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COST-BENEFIT ANALYSIS IN TRANSPORT: A UK PERSPECTIVE

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COST-BENEFIT ANALYSIS IN TRANSPORT – A UK PERSPECTIVE

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1. INTRODUCTION

Economic appraisal of transport projects in the UK, if dated from the studies of Coburn, Beesley and Reynolds (1960) and Foster and Beesley (1963), is now celebrating its fiftieth birthday.

It has always been a controversial tool, generating accusations of unacceptable principle, improper application, inadequate evidence base and bias. One early application was to the appraisal of the proposed third London Airport where a critic labelled the project appraisal as "nonsense on stilts" and the method was defended against accusations of being "bastard science and/or insidious poison in the body politick" (Self 1970, Williams, 1973). Since that time, appraisal has found itself at the centre of public disputes about the road planning system, the treatment of environmental impacts, the so-called "roads generate traffic" issue and the relationship between transport and the economy. The Government established a special independent committee, SACTRA, to advise it. The 1997 Government undertook a review which led to the so-called New Approach to Appraisal, and in 2009 revisited and "refreshed" the NATA, see the link - http://tinyurl.com/natacons.

But the pages of the magazine, *Local Transport Today,* show that transport appraisal remains as controversial as ever, and the new coalition Government is believed to be considering whether yet further change is required.

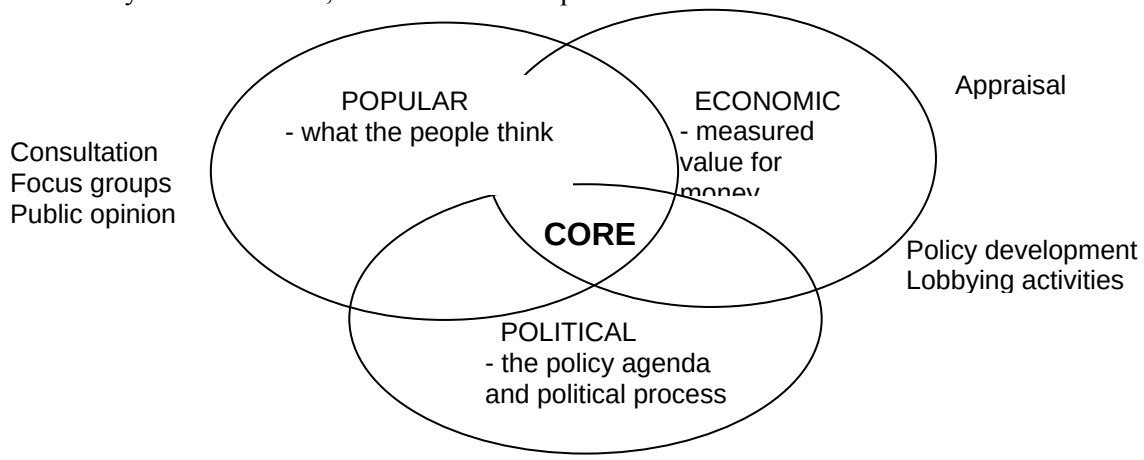
So, transport appraisal in the UK is a hotly contested space, and the idea that transport CBA in the UK is somehow a stable, agreed concept is not true. What is true, however, is that there is a well codified history and development of practice which is discussed below. Before that, though, we review some features of CBA which help to explain its controversial nature and its role in contributing to decision-making.

2. THE ROLE OF TRANSPORT APPRAISAL

The reason that appraisal is controversial is that there is disagreement on the role which it should play in decision-making. Since this is a value laden question, agreement is unlikely to be achieved by reference to logic or rationality. A lot depends on the social, economic and legal framework within which decisions are made.

2.1 The appraisal context

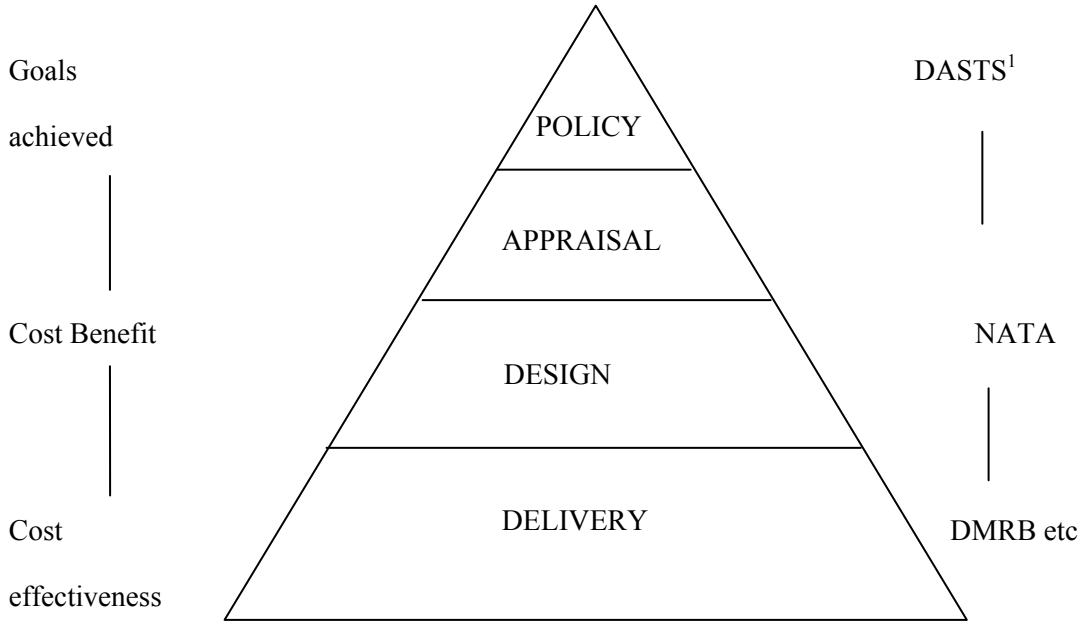
In a country such as the UK, the context can be presented in this form:



Here is the space within which transport planning decisions happen. There is a political space where governments decide their goals and aspirations for transport. There is a social space in which interested parties are consulted, give their views. There is the economic space in which technical studies of an engineering economic kind reside. The three spaces are brought together and are mediated within a planning system which naturally looks for solutions which can satisfy all three spaces.

The construction of the diagram assumes that there is a balance of forces which can be resolved within an overlapping core. Sometimes it may be acceptable to move outside the core, but this can cause trouble. For example both the UK and the Netherlands have found that road user charging may pass the engineering economic test but not be acceptable socially or politically. Note that in some countries, the balance of forces may be different. For example, external funding may be required in which case the goals, criteria and assessment of the external funding agency come into the picture.

A slightly different way of conceptualising transport appraisal is in a hierarchical way:



A point which is frequently made by critics of CBA in the UK is that it is generally not used in other government sectors. So, for example, schools construction requires a building programme budget and a design manual with some indicators to determine priorities. The argument in transport is that schemes are complex, heterogeneous, have a range of impacts across jurisdictions and that something is needed to bind together strategy and design. Also traditionally in the UK transport strategy has been quite weak and the planning level quite strong - this may be different in other countries such as France.

In any transport scheme proposal, the decision is played out among a number of parties – the planning system, the scheme promoter, the objectors, the lobbyists, the transport operators, the funders and so on. The appraisal can be seen as an important part of the rules of engagement within which the interests of these parties are considered and resolved. The appraisal rules are in the ownership of the Department of Transport, in its role as chief transport planner. In formulating the rules, the Department relies on academic and consulting studies, and consults with a wide range of interests. The rules should themselves have a strong foundation and credibility, and the Department is often nervous when the rules themselves come under attack, as they do from time to time. This is a healthy feature of the system.

[1] Delivering a Sustainable Transport Strategy; New Approach to Appraisal; Design Manual for Roads and Bridges.

The position of appraisal in the British system gives rise to a number of tensions and conflicts:

- the need for consistency with the overall appraisal guidance of the Treasury in the Green Book;

- the need to distinguish between the DfT's role as guardian of the appraisal rules and as a scheme promoter in its own right;

- the need to define exactly what appraisal rules apply to. Is it publicly funded projects? Is it projects which require planning permission? Does it apply to revenue as well as capital expenditures? Is it a DfT programme budgeting tool? This is not entirely transparent, especially in relation to airport and port projects where traditionally CBA has played a lesser role than in road and rail sectors;

- the consistency of the appraisal regime with policy objectives and targets set by Government. For example, should all transport projects be at least carbon neutral or can there be trading across projects within an overall transport carbon budget ceiling?;

- the need to define research requirements to help develop the appraisal by expanding the value set, updating existing values and so on. The valuation of travel time has been through three generations of study and a fourth is under consideration at the moment;

- the need for maintenance of WebTAG itself.

So, within any decision system, who owns the appraisal regime itself, how that sits within the overall decision process, and what status it has are important questions for the political economy of transport.

2.2. The applicability of appraisal

It follows from the previous section that formal appraisal is more suitable in some contexts than others. So, where policy initiatives are large, irreversible, and have a range of impacts over space and time, affecting a range of social groups (travellers, residents, businesses, etc), some form of cost-benefit analysis is likely to be useful. This is especially the case if there is a quasi-judicial planning process in which the promoter puts the case and objectors put their case before an inspector. In that context, the appraisal provides a useful reference point around which to organise the material for consideration. In this context, a significant issue is the use of appraisal as a control mechanism – in the modelling and appraisal is a particular scheme context compliant with good practice as set out in relevant user manuals? Does the promoter's case have credibility? Actually one of the strongest technical and analytical cases for some form of appraisal according to rules with the possibility of independent challenge is to consider the counterfactual in which appraisal does not exist. Our conjecture is that political decision making without the checks and balances of decision support tends to produce worse results. This is seen whenever projects acquire prior political commitment and become extremely difficult to stop however poor the economic case (Mackie and Preston, 1998).

Where transport initiatives involve recurrent expenditure or are reversible or can be developed incrementally, the case for social appraisal, though still theoretically valid, is in practice weakened. So fares policy, bus and rail service levels, public transport subsidies, highway maintenance are not generally subjected to the same sort of appraisal as capital projects. But also, appraisal is significantly influenced by the asset ownership and regulatory regime; road and rail projects will generally be seen

as public domain, so that social appraisal has legitimacy, whereas airport and port projects may be more commercial in nature and be considered as quasi-commercial projects with social implications.

2.3. The scope of appraisal

There is not just one concept called cost-benefit analysis. There is really a family of concepts which involve differences of practice in different countries. A fundamental distinction may be drawn between those who see cost-benefit analysis as an extended from of commercial appraisal and those who use it as applied welfare economics a la Bergson.

Both groups would agree that where markets are incomplete (public goods, externalities) or where prices are administered or regulated, commercial appraisal can give poor estimates of the social value of investment. Benefits may accrue to travellers which are not captured by a pricing scheme. Safety and environmental impacts fall upon users and non-users but are not internalised by market processes. It is right that a more comprehensive assessment procedure is devised to capture those impacts in the appraisal. Whether they are all valued in money terms or quantified physically (noise, emissions) or simply written down as impacts – loss of historic or natural assets for example – is a level below the proposition that there should be a comprehensive account of the forecast impacts.

The difference lies in the view taken of transport investment as a tool of social policy. On one view, transport is a quasi-private sector activity with certain externalities attached and some pricing issues. On this view the Kaldor-Hicks criterion is viewed as a sufficient test of project worth – "can the gainers compensate the losers and still retain some gains?" On this view, CBA is an extended economic efficiency calculation to assign an efficiency value to projects but viewed from a social rather than a simple agency commercial perspective. Issues relating to distribution and equity are, on this view, best dealt with through the taxation and social welfare systems and not through sector budgets such as transport, water or energy. Authors such as Harberger and Sugden (1999) broadly take this view. The implication at the technical level is that the task is to find the willingness to pay values for the impacts on travellers and non-travellers which are not represented in the revenue and cost streams of the project. Behavioural values are what count and should be carried through into appraisal at whatever level of disaggregation is considered practical.

The alternative view is that CBA is a form of social calculus in which distributive as well as efficiency considerations are relevant (Pearce and Nash 1981; Galvez and Jara Diaz, 1998). On this view, except in the extreme case where the marginal utility of income is equal at all income levels, some reweighting of the costs and benefits is required depending upon which social group they accrue to. This raises practical difficulties since it is an order of magnitude more difficult to discover the distribution of beneficiaries by income class, Again, a true appraisal would need to consider the distributive effects of land price and displacement effects which might be ignored as transfers in an efficiency analysis, the distributive effects of impacts on intermediate goods sectors like logistics and distribution are problematic, and so on.

Therefore in practice, proxies are used such as standard average values – for example non working time savings and safety benefits in which values are not allowed to vary with the income level of the recipient. This is equivalent to assuming unit elastic marginal utility of income across income groups

2.4. The perspective of appraisal

Cost-benefit analysis is a neoclassical comparative static framework. It relies on comparing a stable baseline case against one or more stable do-something cases. A strength of this approach is that it ties together equilibrium modelling represented in matrix estimation and assignment routines with user benefit calculations based on the "rule of half" codified by Neuburger (1971) and others. But the approach can be criticised as limiting. Paradigms such as prospect theory offer alternatives to utility maximisation but have not yet been operationalised for practical appraisal. Another critique is the failure to consider disequilibrium dynamics and paths to equilibrium. Transport projects cause shocks to the economic systems – household change location, firms enter the market in location A and other firms exit in location B, forces are unleashed which play out in real time. CBA is strong for assessing marginal changes to an established network (marginal in terms of the scale of the changes to generalised cost not the size of the project), weaker for paradigm – altering investments which impact on the macroeconomy at regional or national level. However, the discipline of appraisal clearly linked to scheme modelling and forecasting is essential as a check on unsubstantiated claims especially by those who are not funding the project.

3. TRANSPORT CBA IN THE UK

A useful starting point in a general schema for transport CBA which underpins various appraisal work in which ITS Leeds has been involved – see for example work for the World Bank at www.its.leeds.ac.uk/projects/WBtoolkit and for UNECE (2003).

The following figure describes certain key features of transport CBA.

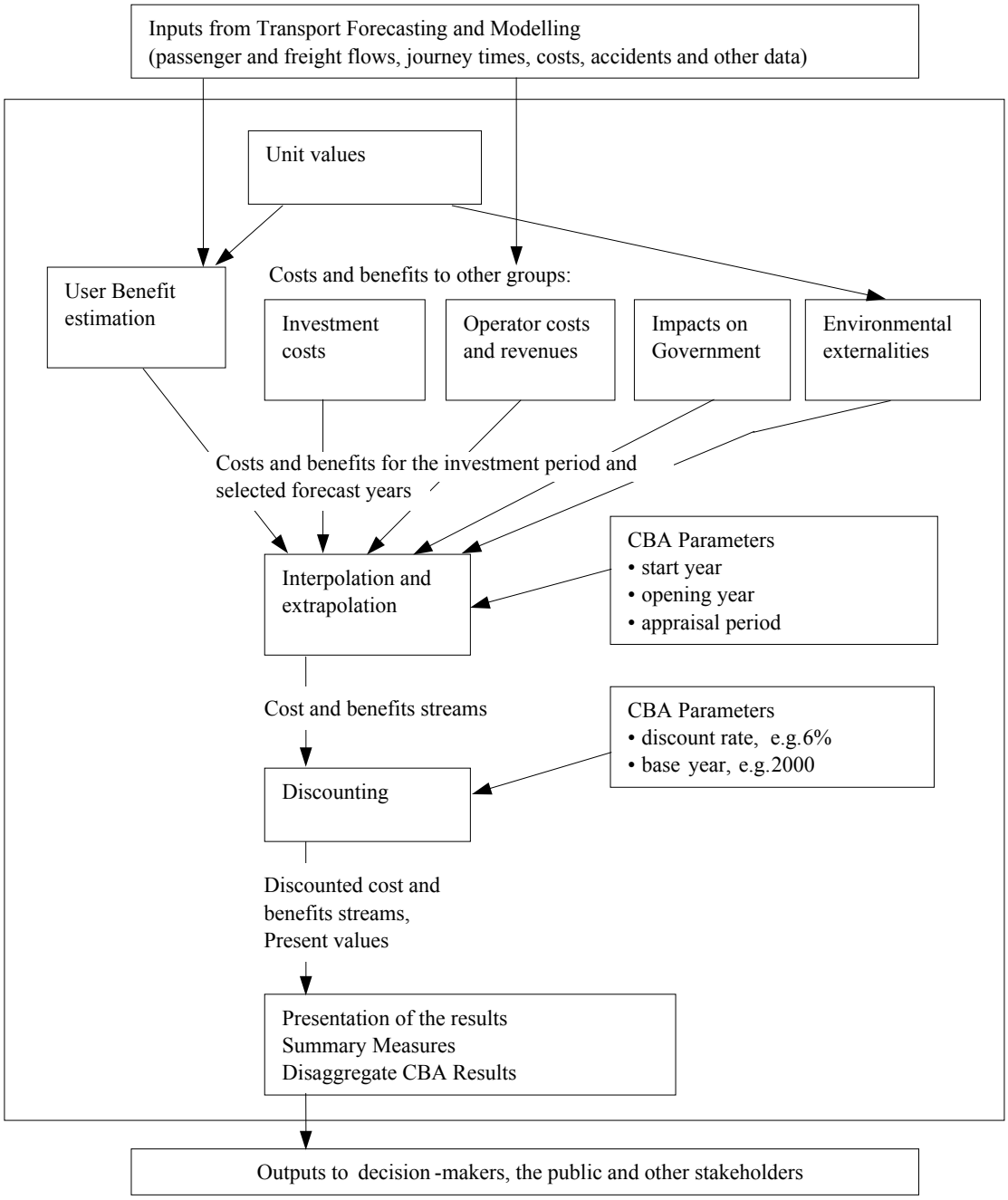
- CBA relies on inputs from transport models and forecasts and in that sense is only as good as the model quality and forecast assumptions which feed it.

- It requires a set of values which are either standard values or at the minimum common principles for devising local values.

- Costs and benefits need to be estimated over the life of the scheme or in practice for a limited number of forecast years with interpolation and extrapolation.

- The results need to be discounted to an equivalent present value within Ministry of Finance rules.

- The results need to be presented in suitable form to the decision makers, the public and other stakeholders.


Inputs from Transport Forecasting and Modelling
(passenger and freight flows, journey times, costs, accidents and other data)
Unit values
User Benefit estimation
Costs and benefits to other groups:
Investment costs
Operator costs and revenues
Impacts on Government
Environmental externalities
Costs and benefits for the investment period and selected forecast years
CBA Parameters
• start year
• opening year
• appraisal period
Interpolation and extrapolation
Cost and benefits streams
CBA Parameters
• discount rate, e.g.6%
• base year, e.g.2000
Discounting
Discounted cost and benefits streams, Present values
Presentation of the results
Summary Measures
Disaggregate CBA Results
Outputs to decision-makers, the public and other stakeholders

A key feature is that in an ideal world, we would like to measure, model and value all the impacts on society of a project or policy measure. The point of view should be an overall societal one. Typically, the project impacts might fall on a range of stakeholders, as in Table 1.

Table 1. **Impacts by stakeholder of a transport project**

Stakeholder group	**Impacts (changes in)**
Transport users	Time Reliability Fares/costs Journey quality Perceived accident costs Option value
Transport operators/ Infrastructure providers	Revenues Operating costs Capital costs
Non-users	External accident costs Environmental impact
Rest of economy outside transport	Agglomeration Competitiveness Labour markets
Government	Subsidies Taxes Charges Grants

Some entries in the table will appear twice – for example, increases in operator revenue will be positive for operators and negative for transport users. The fundamental theorem is that, suitable discounted,

Present Value of Net Social Benefit (**NPV**)

(1) Consumer Surplus (CS)

\+ (2) Revenues to transport operators

\+ (3) Environmental and Safety externalities

\+ (4) Option and Non-use values

\+ (5) Wider Economic Impact

\- (6) Costs,

and a simple indicator of Benefit: Cost Ratio (BCR) if required is

[(1) + (2) + (3) +(4) + (5)] / (6)

Although in an ideal world, all items of cost and benefit might be valued in monetary terms, practice falls short of this. The evidence base is lacking for some environmental impacts and "unique" natural and heritage assets pose ethical as well as practical problems for valuation. In practice, therefore, the framework table is likely to be partly in money, partly in physical impacts and partly in descriptive terms. The final table is likely to be a summary of lengthy documentation. So summary measures such as NPV and BCR are in practice indicators of a subset of the full table and need to be interpreted accordingly.

The purpose of the framework table is to estimate the net social gain from doing something relative to the reference case. Therefore it is essential to avoid double counting. So for example, if a transport improvement is reflected in an increase in transport user benefit (ΔCS) which is then partly transmitted into a change in land rents, which is then transmitted again into a change in prices and wages in the rest of the economy, the project must not be credited with the same benefit as three different stages of the economic transmission system (Mohring 1993). Conceptually, either the analysis should capture the final economic system benefits or it should measure the transport sector benefits plus the additional wider economic benefits. This second approach is the current UK one; we return to some issues with it below.

The UK appraisal regime is codified in a publicly available internet resource WebTAG. All transport projects requiring an input of public capital expenditure apart from small schemes are required to undergo an appraisal of the form described above using the value set and methods set out in WebTAG. So, a significant rule of transport appraisal in the UK is to operate as a control tool to provide a value for money indicators on a consistent basis as an input to the decision-making process. It should be stressed that appraisal is one input to a decision process and NOT the process itself; we have studied the degree to which the decision outcomes on national roads can be modelled and explained by their performance in the Framework, and similar analysis has been carried out in Sweden (Nellthorp and Mackie 2000, Eliasson and Lundberg 2010). The chapter index to the WebTAG site is at www.dft.gov.uk/webtag/documents/index.php

4. CRITIQUES OF UK TRANSPORT APPRAISAL

There are a number of critiques of transport appraisal as practised in the UK which should be treated with some degree of seriousness. The issue of how transport links to the wider economy is deferred to the next section as the most significant source of concern with appraisal practice.

4.1 The policy critique

There are various arguments that appraisal is not adequately aligned to policy, or is inconsistent in certain respects with policy objectives, or is not in practice used across the full range of policy analysis. It is true that in UK practice there is a lot more experience of using appraisal at the "plan" level than at the "strategy" level and there is not a great deal of open discussion of the relative value for money of spending public money across Government sub-programmes. Still less is the overt use

of common appraisal methods to compare across sector boundaries – for example to assess the relative performance of transport, health education, regeneration, etc, in city policy. One disadvantage of CBA in particular is that it is not widely used outside the transport sector and so does not naturally provide metrics for comparison between transport and other sectors. There is a suspicion that this may have led to relative underfunding of transport capital especially at the local and regional level. Another similar point is the absence of points of comparison within the transport budget between small and large and in particular between capital and revenue spending. Some of the conclusions from such a study might be uncomfortable for central government.

Should appraisal be aligned to policy? In a sense the answer must be "yes", but policy is often rather crude, setting out say five goals of transport policy without detailed study of the costs, effects and trade-offs involved in practical choices. Appraisal is about informing those choices, and a degree of independence rooted in good quality evidence on consumer and social values is no bad thing. In some countries such as Sweden, the guardians of transport appraisal are independent of Government. In Britain, a middle way is taken where transport appraisal is within Government but at arm's length from the parts of the DfT which are concerned with particular schemes (responsibility for which in any case is now mainly outsourced to agencies). This can cause tensions. Two of the new Government transport Ministers have expressed reservations about aspects of the appraisal regime, and it will be interesting to see how these are handled.

A different policy critique is that transport appraisal is not particularly agile. It is a set piece with strong internal coherence, and designed to address a subset of policy questions, but not to be easily adaptable to new questions which come along. In a way this is understandable – because one of its strengths is its reliance on a good evidence base, it takes time to develop the new evidence required to support analysis of new policy needs.

One of the most disliked attributes of travel is unreliability defined as some measure of the variance of travel time from which may be derived the safety margin required in order to be on time at the destination on x per cent of occasions. Where the activity at the destination is a job interview, an opera performance, a flight to Mexico, or simply the need to open the shop on time, this becomes important. It is one of the big arguments behind reserved track and priorities for buses and trams in cities and one of the big arguments in how much to spend on managed motorways. But it is a difficult problem for appraisal and an even more difficult problem for modelling.

Another example is resilience. In Britain we need to invest on the transport system so as to insure against various external risks. There are weather risks such as high winds and storms associated with global warming, there are peak oil risks implying need for fuel diversity beyond what the private sector would plan for, and there are security risks. Conventional appraisal is not well set up to address policy needs and forward programmes of this kind.

4.2 The planners' critique

The planners' critique of transport appraisal is that it is not set up in a way which tells society what it needs to know or even what will happen. This relates to the whole question of induced traffic and, more broadly, induced change associated with transport investment.

The basic ethos of transport engineering economics is that one starts from a base trip matrix and assignment, and then estimates the changes in travel cost associated with a change in the network. For many years, until the mid-1990s, it was standard practice to use a fixed trip matrix in which all

behaviours except route choice were assumed to be fixed. Following SACTRA (1994), variable matrix approaches replaced fixed matrix, but normally with constraints such as fixed land-use.

Figure 1.

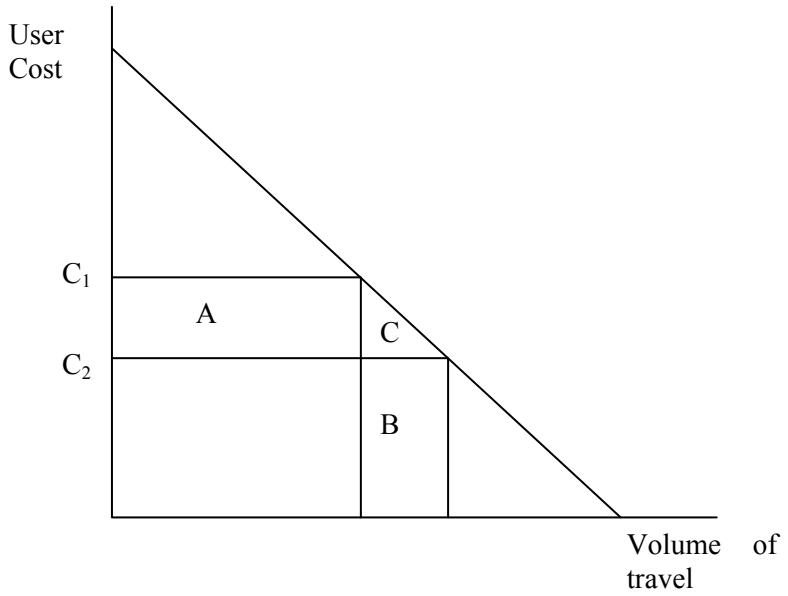


Figure 1 illustrates the difference of approach. Engineering economics teaches us to focus on A (or A plus C) as the measure of user benefit from a change to the transport system. Planners on the other hand argue that in a congested network environment, the difference between C1 and C2 is unstable and will very rapidly be eroded over time, as people take out the benefit of improved accessibility by travelling further. The apparent constancy of travel time budgets is one supporting proposition. Moreover, planners argue that the real interest is in area B – what happens to induced land-use change, employment and economic activity as transport improves. How does the extra capacity impact on the spatial economy? While it is possible for conventional appraisal to dodge these questions by assuming perfect competition, planners are apt to point out correctly that perfect competition is not generally consistent with a spatially separated economy which is the very reason why transport exists! There is therefore a significant issue of how and whether appraisal can be adapted to deal with this issue - see next section.

4.3 Technical critiques

At another level, there are arguments about the value set which is deployed in British practice. While there are some who are philosophically opposed to monetary valuation per se, more common are objections to particulars.

4.3.1 Travel time savings – employers' business

The value of travel time savings (VTTS) on employers' business is important and difficult to study. Although employers' business car traffic in Britain is only around one-sixth of total traffic, the high values used for this traffic mean that it typically accounts for half the travel time benefits for cars. The cost saving approach is used. This says that in a competitive labour and product market, firms hire labour to the point at which the value of the marginal product is equal to the wage rate; thus the value of a travel time saving is equal to the marginal gross cost of labour including labour related overhead. This requires a number of assumptions to be fulfilled:

- All released time goes into work, not leisure;
- Travel time is 0% productive in terms of work; no work can be undertaken while travelling;
- The marginal value of working and the marginal value of travel to the individual are zero (or have equal and opposite value);
- The competitive labour market theorem holds; w = vmpl;
- No indivisibilities in the use of time for production so every minute is equally valuable.

A reasonable conjecture is that these assumptions taken together are approximately true for manual workers travelling in the course of their work duties. So, for example, in the case of professional truck drivers or coach drivers, the cost saving theory remains valid. However it is more doubtful for other business travel in the course of work.

Empirically, a number of authors have cast doubt on whether VTTS for employers' business varies proportionately with the wage rate, as would be implied by the cost saving approach (for example Hensher and Goodwin 2004). In a meta-analysis of 77 studies from 30 countries, de Jong and Shires (2006) found a cross-sectional elasticity of the VTTS to income of between 0.4 and 0.5 for employers' business purpose. This result could be consistent with higher income "white collar" workers partly substituting leisure rather than work for travel and/or being able to use travel time for partially productive work. The world of mobile communications has clearly made this more plausible over time. It is a concern that EB values of time for passengers (as opposed to freight) may on average be too high.

4.3.2 Travel time savings – other issues

Many transport projects give use to a high proportion of relatively small time savings – say 5 minutes or less. Welch and Williams (1997) showed in an urban case study that between 25% and 50% of time saving benefits from fairly major schemes could be attributed to these small time savings. So, two questions legitimately arise:-

How statistically robust are the traffic assignment models which generate the time difference estimates? For most schemes, we are dealing with relatively small absolute and proportionate differences accruing to very large numbers of travellers over a very long period of time which sum to give a large aggregate value. So the security of the model predictions is an important issue.

Can the constant unit value assumption be relied upon? Most countries use the CUV assumption, and there are reasonable logical defences for it, but it is a weakness that stated preference and similar

choice models rely on extrapolation from larger time savings. Direct empirical support for CUV assumption is therefore lacking.

A second issue concerns the relationship between VTTS and trip distance/duration. In British practice the value of time per minute is assumed constant over all trip lengths. But evidence from other countries tends to support increasing VTTS with trip length, and arguments about driver fatigue, boredom, time requirements at the destination are consistent with that. This is a weak point which could affect the relative performance of different sorts of schemes.

If VTTS does vary with distance, a related question is whether the average values are calculated from a pattern of journeys which are representative. I conjecture that in value of time studies, certain sorts of journey such as very short trips to the shops, or to school; long-distance leisure journeys on holiday; trips by foreign drivers on British roads tend to be systematically underrepresented.

Finally, there is the well-known question of whether VTTS derived from stated preference exercises yield values which relate to the driver's personal value or to the value for the driver and other occupants of the vehicle. This is not easy to be sure of, yet it makes a significant difference whether the values are interpreted as "per person" or "per car".

4.3.3 Transport taxation

Another point of controversy in British appraisal practice is the treatment of transport taxes. In a world of uniform taxes on all goods and services, such as a single rate of value added tax, this would be a non-issue. But in practice, road traffic pays a fuel tax, rather high by international standards, equivalent to around $1 US per litre, while public transport, bus and train, is zero rated for VAT and pays little or no fuel tax. This causes complications for appraisal and is the source of arguments that appraisal practice is inconsistent with policy.

Suppose a new road is proposed which induces additional traffic relative to the base case. This road traffic is willing to pay the generalised time and money costs associated with the additional travel. They gain to the extent of the triangle of benefit (area C in Fig 1). But the figure is drawn on the presumption that the cost the user pays for the marginal trip is wholly a resource cost. That is true of the time cost and the resource cost of extracting fuel from the ground, refining it, distributing it and retailing it. However, the fuel tax element in the final price to the user is not a real resource cost but a transfer payment. CBA principles say this element should appear twice in the appraisal, once as a cost to the user and once as an equal and offsetting gain to Government. Providing the marginal track and environmental costs of use are accounted for elsewhere in the appraisal, this approach is correct. However, it is frequently criticised for appearing to treat as a benefit additional consumption of fuel and carbon emissions which the Government is otherwise targeting or trying to reduce. This is said to be sending mixed messages.

This issue is less about the treatment of fuel tax in the appraisal and more about the appropriate shadow price of carbon. If the fuel tax was set equal to the full marginal external cost of road use, including the economy-wide shadow price of carbon, then the issue would not arise. Here is an example of a case where appraisal rules and transport economics can come into conflict with transport politics.

4.3.4 The benefit : cost ratio

Another issue which has occupied many hours of debate in the NATA Refresh is the definition of the benefit : cost ratio. Returning to table 1, where the elements of cost and benefit were defined, it

may be noted that whereas, given the values for the elements, the Net Present Value of a project is a unique quantity, the value of the BCR depends on exactly what is counted in the numerator and denominator of the ratio. For example, should increases in revenues to transport operators be treated as a producer surplus to be added to the consumer surplus in the numerator or an offsetting item to the cost in the denominator? Should a contribution to the capital cost of a scheme from a private developer be counted as a benefit item or as an offset to the cost, or both? For certain kinds of schemes, especially where toll revenue or road user charging revenue is involved, it makes a huge difference to the BCR what definition is used.

It is therefore worth asking why, given that NPV gives a unique result, it is worth bothering with a BCR with all the problems of defining a ratio. In an unconstrained world in which there was enough funding to undertake all schemes with a positive NPV, the BCR would be redundant. It is in the presence of a constrained budget, a rationed resource, which gives rise to the problem. One solution would be to raise the discount rate to the point at which the supply and demand for funds was equalised. But this would distort the relative social values of present and future benefits and destroy the case for long term infrastructure projects. A minimum cut-off BCR is therefore needed as a rationing device or hurdle ratio which project should be required to jump over.

The denominator, therefore, should be the unit of constrained resource, and the question is how to define it. Suggestions have included public capital costs, net public expenditure, and the net public cost to the Department of Transport and its agencies. The NATA Refresh opted for this last concept. This places fuel tax effects on the numerator of the ratio, since these are effects which, in the British public budget system, accrue to the Government budget as a whole and not to the transport sector budget. This exemplifies the need for appraisal practice to have clearly defined rules in order to operate consistently across applications.

Whatever definition of the BCR is used, however, one criticism remains. The BCR is a summary descriptor of the monetised elements of the overall appraisal. By definition, it does not capture the non-monetised elements. While this is widely recognised, it is all too easy to use the BCR alone as an indicator of relative social value for money. This is fraught with danger if the non-monetised elements in the overall appraisal are variable across the scheme.

5. TRANSPORT AND THE ECONOMY

The interaction between transport and the wider economy, and its treatment in appraisal, is one of the most lively current topics. Historically there are different traditions – for example the German approach has been to view transport infrastructure as a tool of regional planning and to pay relatively little attention to transport CBA in favour of a broader regional impact approach. This is perhaps associated with the strong regional governments in the German political system.

The tradition in the UK has been to rely on transport CBA and to assume that the direct transport benefits are a good proxy for the total economic system benefits. In the last decade, following the impetus of the SACTRA report of 1999, the approach has come in for reassessment. In part, this is technically driven – enhanced computing power makes tools such as Spatial Computable General Equilibrium more practically usable than before, giving a framework in which transport-economy linkages can be represented (see for example Elhorst and Oosterhaven, 2008). But mainly they are politically driven by the desire to demonstrate to decision-makers the impact of transport infrastructure on the final economy. Time savings are the base metal of the system but impact on GDP is the gold.

It would obviously be more convincing to decision-takers if the impact of a piece of infrastructure on the final economy could be modelled and estimated within the appraisal. But this is problematic because transport appraisal is effectively a reduced form means of aggregating the demand curves of thousands of different users, representing all stages of the economic process from primary products to final consumption. Except in very simple situations such as feeder roads to serve agriculture or access roads to mines and quarries it is impossible to estimate directly the final impact on GDP. There is a question mark in any case over whether GDP is the correct metric by which to value transport schemes since it gives no weight to leisure time, or most safety and environmental impacts.

For many years, UK appraisal practice relied on a theorem proved by several authors (Mohring 1976, for example) that in an all-round perfectly competitive economy, the correctly measured direct transport benefits are equal to the final economic system benefits. A judgement was made that it was too difficult to try to discover the size, and even the sign, of the divergence between the two in particular cases. On this account, transport impacts would be mediated through effects on accessibility and land development into changes in the pattern of final output, wages and prices, but except in unusual cases it would be reasonable to assume "no additionality" to the primary transport benefits.

Following the 1999 SACTRA report, this assumption has been revisited by the Department for Transport which has identified three sources of additional wider-economy impacts (conceptually, additional may be positive or negative). These are:

- Agglomeration economies – external economies of access to economic mass not captured 1, individual firms or transport users;

- Imperfect competition benefits due to output effects in markets where prices diverge from marginal costs;

– Labour supply effects and the tax wedge benefits of induced labour market behaviours.

We now review very briefly the state of play on each of these potential sources of additionality.

Agglomeration economies are said to exist when the spatial concentration of economic activity gives rise to increasing returns. These increasing returns arise from labour market pooling, knowledge spillovers, specialisation, and the sharing of inputs and outputs. These considerations explain why head offices of corporations, banks and other enterprises are located in major cities and not in small towns. One way in which the spatial scale of an economy can be effectively increased is through a reduction in the generalised cost of travel. Essentially the argument is as follows: - if there are increasing returns to economic mass, and if transport in part determines the level of access to economic mass experienced by firms, then investments in transport which serve to increase accessibility can induce some shift in the productivity of firms via economies of agglomeration. These are external economies and therefore are additional to the transport user benefits.

Quantifying the relationships is a testing task, but significant recent work has been carried out by Dan Graham of imperial College London. The main points we draw from Graham's work are: -

The principal difficulties in estimating elasticities to economic mass are those of causality and confounding. The causality issue is that accessibility in/to large agglomerations may be high because that is where demand is highest rather than because the higher accessibility has created the agglomeration. Confounding problems arise as the variables of interest are often heavily inter-correlated.

Urbanisation economies are larger than localisation economies. Urbanisation economies relate to proximity to economic mass in general while localisation economies relate to proximity to the economic mass of a particular sector (e.g.: textiles).

The UK's current appraisal guidance is centred around urbanisation elasticities. The guidance, based on Graham, Gibbons and Martin (2009) quotes an overall agglomeration elasticity of 0.04 across all sectors of the economy (doubling city size increases productivity by 4%), with 0.02 for manufacturing and consumer services, 0.03 for construction and 0.08 for business services.

Returns to agglomeration vary not only by sector but with city size. With an accessibility measure based on generalised cost of travel, Graham (2007) found that returns vary across sectors, increasing particularly in banking, finance, insurance, business services and public services. So composition of economic activity in a city of a given size could be significant.

There remain questions around the causal effect of transport infrastructure on productivity. Graham and Van Dender (2009) find that variations in productivity between agglomerations may be entirely attributable to differing qualities of labour between locations.

In a spatial economy with regionalised production of goods and services, reduction in transport costs normally increases competition and reduces market deadweight losses due to imperfect competition and spatial monopoly. These can be measured as the price/marginal cost mark-up applied to the increment of output resulting from the transport improvement.

As with agglomeration, the issues associated with measuring this welfare gain are practical rather than theoretical:

- Estimating relevant market output elasticities and mark-ups; different authors from the SACTRA report (1999) produced results ranging from 4% to 20% of the transport benefit;

- Ensuring that net rather than gross estimates are used. For example, if a road scheme improves the market position of firms inside the study area at the expense of other firms outside the study area, there is a difference between the gross effect on the study area and the net effect on the economy as a whole.

The comparative static approach does not allow for dynamic interactions between transport infrastructure and market structures. It is not implausible that the number of firms in sectors like brewing, fuel oil retailing or supermarket retailing and hence the mark-ups, might vary with the quality of the transport infrastructure.

The third wider impact is also related to the changes in the wider economy induced by a transport improvement. Suppose that the result is either an increase in employment to supply additional output or a reshuffling in the labour market with a more efficient match of people to jobs. People will be making their choices based on their net of tax wage, but the marginal value of their output will be their gross of tax wage. There is a tax wedge benefit equal to the difference between gross and net which is not counted in transport CBA.

As with the imperfect competition effect, there are practical issues in computation:

- The relevant elasticities and the extent to which changes in transport costs are reflected in prices and wages;

- The need to consider this effect not only in the transport-using sectors but in the transport sector itself. Increased transport productivity through higher speeds will in the end result in a smaller labour force required to carry out the base transport activity and the tax wedge effects in the transport sector need to be included in the appraisal.

Beyond these points, the tax wedge argument raises questions about the definition of the numeraire in transport CBA. If it is "one dollar's worth of resources in the hands of the Government" then CBA should be about the value of spending that dollar in different ways. It may be that transport expenditure has *exceptional tax* wedge effects relative to other forms of spending, but conceptually we should be counting the *net tax* wedge effects, not the gross.

To summarise, some progress has been made in the UK towards extending transport CBA to cover the wider economy impacts. However, in parallel with that, there are alternative developments in progress which demonstrate that appraisal methods are linked to the political environment within which transport schemes and policies are developed.

While the Department for Transport's approach has been to modify transport CBA for the three sources of additional benefit, there is renewed interest in alternative methods of estimating the impact of transport investment on city region economies. These are driven by several considerations: - the desire to incorporate land development and induced economic activity and employment in the appraisal effects just discussed, and most important of all the changes in the UK transport budget context. The UK has a tradition of strong central government budgetary control and funding even for local transport projects, so that the position has been quite different from the French "versement transport" arrangements for its major cities. Now, however, since the credit crunch and public funding crisis, there will be much less central funding of local transport capital schemes, and the balance of power will swing towards local economic partnerships. In that context, the question of interest is the

value for money *to the city region* of transport infrastructure relative to housing, regeneration and other budget headings for which the city is responsible. So the question the city fathers will ask is: - what is the effect of a transport scheme on output and employment at city level.

Unfortunately, transport CBA is not well placed to answer this question and therefore other approaches have been used to estimate additional activity measured by Gross Value Added (GVA) (LSE 2009, KPMG 2009 a, b). These approaches are cousins to CBA but focus on:

- The impact of transport improvements on accessibility;
- The relationship between accessibility, real wages and employment at area level – both displacement from other areas and net generation;
- The further relationship to agglomeration in the city region.

Compared with the micro approach of CBA, this is a more meso-economic approach of the kind discussed in previous Round Tables (ITF/OECD 2007, 2008).

It clearly depends crucially on the stability of a few key economic relationships which are themselves problematic for the reasons of causality and confounding mentioned earlier. For Britain, with no great tradition of regional accounting and regional economic modelling, this could be a significant step. However, these approaches are best seen as complementary to CBA; whenever national funding or a national value for money perspective is required the NATA remains the mandatory toolbox.

6. CONCLUDING THOUGHTS

It is comparatively easy to trace the development of transport appraisal in the UK over the last fifty years. Starting from a narrow model in which time and operating costs are traded against capital and maintenance cost, appraisal progressively developed:

- through *refining* the values of user benefits and also safety impacts;
- through *incorporation* of behavioural responses represented as fare and generalised cost elasticities with feedbacks to congestion (car) and overcrowding (public transport);
- through *extension* of the user benefit theorem to cover environmental externalities and wider economic impacts;
- through *application* across transport modes and to policy/investment packages;
- through *creating a climate of opinion* within Government and the profession in which the appraisal regime has a certain independence and results are taken seriously as inputs to decision-making, without supplanting the decision-takers' role.

As a result, it has probably been reasonable to claim that the UK has been one of the leading European countries in transport modelling and appraisal, and that the qualities of independence and analytical capability have served UK consultants well in international markets.

And yet, it would be difficult to assert that the transport sector is the crowning glory of the British economy. This is partly due to history and geography which created particular challenges for the UK. But it is also a reminder that transport policy is shaped mainly by politics – central and local government structures, the planning system, the availability of public finance, policy towards tolls, fares and charges or sources of sector revenue, attitudes to public transport revenue support, privatisation and regulation. Appraisal is a useful tool within an overall policy context, but no more than that.

The strength of transport cost-benefit analysis is its link with modelling and basic traffic data which, provided growth scenarios are credible, maintains a strong sense of realism in the assessment. However, the current low discount rate (3.5%) and lengthy appraisal period (sixty years) create major intellectual problems in coping with capacity limits in future years. The weakness is the upward link to regional economic planning and forward strategy. The British have always had a resistance to the top-down master planning approach, preferring bottom-up incremental development.

In the context of very scarce public finance, peak oil, and seriously difficult targets for carbon emissions the content of transport policy is likely to change in the next period – towards policies relating to reliability and resilience, towards electricity and away from fossil fuel dependence, towards the city regions and away from the national network, towards a more integrated economic development approach. Transport appraisal will need to evolve in order to serve these changing needs. This is the next challenge for transport appraisal people.

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