedures, we regard the current British approach as generally state of the art, although arguably there is now sufficient evidence to introduce monetary valuation of air pollution, whilst more empirical study of the value of working time savings is needed, and the issue of small time savings will not go away. Given the importance of time savings, and working time savings in particular, in most appraisals, this is a serious qualification of the judgement that the existing appraisal system is adequate. The other big uncertainty in this area is in the measurement of wider economic benefits. It would be reassuring to have some ex post confirmation that these benefits really exist, but tracing back changes in productivity to particular transport investments is not going to be easy.

The current British approach to decision criteria is also appropriate, except that there is a strong case for introducing an explicit shadow price of public funds into the appraisal and also the treatment of uncertainty is inadequate. A further serious weakness in current British transport project appraisal is the lack of detailed atten-

tion to the distribution of costs and benefits. It is appreciated that this is difficult, but without it, the appraisal must be regarded as incomplete. To some extent, the current interest in the wider economic benefits of transport projects produces some data also on the distribution of impacts, since it focuses on issues such as what happens to wage rates after a transport investment. But no study has explicitly carried out the requirement of the Treasury Green Book to identify the costs and benefits by income group and to apply weights accordingly.

In summary then although transport appraisal is solidly based on many years of research, there remain many issues requiring resolution. Perhaps the most important criticism of the way project appraisal is undertaken in Britain today relates to the issue of uncertainty. Appraisal seems to be seen too much as a purely technical exercise, forecasting impacts up to 60 years ahead for a single view of the future, rather than exploring issues of timing and robustness under a range of future scenarios, whilst the issue of optimal timing of investment – which does require detailed forecasts for the first few years of the project – is often neglected.

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