

# Transport Research Series

Review of Economic Assessment in  
Rural Transport Appraisal

# **REVIEW OF ECONOMIC ASSESSMENT IN RURAL TRANSPORT APPRAISAL**

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## **ABBREVIATIONS**

DfT	Department for Transport (Westminster)
EALI	Economic activity and location impacts
FTE	Full-time equivalent
GDP	Gross Domestic Product
ITS	Institute for Transport Studies
NUV	Non-use value
OFT	Office of Fair Trading (Westminster)
OV	Option value
PVB	Present Value of Benefits
PVC	Present Value of Costs
SACTRA	Standing Advisory Committee on Trunk Road Assessment
STAG	Scottish Transport Appraisal Guidance
TEE	Transport economic efficiency
webTAG	Transport Analysis Guidance website
WEB	Wider economic benefits
WB1	Wider economic benefit due to imperfect competition
WB2	Wider economic benefit due to pro-competition effects
WB3	Wider economic benefit due to agglomeration
WB4	Wider economic benefit due to labour supply effects
WTP	Willingness to pay

# **EXECUTIVE SUMMARY**

## **Introduction**

This review is part of Transport Scotland's ongoing commitment to the maintenance of the Scottish Transport Appraisal Guidance (STAG). Its aim is to consider the tools and procedures presented in STAG for appraisal against the Economy Criterion and assess their application in the context of rural transport schemes.

The Scottish Government definition of a rural settlement is one in which the population is below 3,000 people. The distinguishing aspect of such an environment is a lack of alternatives and choices. Travel choices are limited and in the rural economy choices of employment, opportunities to fill vacancies and choices of supplier are also limited. These characteristics lead to this review concentrating on four core areas:

- (1) Scheduling costs;
- (2) Option and non-use values;
- (3) Value of induced traffic; and
- (4) Rural wider economic benefits.

These four economic concepts are generic. That is they are general economic concepts and do not specifically pertain to the rural environment. They are, however, expected to be much more relevant to rural areas than urban areas – as they focus on a lack of choices – though there will be some urban situations where one or more of the above concepts are applicable. Similarly they are also expected to be relevant to some small towns.

## **Scheduling costs, welfare benefits and induced traffic**

Scheduling costs are welfare costs imposed upon activity scheduling. Within a transport context they arise as transport constraints prevent activities being undertaken at the desired time or for the desired duration. They are most relevant to situations where public transport departure times are infrequent. Scheduling costs, like travel time costs, form an impediment to travel and therefore improvements in transport quality that reduce these costs can give rise to induced traffic.

Evidence that scheduling costs exist can therefore be seen indirectly through changes in patronage for transport services where quality has been improved (e.g. increased frequency, longer operating day) but where the direct costs (travel times and fares) remain unaltered. For example: improvements in frequency on rural rail, ferry and bus services have been seen to increase patronage by up to 42%.

There is also a substantial literature on proxies for the marginal value of scheduling costs, such as the marginal value of headway. For rail, such marginal values are embodied in the rail industry's Passenger Demand Forecasting Handbook. There is also a reasonable amount of evidence related to scheduling costs in the bus sector. There is much less evidence on the marginal value of scheduling costs for the ferry and air modes and also for long headways and short operating days (all modes).



Scheduling costs can be very relevant to the economic assessment of a transport intervention. As such they are often included in rail scheme appraisals, through the mechanism of generalised journey time. In contrast this review was not able to identify a single instance where they were included in an economic appraisal of a ferry enhancement or the construction of a fixed link. Their relevance to ferry/fixed link projects and air services projects is illustrated with the following two case studies.

*Case study 1a: Berneray Causeway and Sound of Harris Ferry:* scheduling benefits are 50% of the time and ferry fare savings to Berneray traffic and 14% of the time savings to Sound of Harris ferry traffic.

The inclusion of scheduling cost reductions (as well as changes in car occupancy), in a re-worked estimate of demand for the Berneray Causeway, substantially improves the demand forecast relative to the ex-ante study (compared to the realised demand).

*Case study 2: Air services in the Highlands and Islands.* This project considered a substantial increase in frequency of air services in the Highlands and Islands as well as fare reductions. Scheduling benefits form 51% of the Present Value of Benefits (PVB) if the PVB is estimated from only time and air fare savings.

The inclusion of scheduling costs can, therefore, have a significant impact on the estimate of the economic assessment but also the demand forecasts. The latter point is also important as it has implications for the appraisal of a project under the STAG safety and environment criteria.

## **Option and non-use values**

Option and non-use values give rise to individuals and households being willing to pay more for a good than the benefit they would expect to derive from consuming it. Option values relate to the willingness to pay to preserve the option of using a transport service, whilst non-use values relate to the willingness to pay to maintain a transport service irrespective of intended use.

There is only limited evidence on option and non-use values with only 6 studies being reported internationally. Three of these are from the UK. All the studies emanate from university research and aside from one Dutch study have small sample sizes. The results of the studies whilst exhibiting a large range are comparable once differences between the studies are taken into account. These differences include whether the option and non-use value relates to a household or an individual, whether alternative public transport options exist, the mode of transport in question and the level of service offered by the transport service.

*Case studies 3 to 7:* Five rail case studies identify that option and non-use values can contribute between 4% and 117% of the PVB of a rail project. This is a substantial variation and relates specifically to the level of use made of the rail service (and, therefore, user benefits). Where rail patronage is low option and non-use values can form a substantial element of the PVB, where patronage is strong

(and user benefits are likewise strong) the inclusion of option and non-use values in an economic assessment has a minimal impact on the PVB

## **Value of induced traffic**

In low income areas induced traffic may be viewed as a positive outcome of economic growth. It is, therefore, important to ensure that it is valued appropriately in an economic appraisal.

STAG advocates that the value of the transport intervention to the existing traffic and the induced traffic is the change in consumer surplus. This is consistent with applied cost benefit analysis theory and practice.

It is unusual to know the exact shape of the demand curve and, therefore, STAG, by adopting the Rule of Half convention, assumes a linear demand curve. This assumption overestimates the benefit of transport project. The overestimation is acceptable if the change in generalised cost is small or medium (i.e. < 33%).

When generalised cost changes are large the overestimation may also become large (>10%). This is because the error associated with assuming a linear demand curve becomes increasingly larger as the cost change increases, but also because if benefits are large relative to incomes the true measure of economic benefit may be significantly smaller than the change in consumer surplus. Some methods are available (numerical integration and direct integration) to more accurately identify the benefits to existing traffic in the presence of large cost changes. These methods can be quite resource intensive.

As already mentioned increased output and employment in rural areas is typically viewed very positively. If increases in business traffic and commuting traffic associated with these increases in economic activity are thought to have added value to user benefits, this should be captured through wider economic benefits, as discussed below, and not through an adjustment to the calculation of user benefits.

## **Rural wider economic benefits**

Transport schemes are expected to have impacts in markets other than transport (e.g. the labour market, product market, land market, etc.). These impacts are only additional to changes in transport user benefits, in a welfare sense, if a market failure occurs. STAG already identifies a number of market failures, of which three were reviewed in this study within a rural context. Two further market failures in the labour market were identified from the international literature.

*Agglomeration effects.* This effect concerns the fact that transport improvements can bring about productivity changes larger than would be implied by the transport efficiency savings alone. In rural areas they may be relevant when linking a remote small town to a large agglomeration or addressing particular industrial clusters.

*Imperfect competition.* Product and services markets in very remote areas are more imperfect than the equivalent markets in more accessible areas. This is as a result of geographic isolation. Evidence from the supply of petrol in the Highlands and

Islands would suggest that price-cost margins in very remote areas are double those in more accessible areas. A mark-up to business user benefits of 20% (i.e. double the mark-up for accessible areas) is suggested for very remote rural areas and very remote rural small towns.

*Pro-competitive effects:* No further evidence on pro-competitive effects to that detailed in Department for Transport guidance has been found.

*Excess labour supply effects:* It is considered that out-migration from rural areas ensures that there is no excess supply of labour in rural areas. There is, therefore, no market failure.

*Thin labour market effects.* Search costs in thin labour markets give rise to a market failure in remote and very remote labour markets. The creation of employment in remote and very remote areas, therefore, has a welfare impact greater than that captured through commuter user benefits. It is suggested this impact is equivalent to 20% of the gross wage for new jobs created. When incorporating these benefits into an appraisal it is also necessary to take into account the welfare costs of displaced jobs.

The link between the EALI component of the appraisal and other aspects of the appraisal (the transport planning objectives and the TEE) can sometimes be weak. The link can be strengthened in two ways. Firstly, the inclusion of thin labour market effects means that the EALI job creation impacts are included in the calculation of the TEE. Secondly, where transport planning objectives have an economic focus the link to the EALI could be enhanced through the calculation of cost effectiveness measures. The measures suggested are the public sector cost per regional job and public sector cost per £1.00 of regional GDP.

*Case study 1(b) Berneray Causeway and Sound of Harris Ferry:* Wider economic impacts form a substantial 19% of user benefits (measured as the sum of time and cost savings) and 14% if scheduling costs are included. The cost effectiveness indicators are £91,000 of public sector expenditure per FTE job and £0.47 of public sector expenditure per £1.00 of regional GDP growth.

*Case study 8: A82 Crianlarich to Fort William:* the inclusion of wider economic impacts increases the overall benefit of the project by 28%. The cost effectiveness indicators are £103,000 of public sector expenditure per FTE job and £0.43 of public sector expenditure per £1.00 of regional GDP growth.

## **Conclusions**

A lack of alternatives distinguishes rural areas from urban areas. This means that economic impacts that specifically relate to a lack of choices (i.e. scheduling costs, option and non-use values and some wider economic impacts) may well be relevant to the appraisal of a rural scheme. There is evidence that positive values can be attributed to each of these impacts. The evidence base is most extensive for scheduling costs, whilst it is quite narrow for option and non-use values and wider economic benefits. The review has also confirmed that an appropriate way to

include the value of induced traffic in an appraisal is through the use of the Rule of Half convention.

Applying the evidence base to case studies demonstrates that the inclusion of scheduling costs, option and non-use values and wider economic benefits in an appraisal can have a marked impact on the predicted economic benefit. This indicates that consideration should be given to including each of the impacts in any update to STAG. The varied quality of the evidence base, however, suggests that option and non-use values and wider economic benefits should only be included as a sensitivity test.

Future research needs for scheduling costs, option and non-use values, the measurement of user benefits and wider economic benefits are identified.

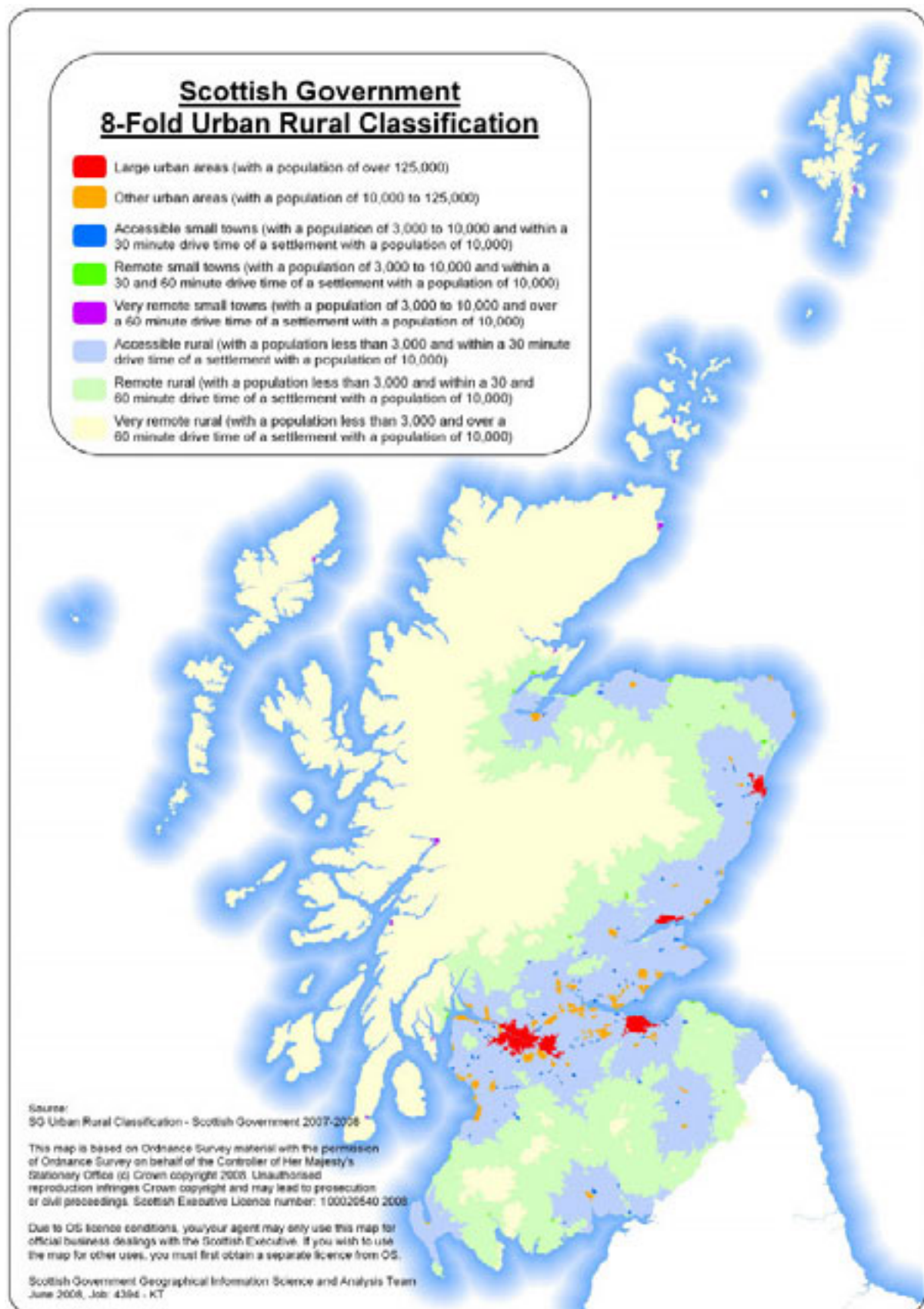
# 1 INTRODUCTION

- 1.1 Dr James Laird and Professor Peter Mackie of the Institute for Transport Studies, University of Leeds were commissioned by Transport Scotland to review economic assessment methods in rural transport appraisal. The study is part of Transport Scotland's ongoing commitment to the maintenance of STAG. Its aim is to consider the tools and procedures presented in STAG for appraisal against the Economy Criterion and assess their application in the context of rural transport schemes.
- 1.2 The distinguishing aspect of a rural transport environment is a lack of alternatives and choices. Travel choices are limited in mode, departure time and route. In the rural wider economy choices of employment, opportunities to fill vacancies and choices of supplier when purchasing goods and services are also limited. This, combined with long distances of travel, the reliance of communities on what is often a single link, and the vulnerability of these links to inclement weather and subsidence, places a burden on businesses and residents in rural communities. This is explicitly reflected in government economic and transport policies which recognise both the role of transport links in sustaining remote and fragile communities (e.g. Scottish Executive, 2006 p.19) and the need to achieve a better regional balance in wealth (e.g. Scottish Government, 2007 pp.36-39).
- 1.3 The lack of alternatives and choices in a rural environment mean that rural areas differ in certain respects from cities and urban areas. This is important as the economic assessment methods embedded in STAG and its English counterpart were pioneered on busy inter-urban routes and further developed to encapsulate the economic impact of transport projects in cities including that of generated traffic and productivity growth (e.g. SACTRA 1986; 1994; 1999 and Eddington 2006). Whether the economic assessment methods implemented within STAG should be enhanced for a rural context is a relevant question and central to this study.

## Scope

- 1.4 The Scottish Government definition of a rural settlement is one in which the population is below 3,000 people (Scottish Government, 2008). The lack of choices faced by those living in a rural area is often also felt by those living in small towns remote from the main urban centres. For this reason the scope of the review encapsulates transport interventions in rural and small town environments in accessible, remote and very remote areas (as illustrated in Figure 1.1). It should also be noted that the economic concepts discussed in this review are generic concepts that can be applied to both rural and urban environments. It is, however, expected that the concepts and issues related to them are far more prevalent in rural areas than in urban areas.

**Figure 1.1: Scottish Government 8-Fold Urban Rural Classification**



Source: Scottish Government (2008, p.12)

- 1.5 All transport modes are considered as relevant, though the nature of the impacts considered in this review, mean that the review is of more relevance to motorised travel (car, bus, rail, ferry and plane) rather than non-motorised modes (walking and cycling). Thus the illustrative case studies used in the report include road infrastructure, rail, ferry and air projects.
- 1.6 The starting point for the review is a robust economic appraisal undertaken in accordance with STAG. The STAG economic appraisal methods centre on reporting the economic impact of a transport project under three criteria briefly described below.
- Transport Economic Efficiency (TEE) which focuses on the welfare benefit of a project. The benefit categories are a mixture of user benefits (travel time savings, vehicle operating cost savings and fare savings) and external costs (safety and the carbon). The user benefits are the change in consumer surplus experienced by users and are estimated using the Rule of Half convention.
  - Wider Economic Benefits (WEBs) are the welfare benefits additional to transport user benefits arising as a consequence of failures in markets impacted upon by the transport intervention (e.g. the labour market and the product market). The WEBs considered in STAG (agglomeration effects, pro-competitive effects, imperfect competition effects and labour supply effects) stem from three sources of market failure in the product and labour markets. These are agglomeration externalities, market power arising through product differentiation or geographic isolation and the presence of a labour tax.
  - Economic Activity and Location Impacts (EALIs) are the impacts on population, employment and income of the transport intervention. These impacts need to distinguish between gainers and losers and disaggregate between study area (i.e. local or regional) impacts and national impacts. The analysis, by its nature, is quite detailed and needs to consider different industrial sectors and impacts on competitiveness, labour markets and land/property. Its role in the economic appraisal lies more towards the spatial distribution of impacts and their scale rather than toward efficiency.
- 1.7 STAG is a framework document. It identifies benefits and costs to be included in an appraisal and specifies economic values to be used (e.g. values of travel time savings). The level of detail that an appraisal adopts is for the scheme promoter to decide and will be subject to the complexity of the transport problems being addressed. STAG does not dictate the demand modelling form nor the data to be used in an appraisal, though a robust appraisal must be defensible. A robust STAG economic appraisal, therefore, needs to account for the local characteristics of a transport intervention. All localities, transport schemes and, therefore, appraisals have unique attributes. Aspects of rural transport schemes that may need particular attention in some appraisals include:
- Treatment of vehicle operating costs: where road quality is very poor vehicle operating costs may exceed that predicted by the standard

vehicle operating cost formula. Similarly where labour costs are low vehicle maintenance costs may be cheaper. A survey of vehicle operators (e.g. haulage firms) and garages may be required. Datasets such as the family expenditure survey can also be informative.

- Treatment of road maintenance. Particular characteristics of rural areas, including geography and weather, and the appropriateness of the existing link for the traffic using it may lead to road maintenance costs that differ from those referred to in STAG – due to, for example, differences in subgrade on peaty ground and/or the effect of coastal environment. Use of a different maintenance cost profile can be derived through engineering cost data.
- Treatment of tourist traffic. If tourist related traffic (e.g. coach tours) will be an important element of induced traffic, a bespoke demand forecasting approach might be needed to analyse this component of the traffic (e.g. through a survey of tour operators and tourists).
- Risk and uncertainty: when comparing revenue projects (such as ferry services) with capital projects (such as fixed links) it is important to ensure that risks in, say, ferry operating costs (e.g. due to the price of marine fuel and labour costs) and the capital cost of the fixed link are appropriately assessed. There is also a need to consider any risk associated with the *ad infinitum* continuation of a subsidy to the 'revenue' option (say a ferry service). Reduction or withdrawal of the subsidy will affect fares, service levels and user benefits. The inappropriate treatment of the different risks in the appraisal may bias the appraisal to either the revenue option or the 'capital' option.

1.8 As the above discussion highlights characteristics in rural areas will differ from urban areas, but it should be noted that costs may be either higher or lower. It cannot be stated *a priori* that cost will be worse or better in rural areas.

1.9 The above list is accommodated within the existing STAG framework. A robust STAG appraisal would, therefore, include these effects within it, if they are relevant. Such a discussion of the above effects does not fall within the scope of this work. This work is focussed around whether any benefit categories, that are important in a rural context, are not captured by current economic assessment tools in STAG.

1.10 This focus leads to a concentration on the principal characteristics of rural areas that differ from those of urban areas. As previously mentioned, the main distinction between the two area types is a lack of choices or a lack of alternatives. We also often find that incomes and economic growth are lower in remote rural areas. These characteristics lead to this review concentrating on four core areas:

- (1) Scheduling costs: these are the welfare costs imposed upon activity scheduling. Within a transport context they arise as transport constraints prevent activities being undertaken at the desired time or for the desired duration. They are most relevant to situations where public transport departure times are infrequent;



- (2) Option and non-use values: these are the values that individuals and households place on having the option to consume – i.e. some form of insurance premium – and the value that they place on a good without consuming it. The lack of transport alternatives in rural areas mean that option and non-use values may be relevant in these areas;
  - (3) Value of induced traffic. In low income areas induced traffic may be viewed as a positive outcome of economic growth. It is, therefore, important to ensure that it is valued appropriately in an appraisal; and
  - (4) Rural wider economic benefits. Rural areas tend to be isolated and this leads to a lack of choices between suppliers and between employers. Consequently the product and labour markets in rural areas may well be more inefficient than in urban areas, leading to differences in the wider economic impacts between the area types.
- 1.11 It is worth reinforcing an earlier point that the above economic concepts are generic. That is they are general economic concepts and do not specifically pertain to the rural environment. As they are primarily related to a lack of choice, and choices are typically more restricted in rural areas, they are expected to be much more relevant to rural areas than urban areas. There will, of course, be some urban situations where one or more of the above concepts are applicable. This review, however, focuses exclusively on their application to the rural and small town environments.
- 1.12 The review considers earlier work by commissioned by HITRANS (Reference, 2007) and HIE (Laird, Mackie and Nellthorp, 2004) which considered appraisal issues in remote and very remote areas. It also draws heavily from the recent research completed at the University of Leeds as part of James Laird's PhD (Laird, 2008). We also note that there is an extensive literature on the appraisal of rural transport projects in developing countries - e.g. the TRL overseas guide to road project appraisal (TRL and DfID, 2005) and the World Bank Toolkit (Laird *et al.*, 2003). We do not draw on this during the course of the review, as Scotland, by comparison, has a mature transport network and economy.

## Consultation

- 1.13 As part of the review we contacted a number of Regional Transport Partnerships (four in total) and local authorities (eleven in total) with an interest in rural transport appraisal. We also contacted Highlands and Islands Enterprise, the Department for Transport and researchers and practitioners in Scandinavia (Denmark, Finland, Norway and Sweden). Our points of contact and whether we received a response is detailed in Appendix A. The objective of the consultation exercise was to augment the available information and evidence on economic impacts in a rural context, considered in the review, other than that already included in STAG.
- 1.14 A limited response was received to the consultation exercise, particularly from the local authorities. This may, in part, be due to some local authorities undertaking relatively fewer STAG appraisals, and, therefore, having more limited experience upon which to base comments.

- 1.15 More opinions regarding STAG came forward from Regional Transport Partnerships. Views were expressed that STAG methods often returned low economic benefits from what were thought to be good transport projects. Furthermore, it was clear from discussions with local authorities and the Regional Transport Partnerships that the STAG methods are sometimes treated as “*de facto* standards”. Some of the discussions during the consultation regarding the reason for the apparent low value for money of schemes therefore often centred around implementation issues – some of which have been alluded to in the previous section, but all of which are outside the scope of this review. No one had commissioned research to quantify any ‘missing’ rural benefits which could then be considered in the review.
- 1.16 It was also clear that economic growth can be an important objective of transport projects in rural areas. In these instances some of the consultees felt that the EALI should have a stronger role to play in the decision-making process. There was, therefore, a feeling amongst some respondents that the link between the EALI and other components of the economic assessment (and, therefore, the whole decision-making process) was weak.
- 1.17 Our Scandinavian contacts indicated that their ‘national’ economic appraisal procedures were similar to STAG. That is aside from external costs, such as safety and carbon, economic benefits are calculated as the user benefits accruing through travel time savings, vehicle operating cost savings and/or fare/toll savings. The exception is Norway where ‘inconvenience costs’ are also included in the appraisal of fixed links. The chapter on scheduling costs, therefore, draws on this Norwegian evidence.

## **Report structure**

- 1.18 Following this introductory chapter, Chapter 2 reviews the evidence on scheduling costs, whilst Chapter 3 reviews the evidence on option and non-use values. The value of induced traffic is discussed in Chapter 4 and wider economic benefits in rural areas are discussed in Chapter 5. Chapter 6 presents the conclusions.

## **2 SCHEDULING COSTS: WELFARE BENEFITS AND INDUCED TRAFFIC**

### **Concept**

- 2.1 Scheduling costs, in a transport analysis context, are the welfare costs imposed upon activity scheduling by transport constraints. They arise as transport constraints prevent activities being undertaken at the desired time or for the desired duration. Hägerstrand (1970) is credited with identifying the importance of temporal-spatial constraints in determining economic behaviour (including travel behaviour), whilst the seminal paper by Small (1982) sets activity scheduling in a transport context. There now exists a large literature on activity-based travel analysis (for a review see Kitamura, 1998; Axhausen and Gärling, 1992).
- 2.2 If generalised cost is specified only as the sum of time (including interchange and wait time) and financial costs (including vehicle operating costs), it may exclude a significant element of welfare costs when scheduling costs are large. From an appraisal perspective the relevant question then becomes whether the exclusion of scheduling costs is important. Where services are reasonably frequent and operating hours are also reasonable the exclusion of scheduling costs from generalised cost is unlikely to be an issue. That is the unobserved component of generalised cost (the scheduling costs) tends to zero when frequencies are high and/or there are alternative services or routes. This is because changes in travel time and interchange time or wait time (e.g. waiting at the pier for a ferry) are included in the specification of generalised cost and these will capture the welfare benefits of switching time between activities. It is when headways are long and operating hours are short that their exclusion is likely to be most acute. In these situations improvements in frequency and operating hours may result in no change in travel time, or queuing and interchange time (as say the arrival time at the ferry pier is planned) but still lead to a re-scheduling of activities. In these circumstances welfare benefits are, therefore, experienced but are not captured in the generalised cost specification.

### **Evidence**

#### ***Indirect evidence – level of induced traffic***

- 2.3 Indirect evidence that scheduling costs can be an important component of generalised cost can be found in ex-post data on the level of induced traffic generated by a transport intervention. Induced traffic is additional traffic that is attracted to the network (by time period and mode) arising through trip re-timing, re-distribution, mode switching, changes in trip frequency and 'pure generation' (SACTRA, 1994). This is illustrated in Table 2.1.

**Table 2.1: Travel behaviour response to change in transport quality and traffic categories**

Behavioural response	Traffic categorisation
Base traffic Re-routeing Wide area re-assignment	Fixed demand
Re-timing Re-distribution Mode switching Trip frequency 'Pure generation'	Induced traffic (variable demand)

- 2.4 This ex-post evidence is most compelling where the transport intervention increases transport availability (e.g. increases frequency or operating hours), but gives no change in travel time or out of pocket costs. This is because a generalised cost specification that excludes scheduling costs would suggest the transport intervention would have no impact on demand, yet ex-post data demonstrates a significant increase in demand occurs. We, therefore, draw on a number of studies below to illustrate the importance of including scheduling costs in determining realised travel demand.
- 2.5 **Rail:** Invernet 1 was implemented in 2005 and substantially increased rail services to settlements immediately north of Inverness. 5 new services per day were introduced to Beauly, Muir of Ord, Dingwall, Alness and Invergordon. For Beauly, Muir of Ord and Dingwall this represented a 60% increase in the number of trains per day (from 8 trains per day), whilst for Alness and Invergordon this represented a 125% service level increase (from 4 trains per day). There was no change in journey time or fares from or to these stations. For example, the majority of stations north of Inverness have experienced a 25% or greater increase in demand with the largest increases occurring at Invergordon (42%) and Muir of Ord (32%) (DHC, 2008 Appendix A p.39).
- 2.6 **Bus:** Service enhancements and improvements in bus quality have led to a significant increase in demand on three bus corridors in Aberdeenshire. For example, for the Stonehaven to Aberdeen service, demand increased by 18.7% as a consequence of an increase in service frequency from between 2 or 3 buses an hour in the inter-peak to 4 buses an hour plus the introduction of new vehicles and the provision of better through travel (for trips between Montrose and Aberdeen) (Aberdeenshire Council, 2009).
- 2.7 **Ferry:** In 2003 the Islay ferry service was enhanced in the summer months to provide an increased number of return sailings (26 per week instead of 19) and extended hours of operation. This led to a 20% growth in passenger traffic, an 18% growth in car traffic and a 10% growth in freight traffic (Reference, 2007 p.7). Further evidence on the existence of scheduling costs for ferry services is provided by Greig and McQuaid (2005). They estimate

frequency elasticities of demand by analysing patronage on ferry services serving islands with similar populations but with different fare pricing structures and service frequencies. On the basis of this analysis they attribute an elasticity of just over 1 for five of the ferry services that serve the Western Isles. An elasticity of demand of 1 implies that a doubling in frequency will double demand. Existing service frequencies are too low for a doubling in service frequency to affect anything but scheduling costs, therefore the increase in demand arises due to the alleviation of transport related scheduling constraints.

- 2.8 **Fixed link:** Significant levels of induced traffic have been observed on three fixed links in the Outer Hebrides (Reference, 2007 pp.3-5). On Scalpay bridge the vehicular traffic in 2006 is 13 times higher than the volumes carried by the ferry in 1996, whilst the traffic volumes using the Berneray causeway in 2006 are almost 6 times larger than the traffic carried by the ferry in 1994<sup>1</sup>. The level of induced traffic on the Eriskay causeway is even larger – 4,000 vehicles in 1998 to 88,000 in 2003/4. That is traffic volumes have increased by a factor of 22<sup>1</sup>. In comparison with the rail, bus and ferry examples above travel time reductions, queuing time reductions and ferry fare savings are significant contributors to the reduction in generalised cost and therefore the increase in travel demand. The levels of induced traffic though are so large, and also exceed the ex-ante forecasts that were based on time and cost savings (e.g. Halcrow, 1996), that it is felt savings in scheduling costs have played a significant part in the creating the levels of demand observed today.

### ***Direct evidence – marginal value of scheduling costs***

- 2.9 Scheduling costs with their impacts on the timing and duration of activities mean individuals value changes in departure time and transport availability (e.g. changes in service headway and operating hours). On this basis Table 2.2 summarises some illustrative studies from the literature on these attributes. For presentational and comparability purposes the valuations in these studies have all been converted to equivalent in-vehicle time minutes (IVT-mins), except for the two air studies where values of time are not available (Scott Wilson Kirkpatrick, 2004; McGregor and Laird, 2005). The valuations presented relate specifically to scheduling costs or the costs of not having complete travel flexibility. It should be noted that for the bus and rail modes there exists a substantial evidence base on values of service quality. Noted UK collations of this are the *Passenger Demand Forecasting Handbook* (PDFH) for rail (ATOC, 2002) and the TRL publication *The Demand for Public Transport: A Practical Guide* (Balcombe *et al.*, 2004).
- 2.10 There have been a large number of studies on the marginal value of headway (for a review see Wardman, 2004). At low frequencies (large headways) the valuation of a change in headway is driven principally by a change in scheduling costs. Contrastingly, headway valuations at high frequencies are driven by use costs. It should of course be noted that because elements of use costs (e.g. wait time) will always be present in headway valuations, headway values do not offer a precise measure of scheduling costs. There is

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<sup>1</sup> Excludes inter-island spinal route traffic using the Sound of Harris ferry or the Sound of Barra ferry.

also a body of evidence associated with departure time choice (for a review see De Jong *et al.*, 2003).

As can be seen from Table 2.2 there is substantial variation in the values. Values vary by whether the trip is work related or non-work related and, importantly, also with distance. The longer the distance travelled the lower the value that a traveller places on improvements in frequency (or reductions in headway). Wardman (2004) and ASEK (2000) explicitly separate values by distance, but the results from Bates *et al.* (2000 cited in ATOC 2002 Table C4.1) can also be considered to exhibit some variation by distance. This is because train operators such as Virgin cater for the long distance market, whilst train operators such as Connex cater for the short distance market. Looking at the ferry and fixed link studies variation by trip distance also exists, with values associated with a 1 hour reduction in ferry headway ranging from zero equivalent in-vehicle time minutes to 34 minutes.

- 2.11 Only Laird (2008) for ferries and McGregor and Laird (2005) for air services present values explicitly associated with increasing the length of an operating day. This is because the Danish fixed link studies considered replacing a 24 hour ferry service with a fixed link, and the Norwegian study bundles changes in headway and operating hours together.
- 2.12 The studies discussed above, whilst valuing scheduling costs indirectly, do not specifically focus on the costs or benefits of activity re-scheduling, that is the specific costs or benefits of altering the time when an activity is undertaken, the duration of that activity or even the replacement of that activity with another activity. Wilson (1989) analysed the costs to workers who started work in the off-peak and found that allowing them to adjust the time they start work towards the peak had a similar value to that of travel time savings. Thus a shift of, say, 30 minutes earlier in their work activity schedule was comparable to a 30 minute travel time saving. Thus, transport projects that allow an adjustment of activity schedules can give rise to significant benefits, other than pure use costs.

**Table 2.2: Literature survey: value of changes in frequency, headway and operating hours**

Study/Mode	Units	Work Trips	Non-work Trips
<b>Bus and rail</b>			
		<b>Equivalent in-vehicle time for a 1 hour reduction in headway</b>	
Wardman (2004 Table 12)	Meta-analysis of public transport values of time from 171 British studies	Trips 2km length: 53 Trips 200km length: 15	Trips 2km length: 43 Trips 200km length: 12
ATOC (August 2002 Table B3.4)	UK rail guidance (PDFH): Penalty costs with headways	90 mins to 30 mins 120 mins to 60 mins 180 mins to 120 mins	Full fare: 25 Reduced fare: 12 Full fare: 24 Reduced fare: 12 Full fare: 24 Reduced fare: 12
ASEK (2000)	Swedish appraisal guidance	Regional: 37 Inter-regional: 29	Regional: 17 Inter-regional: 13
Laird and Whelan (2007 Appendix E)	Quality Bus Model SP data analysis	Not surveyed	From headway 120 mins to headway 60 mins Commuters: 22 Non-commuters: 32
		<b>Equivalent in-vehicle time for a 30 minute reduction in schedule delay (equivalent to a 1 hour reduction in headway)</b>	
De Jong <i>et al.</i> (2003)	Departure time choice study (Netherlands)	30 - 45	
Bates <i>et al.</i> (2000, cited in ATOC 2002 Table C4.1)	Punctuality and reliability study for UK rail services	7 (Central) to 29 (Connex)	2 (Virgin) to 19 (Central)
<b>Air</b>			
		<b>Value of a change in frequency per day (low frequency)</b>	
Scott Wilson Kirkpatrick (2004 p55)	SPASM - UK air demand forecasting and evaluation model	£ (1998 behavioural values)	From 1 to 2 departures/day: £10.80 From 1 to 3 departures/day: £19.80 From 1 to 4 departures/day: £27.30 From 1 to 5 departures/day: £33.60
McGregor and Laird (2005)	Air services in the Highlands and Islands, Scotland	£ (2004 behavioural values)	1 to 2 flights per day £69 Day return trips (8 hrs at destination) £83 1 to 2 flights per day £38 Day return trips (8 hrs at destination) £29

**Table 2.2 (Contd): Literature survey: value of changes in frequency, headway and operating hours**

Study/Guidance		Units	Equivalent In-Vehicle Time (mins)	
			Work Trips	Non-work Trips
Ferry and fixed links				
Periodic departures to continuous departures (ferry to fixed link)				
Bråthen and Lych (2004) (derived from Bråthen and Hervik, 1997)	Proposed guidance for Norwegian ferry and fixed link appraisal	Car veh-mins	Ferry to city centre: 2.2 Other ferry: 6.9	Ferry to city centre: 4.4 Other ferry: 13.8
Equivalent in-vehicle time for a 1 hour reduction in headway				
Daly <i>et al.</i> (1998)	Great Belt Bridge, Denmark	Person-mins	16	No data - Frequency model
FTC (1998)	Fehrman Belt Bridge, Denmark	Person-mins	19	15
COWI <i>et al.</i> (1999)	Oresund Bridge, Denmark	Person-mins	Short distance trips (p.16) Long distance trips (p.67 Table 11.3)	34 2
Laird (2008)	Outer Hebrides: Sound of Harris and Sound of Barra ferries; and Scalpay, Berneray, Eriskay and Vatersay fixed links	Car veh-mins	Not surveyed	Long distance trips (Table 5.12) Headways < 3hrs: 0 Headways ≥ 3hrs: 8.4 Short distance trips (Table 6.23) Headways > 30 mins and < 60 mins: 25.2 Headways ≥ 60 mins 4.2
Equivalent in-vehicle time for a 1 hour change in operating day				
			Not surveyed	Long distance trips (Table 5.12) Op. day is 8hrs : 2.4 Op. day is ≥ 12 hrs: 0.8 Short distance trips (Table 6.23) Op. day is 8hrs : 1.3 Op. day is ≥ 12 hrs: 0.7

Adapted from Laird (2008 Table 2.1, Table 5.12 and Table 6.23)



- 2.13 Another feature regarding the empirical data available is that there is very little data on low frequency services. This can be illustrated by Wardman's review. He reviewed 171 value of time studies from the UK and identified 49 studies that considered headway - giving rise to 159 valuations of headway. However, only 5 of these valuations were associated with headways of 1 hour and none were associated with headways over 2 hours. The PDFH also provides no advice on headways over 3 hours duration, whilst the Danish and Norwegian fixed link work relates to crossings which previously had high frequency ferries (a minimum of 2 ferries an hour).
- 2.14 To summarise, there is a large body of evidence that indicate scheduling costs exist. In the main this evidence focuses around the bus and rail public transport modes and for values of headway less than 2 hours. There is much more limited evidence for the air and ferry modes, for the value of increasing the operating day and the value of headways greater than 2 hours.

## **Relevance of scheduling costs to transport appraisal**

### ***Using the research evidence base***

- 2.15 Scheduling costs have relevance when transport induced constraints impact on activity patterns including activity start times, durations and which activities are undertaken. This emphasis on timing means they have most relevance to transport appraisals in temporally thin networks. That is transport networks that are thin in terms of departure time choice. This leads to a focus on public transport networks when including scheduling costs in an appraisal. There are, of course, instances where long journey times arising through limitations in route or mode choice will also give rise to scheduling costs, but in the main restrictions in departure time choices will be the primary driver for scheduling costs.
- 2.16 As has been discussed, there is a close relationship between headway and queuing time (a use cost). For example a small change in ferry headways at long headways (e.g. 4 hours to 3.5 hours) will not change planned arrival times at the pier. A survey of willingness to pay for such a headway change would therefore provide an estimate of scheduling costs alone. In comparison at much lower headways (e.g. less than 30 minutes) arrival times are not planned to the same extent, and therefore a change in headway at small headways affects both queuing time (a use cost) and scheduling costs. The value of headway, therefore, includes both a use element and scheduling cost element. This is discussed more fully in the rail industry's PDFH. Consequently when scheduling costs are included in an appraisal through values of headway it is, therefore, necessary to exclude queuing time (or wait time), at, say, the ferry pier head, from the appraisal. If this does not happen some double counting of the costs will occur. This situation is illustrated in the Berneray causeway and Sound of Harris ferry example below.

- 2.17 It is straightforward to include scheduling costs in an appraisal where an evidence base exists of values for headway and operating hours. For the rail and bus sector there is a well developed evidence base. Additionally, proprietary public transport modelling software invariably includes a utility to include the cost of headway in the generalised cost function. Scheduling costs are, therefore, already included in some STAG appraisals (for example of heavy rail and light rail interventions). This is despite there currently being no guidance on scheduling costs in STAG. The demand modelling associated with these appraisals, as advocated in PDFH, often makes use of the concept of generalised journey time, where service quality attributes (such as frequency) are given a journey time equivalent and this, together with journey time and fares, form part of the generalised cost specification. The change in generalised journey time between the Do Minimum and the Do Something then forms an input to the appraisal, and appears in the TEE table as a journey time saving (even though it is actually the sum of a journey time saving and a scheduling benefit).
- 2.18 Given that scheduling costs are sometimes included in appraisals of rail projects (albeit in the guise of journey time savings) the two case studies used to illustrate the importance of scheduling are based around the ferry, fixed link and air modes. The first case study is the Berneray causeway and Sound of Harris ferry proposal, whilst the second is the proposal to provide an enhanced air network for the Highlands and Islands.

### ***Case study 1 – Berneray causeway and Sound of Harris ferry***

- 2.19 The Berneray causeway opened in April 1999 at a capital cost of £6.6 million. It is just less than 1km in length and is free to use (i.e. there is no toll). As illustrated in Figure 2.1 the causeway replaced the Berneray ferry (between Berneray and North Uist) and shortened the Sound of Harris ferry crossing between Harris and North Uist. The shorter crossing for the Sound of Harris ferry was expected to lead to an increase in service frequency in the summer (to two hourly). Halcrow Fox (1996) undertook the ex-ante appraisal of the project.
- 2.20 The “Do Something” delivers the following benefits compared to the “Do Minimum”:

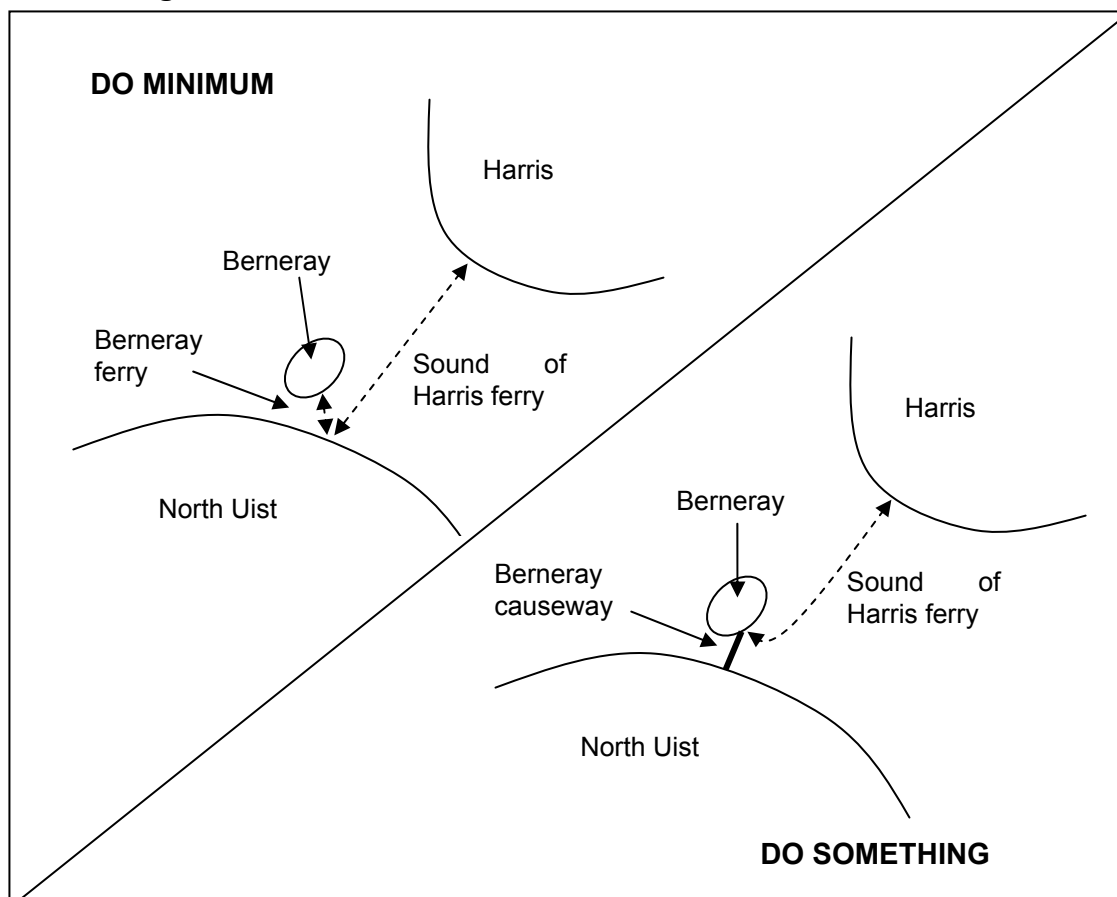
#### **BERNERAY TRAFFIC**

- a time saving of 12 minutes and the elimination of queuing time;
- a fare saving of 48p per passenger and £1.92 per car (for residents) and 75p per passenger and £2.60 per car (non-resident);
- no net vehicle operating cost saving;
- A reduction in average headway over the year from 89 minutes to an effective headway of zero with the construction of the causeway; and
- An extension of the effective operating day from an average of 12 hours to 24 hours.

## SOUND OF HARRIS FERRY TRAFFIC

- a time saving of 16 minutes and no change in queuing time;
- no fare saving;
- an increase in vehicle operating costs associated with increased causeway length and access roads on North Uist (0.9km);
- a reduction in headway from an average of 3hrs 45mins to 2 hrs in May, to June, July and August. 62% of the ferry's annual demand occurs in these four months; and
- a reduction in headway from an average of 3hrs 13mins to 2 hrs in April and September. 18% of the ferry's annual demand occurs in these two months.

**Figure 2.1: Berneray Causeway and Sound of Harris ferry: Do Minimum and Do Something**



Source: Halcrow (1996, Figure 1.3)

## SCHEDULING BENEFITS

2.21 Laird (2008 pp.222-224) calculates the additional value that scheduling costs add to the appraisal of the Berneray causeway and the Sound of Harris ferry. The results of this calculation are summarised in Table 2.3. As can be seen from this table, time and cost savings deliver a single year's users' benefits of

£200,000 in the first full year of operation (2000). Of this just over 60% is attributed to traffic to/from Berneray and the remaining 40% to traffic using the Sound of Harris ferry.

**Table 2.3 Berneray causeway and Sound of Harris ferry: benefits by market segment, Year 2000 (£ 1996 resource prices)**

	<b>Berneray Traffic</b>	<b>Sound of Harris traffic</b>	<b>Total traffic</b>
<b>Time and cost savings</b>			
Time savings	£51,000	£80,000	£131,000
Fare savings	£75,000	£0	£75,000
VOC savings	£0	-£6,000	-£6,000
<b>Time and cost savings sub-total</b>	<b>£126,000</b>	<b>£74,000</b>	<b>£200,000</b>
<b>Scheduling benefits</b>			
Queuing time at pier (double counted with time savings)	-£18,000	£0	-£18,000
Scheduling benefits (residents)	£49,000	£10,000	£90,000
Scheduling benefits (non-residents)	£31,000		
<b>Scheduling benefits sub-total</b>	<b>£62,000</b>	<b>£10,000</b>	<b>£72,000</b>
<b>Total</b>	<b>£188,000</b>	<b>£84,000</b>	<b>£272,000</b>
<b>Scheduling benefits as proportion of time and cost savings</b>	<b>49%</b>	<b>14%</b>	<b>36%</b>

Source: Halcrow Fox (1996, Table 2.5); Laird (2008 Table 9.3)

- 2.22 The second half of the table presents the benefits attributed to a reduction in scheduling costs (to e.g. zero headway and 24 hour availability for Berneray traffic). These benefit estimates have used estimates of the value of changes in headway and operating hours from the Outer Hebrides surveyed by Laird (2008) – see the last row of Table 2.2. As the value associated with reducing headway includes queuing time (already included in the travel time savings calculation) such costs need to be deducted from the scheduling benefits to prevent double counting. It is clear from this table that the scheduling benefits to traffic to/from Berneray traffic is substantial relative to the traditional elements of user benefit – the scheduling benefits are just under 50% of the time and cost savings. The scheduling benefits to the Sound of Harris traffic are much smaller, despite the higher marginal values per trip (14% of user benefits). This arises as the change to the Sound of Harris service is not as large as that to the Berneray service, but also because users of the Sound of Harris service only value changes in headway up until headways of 3 hours (see the summary of the Laird, 2008 survey on willingness to pay in Table 2.2). The benefit is, therefore, driven by reductions in headway to 3hrs since further reductions (to 2 hours) hold no value. It is interesting to note that the proposal to reduce headways to 2 hours has never been implemented – possibly in recognition of the preferences of the existing customer base.

## MODELLING INDUCED TRAFFIC

- 2.23 The reduction in generalised cost of the crossing between Berneray and North Uist will lead to three main behavioural responses:
- Trips will occur at different times of the day;
  - Individuals will make more trips; and
  - Car occupancy will lower.
- 2.24 The second two have implications for both total person trips and total vehicle trips.
- 2.25 SQW (2003 pp.4-5) indicate that in 1997 the Berneray ferry carried 27,781 passengers (one-way). If ferry passenger traffic was to grow at the rate of 3% per annum from 1997 to 2004, this would suggest that 34,200 passengers would have travelled on the ferry in 2004 if the causeway had never been constructed (i.e. in the Do Minimum).
- 2.26 In 2003/4 SQW estimate 124,000 one-way person trips were made over the causeway. This includes 18,900 passenger trips on the Sound of Harris ferry, leaving 105,400 one-way person trips to/from Berneray (Scottish Government and National Statistics, 2008 Table 10.14). We, therefore, estimate that the Berneray causeway led to a threefold increase in the number of person trips between Berneray and North Uist. Halcrow Fox (1996) in the ex-ante appraisal of the Berneray causeway estimated that the number of passenger trips would only double (Halcrow Fox, 1996 Table 2.5). This is based on the change in generalised cost of an average trip across the causeway and a demand elasticity to generalised cost of -0.5.
- 2.27 Ex-ante the number of induced person trips was, therefore, underestimated by 50%, and the total number of person trips underestimated by 33%. This is a significant variation in the context of appraisal. Given that the ex-ante appraisal did not include scheduling costs in the generalised cost specification the difference is hardly surprising. Our re-working of the demand forecast calculation indicates that with scheduling benefits included (which form 50% of the time and cost savings) person-demand would be forecast to almost triple. This reflects almost exactly the outcome. Changes in car occupancy, from an average of 2.7 with the ferry to an average of 1.5 with the causeway, then account for the higher growth in vehicle traffic compared to person traffic.
- 2.28 This case study illustrates two key issues when forecasting demand for new fixed links:
- (1) A full specification of generalised cost should include scheduling costs; and
  - (2) A large change in car occupancy can occur as a result of the removal of fares on a crossing.
- 2.29 The exclusion of scheduling costs from the appraisal of fixed links can underestimate demand in the Do Something and the welfare benefits of the

Do Something. The former, the underestimation of demand has implications for other aspects of the STAG appraisal – such as the environmental assessment.

### ***Case study 2 – air services in the Highlands and Islands***

- 2.30 In 2004, HITRANS developed proposals to provide a cheaper air service and an enhanced air service from and to the ten Highlands and Islands airports plus the opening of new routes to Oban and Skye. The operating pattern proposed was a combination of: improved schedules (offering longer times at destinations, and reducing the number of overnight stays required); extra frequencies (giving passengers a wider range of possible itineraries); new airports (with operations to Oban and Skye – Broadford); and new routes, such as Stornoway – Aberdeen and Benbecula – Inverness. Aside from providing day trip opportunities from all the airports to at least one of the main Scottish urban centres, one of the significant features of the new network was the proposed creation of a single wave, early afternoon hub at Inverness Airport. This would enable all parts of the Highlands and Islands to have rapid daily access to all parts of Scotland.
- 2.31 Aside from the fare reduction (a third on average) a significant element of the proposal is an improvement in frequencies (from 1 to 2 or 3 services a day) and the creation of day trip opportunities. Large changes in scheduling costs were, therefore, expected. Willingness to pay surveys for these changes in cost were, therefore, conducted (McGregor and Laird, 2005). The impact of this survey on the economic appraisal is detailed in Table 2.2. As can be seen from this table scheduling benefits are substantial at just over a half of time, reliability and cost benefits (51%). The inclusion of scheduling benefits also increases the benefit to cost ratio from 1.61 to 2.73.

**Table 2.4: Enhanced air services: economic appraisal summary (£million, 30 year discounted values, 2002 prices and values)**

Appraisal elements	Excluding scheduling benefits	Including scheduling benefits
<b>Consumer user benefits</b>		
Travel time	31.844	31.844
Scheduling benefits: frequency improvements		39.041
Scheduling benefits: creation of day trip opportunities		10.800
Vehicle operating costs	0.000	0.000
Reliability	2.593	2.593
User charges	93.228	93.228
<b>Sub-total</b>	<b>127.665</b>	<b>177.506</b>
<b>Business User benefits</b>		
Travel time	201.966	201.966
Scheduling benefits: frequency improvements		150.719
Scheduling benefits: creation of day trip opportunities		59.872
Vehicle operating costs	0.000	0.000
Reliability	1.081	1.081
User charges	175.866	175.866
<b>Sub-total</b>	<b>378.913</b>	<b>589.504</b>
<b>Net Present Value</b>	140.171	400.603
<b>Benefit to Cost Ratio</b>	<b>1.61</b>	<b>2.73</b>

Source: McGregor and Laird (2005)

## Recommendations for STAG

- 2.32 The evidence that scheduling costs can have a key influence on travel demand and welfare benefits is compelling. It is our understanding that for some rail schemes consultants may already include scheduling costs as a form of time saving via the formulation of generalised journey time used in the demand forecasting. The lack of guidance on scheduling costs in economic appraisal guidance means that there is, however, a degree of haphazardness as to whether the benefits are included or not – some rail appraisals include them and others do not. Furthermore, to our knowledge aside from the two examples above, scheduling benefits are not included in the appraisal of other modes.
- 2.33 It is recommended that STAG be enhanced to make explicit reference to scheduling costs and that they should be used to develop demand forecasts and should be included in an economic appraisal where relevant. Improved

demand forecasts are relevant to not just the economic assessment but to other aspects of the appraisal including the assessment of the impact on safety and the environment.

- 2.34 Scheduling costs are relevant to the development of demand forecasts and the economic appraisal when transport departure times are constrained – as they are on public transport networks (see Table 2.5).

**Table 2.5: Applicability of scheduling costs by area type and mode**

	<b>Accessible rural / accessible small town (&lt;30 mins from urban area with population&gt;10,000)</b>	<b>Remote rural / remote small town (&gt;30 mins and &lt;60 mins from urban area with population&gt;10,000)</b>	<b>Very remote rural/ very remote small town (&gt;60 mins from urban area with population&gt;10,000)</b>
<b>Non-motorised modes</b>	Not-applicable <sup>(1)</sup>	Not-applicable <sup>(1)</sup>	Not-applicable <sup>(1)</sup>
<b>Car</b>	Not-applicable <sup>(1)</sup>	Not-applicable <sup>(1)</sup>	Not-applicable <sup>(1)</sup>
<b>Bus</b>	Applicable	Applicable	Applicable
<b>Rail</b>	Applicable	Applicable	Applicable
<b>Ferry (including fixed links)</b>	Applicable	Applicable	Applicable
<b>Air</b>	Applicable	Applicable	Applicable

Notes: (1) The transport network does not constrain walkers', cyclists' and car drivers' choice of departure time (and hence does not constrain activity scheduling).

- 2.35 There is a reasonable body of evidence on the value of scheduling costs for the rail and bus modes, though this is limited to situations where frequencies are good (e.g. headways of less than 1 hour). There is much less evidence on the cost of long headways, short operating hours and the scheduling costs of ferry and air modes. Expansions to this evidence base in these areas are needed, but are not considered to be a pre-requisite for recommending that appraisals should take account of scheduling costs.
- 2.36 It is straightforward to include scheduling costs in an appraisal and proprietary public transport modelling software often provides a facility to do so through the concept of generalised journey time.
- 2.37 When scheduling costs are modelled using the willingness to pay for changes in headway and operating hours (as in the case studies above), some double counting of use benefits occurs. This is because the willingness to pay for headway includes the willingness to pay to reduce wait time and interchange time as well as the willingness to pay to reduce scheduling costs. Any appraisal that includes scheduling costs through the proxy of headway must, therefore, eliminate double counting (as in the Berneray causeway and Sound of Harris case study).
- 2.38 As identified in the ex-post analysis of fixed link projects, including the Berneray causeway case study, aside from scheduling costs, it is also



important to model changes in car occupancy. Changes in car occupancy are associated with almost half the change in vehicular traffic on the new fixed links. It is recommended that this point is emphasised in STAG.

### 3 OPTION AND NON-USE VALUES

#### Concept

3.1 In environmental economics the term total economic value is used to describe the total willingness to pay for a good. For public goods, such as transport, the total willingness to pay (i.e. the total economic value) is greater than the value of direct consumption (i.e. the use benefits). Whilst the concept of total economic value is accepted the definition of its components is still subject to some debate. Aside from use values concepts such as option values, passive non-use values, existence values, bequest values, altruistic values, stewardship and intrinsic values have been defined by various authors (see Pearce and Turner, 1990 pp.120-140, for a discussion), as have the concepts of vicarious-indirect-use and functional-indirect-use (see Humphreys and Fowkes, 2006, for a discussion). Ultimately, the boundaries between the different components of total economic value are unclear and tend to overlap. Without wishing to be drawn into the debate regarding the nomenclature of its components, it is clear there is a consensus that the total economic value concept exists and that it will differ from the value of direct consumption if individuals are willing-to-pay for:

- (3) The option of consuming the good at some point in the future, even if they may never actually take up that option - i.e. the option value (OV); or
- (4) The continued existence of a good which they themselves do not directly consume or ever intend to consume. Following Bateman *et al.* (2002 p.29) this is referred to as the non-use value (NUV)<sup>2</sup>.

#### ***The option value and risk premium***

3.2 An option value, in the transport context, is the willingness-to-pay over and above the expected value of future use to preserve the option of using a transport service for:

- future trips not yet anticipated;
- future trips anticipated but with some uncertainty; or
- trips currently undertaken by other modes.

3.3 It was first identified by Weisbrod (1964) as the “price people are willing to pay for an assurance (an option) that the good in question will be available (at a predetermined price) if they want it” (Pearce and Nash, 1981 p.79)<sup>3</sup>.

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<sup>2</sup> Whilst such a categorisation of option values and non-use values is consistent with that adopted by one of the strands of the literature (e.g. Bateman *et al.*, 2002; Geurs, Haaijer and van Wee, 2006), Humphreys and Fowkes (2006) define option values as a non-use benefit. The primary motivation for using the Bateman *et al.* nomenclature is that this categorisation more easily dovetails into transport appraisal practice. This is because the option value is always additional to user benefits, whilst some or all of the non-use value will double count user benefits.

<sup>3</sup> The literature also identifies a concept referred to as a quasi-option value, which represents the value of maintaining a facility until better knowledge is available as to its future demand (Arrow and Fisher, 1974). Its estimation involves estimating the probability distribution of future demand and how

Importantly, it only exists if there is uncertainty, individuals are risk averse and individuals value consuming the good. It is also analogous to the concept of the risk premium (Pratt, 1964), which is the income a person would forgo to eliminate uncertainty in a future income stream. A risk premium in a transport context is relevant when there are no alternatives but either supply is unreliable or future demand is uncertain. The terms option value and risk premium, therefore, relate to the welfare costs arising through some economic circumstance (uncertainty), but in a transport context relate to either situations where options exist (e.g. a rail service for car commuters) or ones where there are no alternatives (e.g. a single ferry service to an island). From a cost-benefit analysis perspective the option value (and the risk premium) are always additional to the change in the value of consumption (i.e. change in consumer surplus). Therefore, either the option value or the risk premium can always be included in a cost-benefit analysis without double counting other economic impacts.

- 3.4 The term option value in transport is typically used in relation to the value attached to an alternative transport good to the one in use – e.g. the value of a rail service to car users. The reason why the transport good holds an option value is that an individual's existing mode of transport may become unavailable or their personal circumstances may alter (e.g. changing job). The alternative transport mode is, therefore, needed to continue to access existing activities and potentially new activities at some point in the future. When no alternatives exist (e.g. the scenario of a single ferry or fixed transport link to an island), clearly an option value only becomes relevant to the appraisal if the transport intervention creates an alternative (e.g. an air link). However, if the transport intervention can reduce uncertainty (e.g. in future incomes) faced by households and businesses then the risk premium is of relevance to the appraisal. A potential example could be replacing a ferry with a fixed link.
- 3.5 Situations in which people might become highly dependent on a transport link in the future would be expected to generate high option values/risk premiums. The most likely of these cases would be the need to change employment in circumstances in which the transport link offers a substantially better service than the alternatives. Thus, the combination of lack of car availability and a poor bus service, or of severe road congestion and parking difficulties, might raise such an issue. Other regular journey purposes such as shopping, visiting or medical related trips might also create significant option values / risk premiums, although given that these trips are generally less frequent than commuting trips, these are unlikely to be as large as for commuting trips. With respect to rail significant option values / risk premiums would be expected to be associated with stations upon which people become dependent. Origin stations and major destination stations – where they are major attractors e.g. in cities – would form the primary candidates, as would stations that primarily serve the commuter market.

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this may change in future with better information; it is not considered further, although to the extent that such a benefit exists at the individual level, it may be indistinguishable from option values as defined here.

### ***The non-use value***

3.6 Non-use values, on the other hand, differ from use values and option values in that a value may be placed on the continued existence of a good regardless of any possibility of future use by the individual in question. The motivation for continued existence of the good may, however, vary from one circumstance to another. For example, individuals may value a good for altruistic reasons, reasons of indirect use or because the good has some existence, bequest or intrinsic value. Examples of situations where non-use values may exist in a transport environment include:

- a resident in a village deriving benefit from the knowledge that the elderly can use public transport to access the facilities they need;
- a householder living on a busy road experiencing less noise, and a car commuter experiencing less congestion as a consequence of other commuters using a rail service;
- where the vitality of a community may depend on the transport link – for example where a substantial proportion of the economic activity in the community stems from either passing trade or from business associated with the provision of transport services; and
- where the cultural heritage value of transport infrastructure is large.

3.7 Clearly there may be other context specific circumstances in which non-use values may exist - see Table 3.1. Importantly, from the perspective of a transport cost benefit analysis, some double counting between non-use values and other items of cost / benefit included in a transport appraisal can occur. This is particularly the case when the motive giving rise to the non-use value is associated with personal gain / loss – such as de-congestion benefits for road users, noise and pollution benefits for householders and loss or gain in income or house values. Where the motives that give rise to non-use values are purely altruistic, non-use values can be included in a cost-benefit analysis without double counting (McConnell, 1997)<sup>4</sup>. Given the potential for double counting benefits when including non-use values it is important that any surveyed non-use values are adjusted for double counting prior to inclusion. This is a non-trivial task as it requires the survey methodology to be able to distinguish between the different motives underlying non-use values. Ideally, the survey method should also account for the bias introduced by those households who are willing to pay to maintain a transport service, not because they hold use, option and non-use values for it, but because they believe its presence influences the value of their property.

3.8 In contrast with option values the motives that give rise to non-use values are quite varied and, as a consequence, the situations in which high non-use

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<sup>4</sup> McConnell (1997) shows that the motive for altruism is important to whether the non-use value is additional to consumer surplus. Where the motive is paternalistic altruism, which will prevail in a transport context, the non-use value is always additional to consumer surplus in the cost benefit analysis. Paternalistic altruism, in a transport context, is when the altruist cares about the consumer surplus of or the quantity of services available to a particular group in society (the poor, children, the elderly).

values might be expected to exist are also varied. Given that non-use values arise through either altruism (e.g. concern for the poor or children) or personal loss / gain (e.g. reduced congestion, vitality of community) the largest non-use values would be expected to be found where personal losses / gains are large. Such a situation occurs where businesses rely on transport infrastructure to bring in customers (e.g. retailers or tourist attractions which are fixed in location). The minimum bound on the non-use value held by a firm is the fall in profit from a loss of the transport infrastructure availability. For individuals, on the other hand, the minimum bound is the drop in income. Such an income drop could occur if individuals had to change job or reduce work hours as a consequence of the loss of availability of transport infrastructure. It should of course be noted that non-use values arising through personal loss / gain either double count benefits already included in a transport appraisal (e.g. environmental benefits for householders) or do not represent a net welfare loss / gain to society (e.g. a change in business profitability). It is only when the motive for the non-use value is altruism that it is additional to benefits already included in a transport appraisal.

**Table 3.1: Motives for willingness-to-pay for the provision of transport services**

	Use value (as generally measured)	Option value	Non-use value
User	Expected value of future use.	Value of preserving the option of using it in the future for trips not yet anticipated, anticipated but with some uncertainty or currently undertaken by other modes over and above expected value of future use.	Use by other members of the household; Use by friends, family; Concern for other people in society in general; Concern for particular groups, poor, elderly, children; Concern for future generations; Reduced congestion; Reduced environmental problems; Cohesion effects, link to larger communities
Non-user	N/A	As user.	The same as above

Source: Laird, Geurs and Nash (2007)

## Evidence

3.9 Despite transport related option values being first identified thirty five years ago by Weisbrod, and, in stark contrast to the plethora of environmental economic studies on option values, there has been very little activity on option values for transport services. Laird, Geurs and Nash (2007) identify six studies on option and non-use values of which only the results from five are published (see Table 3.2). Two of these studies have focussed on values associated with bus services and three on rail services. All have focussed exclusively on passenger transport by households. As can also be seen from this table, a wide range of values regarding the willingness-to-pay for transport

services, above and beyond pure use costs, appear to exist. These range from £36 per year (Crockett, 1992) to £190 per year (Humphreys and Fowkes, 2006). With only five reported studies and with all the studies aside from Geurs, Haaijer and van Wee (2006) having small to modest sample sizes it is apparent that the field of measuring transport option values is in its infancy.

3.10 Laird (2008, pp.40-43) qualitatively reconciles the five studies against one another. The main points that emerge are as follows:

- Each study defines users and non-users differently. Only the sample weighted average value for users and non-users should, therefore, be compared between studies;
- When converted to a common price base and currency the range narrows slightly (see Figure 3.1);
- Where values relate to households (e.g. the North Berwick study) the values exceed those that relate to individuals (e.g. the Dutch Arnhem – Winterswijk and Leiden – Gouda rail study);
- Where alternatives exist the values are lower than where there are no alternatives. For example, the existence of an alternative line to Settle-Carlisle for the residents of Settle is part of the explanation as to why the option and non-use value of the Settle-Carlisle line is low;
- The values are higher for services upon which a household is or could become dependent – e.g. a service that offers commuting opportunities. Thus, for example, the Rainow, Hawksworth bus studies, which offer 4 services an hour to large employment centres (Manchester and Leeds), have a higher value than the rural US bus network. Similarly, the Settle-Carlisle service has a low value, as at the time it was surveyed it was not possible to use it for commuting purposes, compared to the North Berwick service or the Dutch services both of which had half hourly services in the peak to large employment centres.

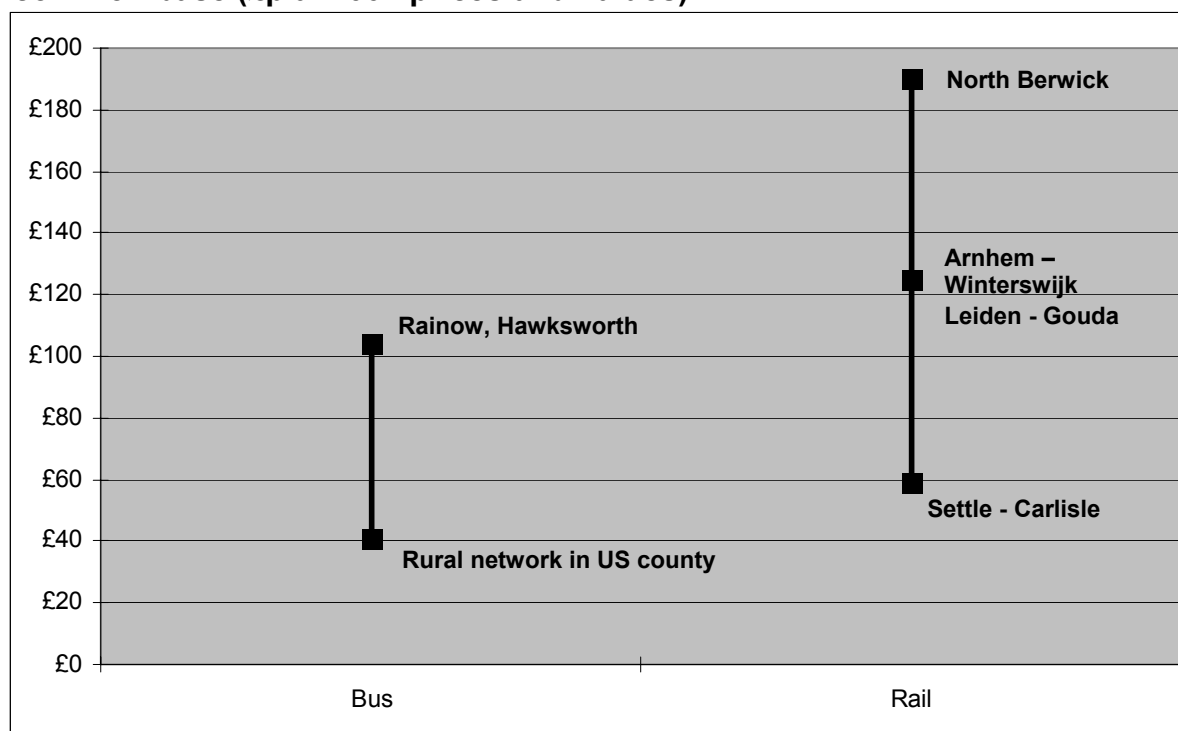
3.11 Preliminary results from PhD research at the University of Leeds looking at three rural rail lines in North West England (Jackson, Johnson and Nash, 2009) indicates that willingness to pay for the existing rail service against a replacement bus service is in the region of £70 per household. These results need to be viewed as preliminary. Included in the £70 per household figure is the expected loss of consumer surplus from a replacement bus service as well as the option and non-use value of the rail service against the replacement bus service. At this stage in the work no attempt has been made to disaggregate these different components. These results are difficult to compare with values presented in Table 3.2 and Figure 3.1 as Jackson, Johnson and Nash's results not only include the expected loss of consumer surplus associated with a replacement bus service, but relate to the difference in total economic value between an existing rail service and a replacement bus service. The values presented in Table 3.2 and Figure 3.1 are, in comparison, absolute values (for option and non-use values of either a bus or a rail service).

**Table 3.2: Literature survey: option and non-use values (average values converted to yearly willingness to pay values)**

	UK case studies			Non-UK case studies	
	Bristow <i>et al.</i> (1991)	Crockett (1992)	Humphreys & Fowkes (2006)	Painter <i>et al.</i> (2002)	Geurs, Haaijer and van Wee (2006)
<b>Mode</b>	Bus	Rail	Rail	Bus	Rail
<b>Study area</b>	Hawthornthwaite, Leeds; Rainow, Cheshire	Settle	Edinburgh to North Berwick, Scotland	Chelan County; Clallam County, both Washington State, USA	Arnhem to Winterswijk and Leiden to Gouda, the Netherlands
<b>Base year</b>	1990	1992	2002	1999	2004
<b>Currency</b>	UK pound	UK pound	UK pound	US dollar	Euro
<b>Unit of analysis</b>	Possibly household WTP, but not specified in CV questions, so could be individual WTP	Possibly household WTP, but not specified in CV questions, so could be individual WTP	Household	Not specified in the survey. A follow-up survey identified it to be a mixture of individual and household values	individual (4)
<b>Consumer surplus</b>	user: £102 (year)	not estimated	user: £46 (year)	not estimated	user: €86 (year)
<b>Option value (OV)</b>	not estimated	not estimated	user: £150 (year) non-user: £172 (year) average(2): £154 (year)	not estimated	user: £112 (year) non-user: €96 - £132 (year) average (3): €94
<b>Non-use value (NUV)</b>	not estimated	not estimated	total indirect use value: user: £28 (year) non-user: £22 (year) average(2): £27 (year) altruistic value: user: £17 (year) non-user: -£27 (year) average(2): £9 (year)	not estimated	user: €196 (year) (4) non-user: €97 (year) (4) average: €148 (4)
<b>OV + NUV</b>	user: £22 to £30 (year) non-user: £78 to £84 (year) average(1): £58 (year)	user: £43 (year) non-user: £24 (year) average: £36 (year)	user: £195 (year) non-user: £167 (year) average(2): £190 (year)	user: not estimated non-user: \$56 (year)	user: €308 (year) (4) non-user: €193 - €229 (year) (4) average: €242 (4)
<b>Basis of OV + NUV valuation</b>	No alternative PT service	Existing bus service and alternative rail line/train station	Existing bus service	No alternative PT service	No alternative PT service

Notes: (1) Average values calculated using user/non-user proportions in Bristow *et al.* (1991 Tables 3.13), (2) Average values calculated using proportions: 81% users and 19% non-users (Humphreys and Fowkes, 2006), (3) Average option value calculated assuming that those who indicated that they would never catch the train have an option value of zero, (4) Geurs (2006): non-use values may reflect household WTP. Furthermore, user non-use values may also be biased upwards by use motives. The OV+NUV total is, therefore, likely to be biased upwards compared to the true total for an individual.  
Source: Laird (2008 p.31)

**Figure 3.1: Published option and non-use value studies converted to a common base (£p.a. 2002 prices and values)**



Source: Laird (2008, Table 3.3 p.41)

3.12 Oxera (2008) in a report to the Department for Transport investigated the applicability of one of the methods used to predict the option price for financial options (the Black-Scholes method) as a means for estimating transport option values. The method they proposed is a development of that set out in a 2002 US Transportation Research Board report (ECO Northwest and Parsons Brinkerhoff Quade and Douglas Inc., 2002). The similarities between a financial option and the risk premium are quite striking. The household (the buyer) is willing to forgo some income (buy an option) to have the certainty of consuming a good (buy an equity) at a fixed price at some point in the future. There are a number of difficulties associated with applying the Black-Scholes method to a transport context, as some of the parameters do not have a ready transport analogy. As evidenced from the Oxera work, possibly, the biggest difficulty is defining the distribution of generalised cost on the alternative mode (in this case road). For computational reasons Oxera assumed a log-normal distribution for generalised cost of road travel. The validity and sensitivity of the results to this assumption were not examined. The values derived by Oxera for the 'stand-by' value of an option value are broadly consistent with the Humphreys and Fowkes result (see Table 3.2). Oxera took this to mean that the method is well validated and appropriate for use in deriving option values for use in a transport appraisal.

3.13 We are in broad agreement with Fowkes (2008), who peer reviewed the Oxera study, in that the method has merit, but that further work needs to be done before it could be used as a means of predicting option values for use in a transport appraisal. Our view is that the values Oxera derived for the option



values are very high. Whilst the values derived are broadly consistent with the Humphreys and Fowkes result, the Oxera work relates only to option values that arise because of the stand-by value of rail (i.e. a form of supply side uncertainty). It is our view that for branch lines, linking small rural populations with large urban areas, the majority of the option value arises through demand side uncertainty (i.e. future trips not yet anticipated or anticipated with some uncertainty). Furthermore, the Humphreys and Fowkes figure is a value for the sum of the option and non-use value and is not just that for an option value. It is considered that before the Black-Scholes method could be used to derive option values for transport schemes it appears necessary to undertake further research on its general applicability and sensitivity in the transport context. It is our understanding that the Department for Transport has some reservations about applying the methodology set out by Oxera as it currently stands. They see the work very much as research in progress. Once the Department publish the Oxera report on their website with a covering note their official position will be known.

- 3.14 The only evidence on a transport infrastructure related risk premium is that found by Laird (2008 Chapter 6). In a survey of households on four islands in the Outer Hebrides he found no evidence of a difference in risk premium between a high quality ferry and a fixed link. Possibly the reason for this is that the ferry service against which the fixed link was compared, in the stated preference survey, was of a very high quality – it operated 24 hours a day at half hourly intervals and was free at the point of use. The risk premium between a ferry that operates only 12 hours a day at 1.5 hour intervals for which a fare has to be paid and an untolled fixed link may well be statistically significant, but this remains an issue for future research.

## **The relevance of option and non-use values to transport appraisal**

### ***Using the research evidence base***

- 3.15 To apply the available evidence base in a transport cost benefit analysis a number of considerations need to be borne in mind. Firstly, the evidence is restricted to household values for personal travel and does not include the values businesses may hold for employees travelling on company business or for the transportation of freight. It is also restricted to local services and not national or long distance services<sup>5</sup>, and values are only available for bus and rail services. Furthermore, the values relate to trip origins (e.g. origin station) and to households within the catchment area of the transport service. It is possible that option and non-user values may be held by households outwith a service's catchment area - for example Deberezion *et al.* (2006) find that rail stations influence house prices up to 10km from the station. The evidence also relates to the complete loss of a service. Thus, it cannot be applied to communities which experience an incremental loss (or improvement) in terms of access to employment and service opportunities.

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<sup>5</sup> The surveyed values in the evidence base are associated with the loss of a local rail service and not the loss of mainline services. Some of the willingness to pay values associated with the local services are however associated with long distance trips that would utilise both the local rail service and mainline rail services.

- 3.16 Finally, and as discussed earlier, the non-use value may double count benefits already included in a transport cost-benefit analysis. To avoid double counting one ideally just excludes the element of the non-use value that is not altruistic. Drawing from Humphreys and Fowkes this would appear to be approximately 14% of the sum of the option and non-use value. A much more conservative approach to avoid double counting would be to exclude all the non-use value from the appraisal. Unfortunately, the two studies that separately examined option and non-use values (Humphreys and Fowkes and Geurs, Haaijer and van Wee) suggest very different levels of importance for the non-use element of total economic value compared to the option value element. Humphreys and Fowkes found that the non-use element comprised 25% of the sum of the option and non-use value whilst Geurs, Haaijer and van Wee found that it comprised between 40 and 60% (depending on the category of user). Both studies were exploratory and the results may in fact be artefacts of the survey design. Humphreys and Fowkes treated option values as a 'residual' category and used proxies for the different non-use motives to estimate the non-use value. As their proxies may have been insufficient to capture all the non-use benefits, it is likely that they underestimate non-use values and overestimate option values. Geurs, Haaijer and van Wee, on the other hand, estimated option values for individuals but the phrasing of the questionnaire means that the non-use values estimated may reflect household values and should, therefore, be interpreted as an upper bound for individual non-use values. Some sensitivity testing of the results to the inclusion of non-use values is, therefore, prudent when undertaking a cost-benefit analysis.

***Case studies 3 to 7 (Beaully station, Conon Bridge station, Invernet 1, Airdrie-Bathgate, anonymised rail closure example)***

- 3.17 England is the only country where appraisal guidance is given on option and non-use values of transport services. The current guidance on option values (DfT, 2003) suggests a qualitative approach to identify which group of transport services within a particular strategy (or option) are the source of any additional (or reduced) option value, the nature of the change in service and the sign of the change (i.e. option value gained or lost). A quantitative approach to report the total monetary benefits (or disbenefits) of the option or strategy being appraised is suggested when it is feasible to carry out such empirical analyses. To our knowledge, no transport appraisal study based on English standard practice has so far monetised option and non-use values. This guidance on option and non-use values is currently under revision following a study by ourselves for the Department for Transport (Laird *et al.*, 2006; DfT, 2007). The updated guidance follows a three step approach. In the first step, it is necessary for all schemes for which option and non-use values are considered to calculate the number of households that will be affected by the proposals and to qualitatively score that impact. As there is no evidence on how values vary with distance from access / egress points to the infrastructure/service (stations, bus stops, etc.), it is assumed that the population who hold an option and non-use value for a transport service have a similar geographic spread to those who hold use values for the same service. The second step is, once the number of households affected has been identified, to assign a qualitative score following the scoring procedure

from the original guidance. The third step, only to be included in an appraisal for schemes that consider changes in local bus and rail services linking suburbs / outlying towns to a major employment and service centre, is to monetise option and non-use values using recommended willingness-to-pay values. These are currently £170 per household p.a. for rail and £90 per household for bus. These have been derived from Humphreys and Fowkes (2006) for rail and Bristow *et al.* (1991) for bus, converted to a 2002 price base and deflated by 14% (and rounded up to the nearest £10) to account for double-counting in the non-use value. The additional welfare benefit of adding a train service to a bus service is, therefore, taken to be £80 per household per annum (i.e. the difference between the rail value and the bus value). The values are to be applied to the population within 2 km of the service, unless it can be demonstrated that catchment areas differ.

- 3.18 As can be seen from Table 3.3 the importance of option and non-use values varies with the characteristics of the service and the type of proposal. All of the case studies are located in Scottish Government Accessible rural or Remote rural area types, as well as being associated with local rail services. Three of the studies are in the Inverness area of the Highlands and Islands in Scotland (Highland Rail Developments, 2000; Highland Rail Partnership, 2003; Halcrow, 2006). In this region the rail network historically served a long distance function and, therefore, did not serve the immediate needs of the local communities particularly well – frequencies were low and service timings did not facilitate access to employment and social opportunities. This, combined with the fact that the area is sparsely populated, aside from Inverness, means that the rail network is lightly trafficked. In contrast the fourth and fifth case studies are situated near much larger conurbations. The fourth scheme is in central Scotland (Jacobs, 2006) and the fifth in the south of England (DfT, 2006). Importantly, from the perspective of these case studies, both have a reasonably frequent rail service and consequently the lines are more heavily trafficked than the north of Scotland lines.
- 3.19 The large variation in the relationship between user benefits and option and non-use value benefits reflects the different characteristics of the schemes. At one extreme is the Conon Bridge station re-opening where option and non-use values are almost six times the level of user benefits.

**Table 3.3: Size of option and non-use values relative to user benefits and the present value of benefits**

Scheme	Area type	No. of households affected (opening year)	Annual patronage on line (single trips in opening year)		Option and non-use values as percentage of:	
			Do Minimum	Do Something	Transport user benefits	Present Value of Benefits (PVB)
Beaulieu station re-opening (opened 2002)	Accessible rural	550	125,000	148,000	87%	84%
Conon Bridge station re-opening (proposal)	Accessible rural	1,000	250,000	270,000	561%	117%
Invernet – provision of services within the Inverness travel to work area (opened 2005) (a) Increase in service frequency by approximately 50% immediately north of Inverness plus provision of commuting opportunities for 3 communities (Ardgay, Culrain/Invershin, Lairg) (b) Provision of a commuter service from the south to Inverness (from Kingussie to Inverness)	Accessible rural / Remote rural	2,600	485,000	557,000	64%	57%
		700	145,000	210,000	23%	20%
		1,900	340,000	347,000	197%	178%
Airdrie-Bathgate proposal – line re-opening between Airdrie and Bathgate providing travel opportunities for communities in the corridor to access both Glasgow and Edinburgh	Accessible rural	7,400	0	4,000,000	Not known	4%
Anonymised example (rail closure)	Accessible rural / Remote rural	3,700	3,798,000	0	9%	9%

Note: Transport appraisals have been undertaken in accordance with STAG economic appraisal practice with the addition of option and non-use values.

Source: Laird (2008 p.46)

Primarily this occurs because user benefits are low, rather than option and non-use values being high. User benefits are low because dis-benefits to existing users (caused by the extra stop) almost cancel out benefits to new users. Whilst dis-benefits to existing users are similarly large for the reopening of Beaulieu station there is a much larger demand at this station – despite the lower population – and, as a consequence, user benefits are stronger. This results in option and non-use values, therefore, forming just over 80% of the user benefits of re-opening Beaulieu station.

- 3.20 The Invernet project contains two distinct elements: a significant strengthening of services to the north of Inverness plus the provision of commuting opportunities to three communities (north of Inverness); and the provision of commuting opportunities to three communities south of Inverness. The latter 'southern' element of the project occurs without any strengthening of services, beyond the provision of the morning commuter service. It, therefore, generates only small amounts of user benefit, whilst providing quite large option and non-use values due to the size of the population served. Contrastingly, the strengthening of services to the north of Inverness generates large user benefits. Option and non-use value benefits, therefore, forms a much lower proportion of the total Present Value of Benefits (PVB) of the northern element of the scheme than for the southern element.
- 3.21 The fourth case study concerns the re-opening of a line between Airdrie and Bathgate. The primary function of the line is to provide access for the communities within the corridor to employment and service opportunities in both Glasgow and Edinburgh. As the majority of the communities within the corridor already have access to the opportunities in one of the conurbations, the benefits of the service are driven by the use of the rail service, rather than the increased opportunities it creates. This is because the evidence base on option and non-use values is too limited to identify the difference between a community being connected to two large employment and service centres rather than just one. Option and non-use value benefits only form 4% of the PVB. The final case study, a line closure appraisal, combines both station closures and the loss of a well used fairly good rail service. Here even though several communities lose their rail service the scale of the user costs dominates the option and non-use values – which form 9% of the total PVB.
- 3.22 A pattern, therefore, emerges: the importance of option and non-use values is high for lines where user benefits are low – typically lines with relatively infrequent levels of service and low levels of demand - and for projects that involve the provision (or loss) of commuting opportunities (including station openings/closures). Such projects occur in areas where rail performs a strong social function, such as providing accessibility for isolated communities to employment opportunities and other social needs necessary to sustain the community's vitality. Clearly, therefore, option and non-use values are an important element of the total economic impact of a rail project in a sparse network when user benefits are low.
- 3.23 It is interesting to note that the impact of option and non-use values on the PVB (increasing the PVB by between 4% and 178%) differs significantly from

the contribution to total economic value as reported in the empirical studies. Humphreys and Fowkes for example find that option and non-use values for rail users form 51% of the total economic value of rail, Geurs, Haaijer and van Wee find that they form 40-45% on average and Bristow *et al.* find they form around 20% of the total economic value of bus for bus users. The difference between the total economic value and PVB proportions occurs because a transport appraisal considers an incremental adjustment to the existing transport system and is, therefore, concerned about the change in option and non-use values rather than their absolute level. Furthermore, a transport appraisal considers all users and non-users and, therefore, considers the benefits / costs to through traffic in addition to local traffic as well as the full cost of any safety or environmental externality – all of which, but particularly the benefits / costs to through traffic, can be substantial relative to the change in the option and non-use value for the households affected.

- 3.24 A consequence of the lack of development in the field of transport related option and non-use values means a number of difficulties arose in applying them in the case studies. Uncertainties in the catchment area of stations and whether option and non-use values are held by households outside those catchment areas; the real growth in values over time; the potential for double counting in the non-use value; and the option and non-use value of a mixed mode (bus and train) package all can significantly affect the present value of option and non-use values in an appraisal. Furthermore, the limited data on option and non-use values means that variations in frequency of service and connectivity to different sized employment centres are not reflected in the appraisal. For example, one might expect the option and non-use values associated with the new stations and train services in the north of Scotland case studies to be less than those derived by Humphreys and Fowkes. This is because the frequency of train services is lower in the north of Scotland compared to the North Berwick to Edinburgh service and Inverness does not offer as many employment and social opportunities as does Edinburgh.

### **Recommendations for STAG**

- 3.25 The field of measuring transport option and non-use values is far from developed. To date only values from five empirical studies worldwide are available. These studies have in the main small sample sizes and are restricted to the bus and rail modes. There is no evidence on option values for air services and only one study on the difference in risk premiums (analogous to option values for situations where there are no alternatives) between fixed links and ferries. The latter study indicates there is no perceived difference between ferry and fixed link infrastructure *per se* above and beyond use values. If a risk premium exists it is related to the operating restrictions of the ferry, but only further research can confirm this.
- 3.26 The five available empirical option and non-use studies give a potentially large range for the sum of option and non-use values of between £41 and £190 (2002 prices). Despite this it is possible to reconcile, in a mainly qualitative manner, the results against each other. The upper end of the range reflects a high quality train service linking a community to a large employment and service centre and for which there already exists a strong commuter demand.

In the middle of the range we find values associated with high quality bus services (3 or 4 buses an hour with good evening and weekend services). At the lower end of the range we find lower quality bus services and potentially lower quality rail services, neither of which may necessarily serve the community's needs particularly well. The evidence base is too small, however, to indicate how values may vary with: quality of service; the mix of public transport services that may be available in the study area; socio-economic factors such as car ownership; or to communities adjacent to mainline stations or 'hub' stations.

- 3.27 The financial options methods may prove useful for predicting option values associated with particular transport infrastructure, and the Oxera (2008) study is, therefore, important for its contribution. The values derived by Oxera are, however, considered to be very high. It is, therefore, considered that the methods need to be developed further before they can be applied to a real transport appraisal. A useful future piece of research, as Fowkes (2008) suggests, would be to undertake a combined stated preference and financial options investigation. This would not only enlarge the current evidence base, but would ascertain if synergy between the methods improves estimation and would determine if the financial options method could be used on its own in the future as a partial analysis from which its results could be grossed up to give a full measure of the sum of the option and non-use value.
- 3.28 The rail case studies clearly demonstrate the importance of option and non-use values for some rail scheme appraisals. The influence that they have on an appraisal is very varied and depends on the context of the scheme, particularly the strength of the user benefits / costs rather than the area type (urban, accessible rural, remote rural). The importance of option and non-use values increases for lines where user benefits are low – typically lines with relatively infrequent levels of service and low levels of demand - and for projects that involve the provision (or loss) of commuting opportunities (including station openings/closures). Option and non-use values may in particular swing the balance towards increasing numbers of stops services made at the expense of longer journey times.
- 3.29 It is recommended, therefore, that STAG is enhanced to include an option values sub-objective. However, the limited evidence on option and non-use values needs to be taken into account in developing any recommendations for option values. However, the following enhancement principles are considered to be appropriate given the evidence<sup>6</sup>:
  - A qualitative assessment is carried out for all transport interventions (based on the number of households affected by the intervention);
  - Monetisation of the option and non-use value is only undertaken for bus and rail schemes;

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<sup>6</sup> DfT (2007) is an example of how these principles can be developed into a guidance note. It is our understanding that the Department for Transport will publish this guidance in a form similar to that set out in the consultation guidance note.

- Due to the limited data on option and non-use values, the monetised values should only be included in an economic appraisal as a sensitivity test;
  - As the main determinant of option and non-use values is access to employment opportunities, option and non-use values should only be applied when commuting opportunities either become available (through the introduction of a new service) or are removed (through the closure of a service);
  - Option and non-use values are not applied to changes in service frequency or quality (beyond the provision of commuting opportunities); and
  - The results are sensitivity tested to the possibility that all of the non-use value double counts impacts already included in an economic appraisal.
- 3.30 The values that could be used in an appraisal are those used in the case studies presented earlier and are derived from the Humphreys and Fowkes and Bristow *et al.* studies. That is an option and non-use value of £170 per household per annum is attributed to rail and £90 per household per annum to bus. This gives a welfare benefit of £80 per household per annum through the introduction of a rail service (with commuting opportunities) where only a bus service previously existed. Clearly services of a different quality to those surveyed by Humphreys and Fowkes and Bristow *et al.* may have different option and non-use values to those recommended above. In particular we would expect that lower frequency services have lower values, as might services which do not serve major employment centres. It is important to note that Jackson, Johnson and Nash's (2009) preliminary results indicate that a significant option and non-use value for rail over a replacement bus service still exists for lower quality rail routes which serve employment centres much smaller than Edinburgh, Leeds and Manchester (the focus of Humphreys and Fowkes and Bristow *et al.*'s work).
- 3.31 The inclusion of option and non-use values in STAG should form part of the appraisal under the Accessibility and Social Inclusion criterion. The option and non-use values are, in essence, a monetisation of the value that households place on having access to hospitals, future employment opportunities and schools, even if they do not currently use these services. As no part of the Accessibility and Social Inclusion criterion is monetised in STAG there will be no duplication with other impacts already included in STAG. Option values and non-use values could, therefore, easily form part of one of the existing sub-objectives (e.g. community accessibility).
- 3.32 Table 3.4 sets out a broad guideline on the appropriateness of option and non-use values by mode and area type. The principal factor determining appropriateness is the provision of commuting opportunities – as it is access to employment opportunities that is considered to be the primary driver behind option and non-use values. For the purpose of this review 60 minutes journey time has been taken as a threshold for commuting being viable. It is straight forward to include option and non-use values in an appraisal. This is because the values are applied to the number of households within proximity of the



new infrastructure (e.g. a train station). Such data is available in census datasets including online (see for example [www.scrol.gov.uk](http://www.scrol.gov.uk)).

**Table 3.4: Applicability of option and non-use values by area type and mode**

	Accessible rural / accessible small town (<30 mins from urban area with population>10,000)	Remote rural / remote small town (>30 mins and <60 mins from urban area with population>10,000)	Very remote rural/ very remote small town (>60 mins from urban area with population>10,000)
<b>Non-motorised modes</b>	Not-applicable <sup>(1)</sup>	Not-applicable <sup>(1)</sup>	Not-applicable <sup>(1)</sup>
<b>Car</b>	Not-applicable <sup>(2)</sup>	Not-applicable <sup>(2)</sup>	Maybe applicable where there is a very large change in journey times [no evidence on values, qualitative assessment only]
<b>Bus</b>	Applicable	Applicable	Maybe applicable for services into very remote small towns
<b>Rail</b>	Applicable	Applicable	Maybe applicable for services into very remote small towns
<b>Ferry (including fixed links)</b>	Applicable [no evidence on values, qualitative assessment only]	Applicable [no evidence on values, qualitative assessment only]	Applicable [no evidence on values, qualitative assessment only]
<b>Air</b>	Not-applicable <sup>(3)</sup>	Not-applicable <sup>(3)</sup>	Not-applicable <sup>(3)</sup>

Notes: (1) A walking or cycling transport intervention is highly unlikely to create a step-change in commuting opportunities. (2) There is no change in commuting opportunities as household is already within commuting distance of an urban area (3) Due to cost and timetabling internal air services do not provide daily commuting opportunities.

3.33 One concern about the inclusion of option and non-use values in a transport appraisal relates to the fact that such values also exist for other goods (e.g. environmental goods, health services, provision of emergency services). It is then argued that it would be less distortionary to exclude all option and non-use values from an appraisal than to just include those that relate to transport. For certain applications we agree with this position, in that if cost benefit analysis is used as the **only** means to prioritise spending across multiple sectors for which significant option and non-use values might be expected to exist (e.g. transport, national parks, provision of hospitals, education, emergency services) than it would be inappropriate to include option and non-use values in the transport appraisal, but not in the appraisal of projects in the other sectors. However, where cost benefit analysis is used as part of a framework to prioritise transport projects within the transport sector alone then we view it as acceptable to include the transport option and non-use values, but not the environmental option and non-use value. This is because ignoring option values that are potentially significant is only appropriate if they are of a similar order of magnitude on both the costs and benefits side. Without any

evidence on the, for example, environmental side no judgment can be made. Furthermore, the nature of the STAG appraisal summary table is that the environmental impacts are included in a non-monetised form (with the exception of CO<sub>2</sub>) so it is possible for the decision-maker to weight up all the impacts of the transport intervention both monetised and non-monetised.

- 3.34 A consequence of the present lack of development in the field of transport related option and non-use values means a number of uncertainties regarding their properties exist. These include: uncertainties in the catchment area of the transport infrastructure and whether option and non-use values are held by households outside those catchment areas, the real growth in values over time, the potential for double counting in the non-use value and the option and the non-use value of a mixed mode (bus and train) package all can significantly affect the present value of option and non-use values in an appraisal. Furthermore the limited data on option and non-use values means that variations in frequency of service and connectivity to different sized employment centres are not reflected in the appraisal. More empirical research is needed to examine the range of values that residents attach to existing road infrastructure and bus and railway services. Additionally there is no evidence on the values that residents may attach to new railway links (e.g., high speed rail) and values that business may attribute to either bus, rail or air networks either for the carriage of freight or for employees travelling on company business. It is recommended that these evidence gaps form the basis of future research.

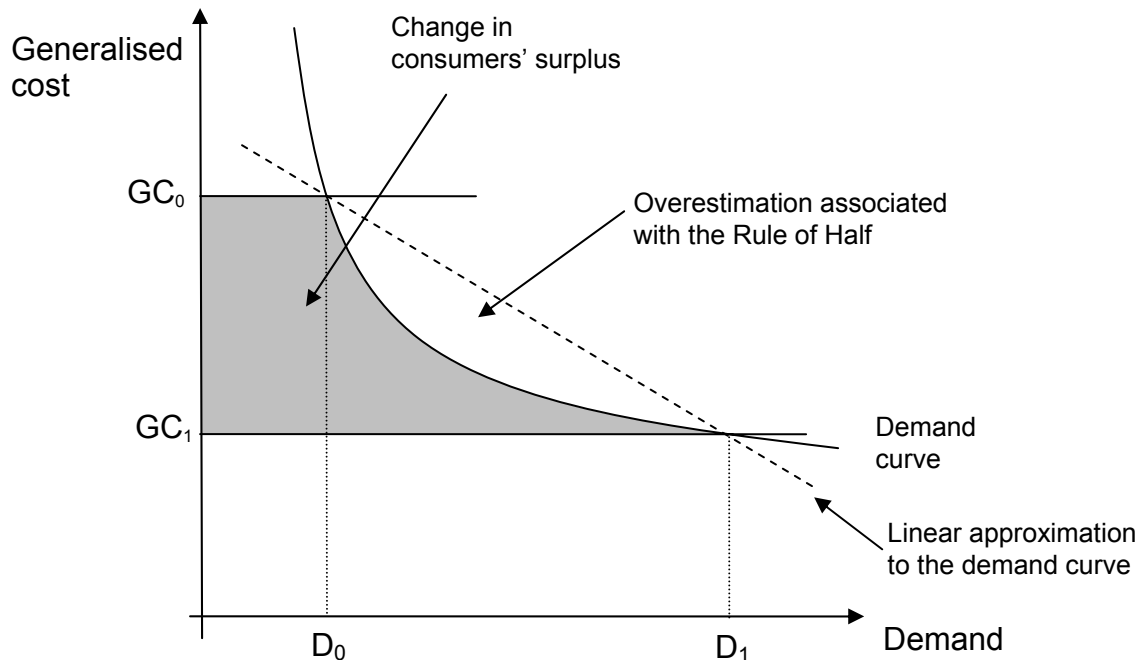
## 4 THE VALUE OF INDUCED TRAFFIC

### Concept, evidence and relevance to transport appraisal

- 4.1 STAG advocates that the value of the transport intervention to the existing traffic and the induced traffic is the change in consumer surplus. As discussed in paragraph 2.3, and illustrated in Table 2.1, induced traffic is additional traffic attracted to the network (by time period and mode) as a result of trip re-timing, re-distribution, mode switching, changes in trip frequency and 'pure generation'. In addition to the change in consumer surplus the value to society as a whole also includes the change in producer surplus for transport operators – this is also as set out in STAG. Thus, if an improvement in road quality reduces bus travel times and induces traffic onto the bus network, the increased profitability of the bus services is a benefit associated with the induced traffic. This method of valuing both the benefit to the existing traffic and the benefit to the induced traffic is consistent with applied cost benefit analysis theory (e.g. Boardman *et al.*, 2001 Chapter 3).
- 4.2 The consumer surplus is the difference between what someone is willing to pay for a good and what they actually pay. If the price of transport (the generalised cost of transport) falls then users receive a benefit equal to the change in consumer surplus. This is illustrated by the shaded area in Figure 4.1. As the generalised cost of transport falls (from  $GC_0$  to  $GC_1$ ) demand increases (from  $D_0$  to  $D_1$ ) along the demand schedule. The demand schedule (or demand curve) indicates the demand at different levels of generalised cost. The demand curve slopes downwards, as each additional unit of demand is generated through an incremental decrease in generalised cost. The change in consumer surplus for each unit of induced traffic is, therefore, less than that experienced by existing users ( $D_0$ ). Furthermore, it becomes progressively less as each additional unit of demand is generated until, for the marginal user, the change in consumer surplus is zero. This is because the marginal user is indifferent between travelling to a new activity and undertaking the activity they were doing prior to the lowering of generalised cost.
- 4.3 It is unusual to know the exact shape of a travel demand curve and, therefore, it is difficult to calculate the exact change in consumers' surplus for a transport intervention. The convention, and that advocated by STAG, is, therefore, to assume the demand curve is linear. This is illustrated in Figure 4.1. Once a functional form for the demand curve has been assumed the change in consumer surplus can be calculated knowing only the generalised cost before and after the intervention, as well as the demand before and after. This approximation is known as the Rule of Half.
- 4.4 An important point to note here is that the Rule of Half convention actually overestimates the change in consumer surplus. This is illustrated in Figure 4.1. The overestimation of benefit occurs as the demand curve is convex to the origin. The Rule of Half convention, therefore, assigns more value to induced traffic than it should. This is the main approximation associated with its use and can dictate the circumstances when alternative methods should be adopted (as discussed below). It should also be noted that whilst the Rule of

Half on average assigns half the benefit derived by the existing traffic to induced traffic this disguises a wide variation with the first trip generated actually deriving almost the same benefit as the existing traffic, whilst the last trip generated derives almost zero benefit.

**Figure 4.1: The change in consumer surplus**



- 4.5 When increased economic output in a low income regional economy is one of the aims of a transport project, allocating less benefit to induced traffic than existing traffic can provoke criticism (e.g. Reference, 2007 pp.19-20). This is in spite of the Rule of Half being an appropriate method to value the benefit to both existing and induced traffic. It is perfectly understandable that in fragmented regional economies more economic welfare might be associated with increased economic output and increased employment than in other regional economies, however, this additional welfare impact does not occur in the transport market. Instead it occurs in the product market and/or the labour market as the following chapter discusses. Adjusting the Rule of Half method to pick up this added value is inappropriate – instead the added value of increased output and employment should be measured directly in the product and labour markets as argued in the following chapter.
- 4.6 The Rule of Half convention is only a robust measure of welfare benefits when generalised cost changes are small to medium sized. This is for two reasons. When cost changes are large the error of approximating the demand curve with a linear schedule becomes important (see Figure 4.1). Nellthorp and Hyman (2001) argue that the Rule of Half overestimates the change in consumer surplus by more than 10% when generalised cost changes exceed 33%. For rural transport schemes it is quite realistic to get reductions in generalised cost exceeding this threshold. For example, in the Berneray causeway case study generalised cost has fallen by approximately 85% (when scheduling benefits are included in the formulation).

- 4.7 Secondly, when cost changes become large relative to incomes, the change in consumer surplus is no longer a good measure of the willingness to pay for improved transport quality. This is well known in the applied cost benefit analysis literature (e.g. Boardman *et al.*, 2001 pp.59-64; Alston and Larson, 1993). Instead the exact measure of welfare benefit is the compensating variation.
- 4.8 Ideally welfare benefits in all cost benefit applications would be measured using the compensating variation. The fact that it isn't is a reflection of how much more challenging it is to estimate the compensating variation than the change in consumer surplus. Furthermore, Willig (1976) argues that in almost all circumstances, and certainly where the change in consumer surplus is less than 5% of income, consumer surplus is a robust approximation to the 'exact' compensating variation measure. For example, with an income elasticity of 0.8 and a consumer surplus that is 5% of income the compensating variation is within 2% of the change in consumer surplus. For the majority of projects the change in consumer surplus is, therefore, a quite acceptable measure of welfare benefits. For some projects research has questioned its appropriateness when cost changes are high and incomes of those affected are low. For example, Jara-Díaz and Videla (1990) found that for medium income Chilean households the change in consumer surplus is 12% higher than the compensating variation. Cherchi and Polak (2007) found for a low income Italian sample (transport expenditure comprises 50% of total expenditure) the change in consumer surplus is 30% larger than the compensating variation. For high income people (transport expenditure comprises 13% of total expenditure) the error is much smaller (<5%) as it is for a mixed sample of high and low income people. Daly *et al.* (2008) estimate that the change in consumer surplus overestimates the 'exact' welfare benefit by just over 50%. Laird (2009), using empirical data from the Outer Hebrides, estimates that when the change in consumer surplus is 25% of household income (as it is for residents of Berneray following the construction of the causeway) the combined error of using the Rule of Half and the change in consumer surplus may overestimate the exact welfare benefit by as much as 100%.

## **Recommendations for STAG**

- 4.9 STAG appropriately recommends the use of the Rule of Half as an approximation to the change in consumer surplus. The Rule of Half, whilst leading to an overestimation of the change in consumer surplus, is an appropriate tool for valuing the benefit to both the existing and induced traffic for small and medium sized changes in generalised cost (<33%). The only comment would be that a more detailed exposition in STAG of the rationale behind the Rule of Half may help non-economist users of STAG to understand that the methodology is appropriate. When induced traffic is seen as a positive sign of increased output and employment in low income areas this may lead to significant wider economic benefits, but does not change the calculation of the change in consumer surplus.
- 4.10 The Rule of Half is only an approximation to the exact welfare benefit of a transport intervention. Where cost changes are large (>33%) the error

associated with applying it also becomes large (>10%). The method of numerical integration – where the curvature of the demand curve is approximated through one or two intermediate points – is one method that can be used when the transport project gives rise to such large cost changes. Nellthorp and Hyman (2001) describe this method. Alternatively the change in consumer surplus can be estimated through the direct integration of the area under the demand curve. This can only be done when the demand model includes a fully specified demand curve (e.g. a multi-nomial logit model). An example of an application of this method is described in Kouwenhoven *et al.* (2006) for the case of an appraisal of a replacement ferry to the Isles of Scilly. We recommend that STAG specifically alludes to these alternatives to Rule of Half for calculating the change in consumer surplus when the change in generalised cost exceeds 33%. It should of course be noted that applications of these processes are limited. This is because the number of instances in which a bespoke demand model is developed (e.g. as in the Isles of Scilly study mentioned above) is limited and there can be a significant resource challenge in applying the numeric integration method in large staged transport models (e.g. TMfS). It may, therefore, be necessary to commission some research to see if simple rules of thumb can be developed that relate percentage changes in generalised cost to the level of benefit overestimation that the Rule of Half gives.

- 4.11 Welfare benefits can also be seriously overestimated if the change in travel cost is large and incomes are low. In these situations the compensating variation should be estimated as the measure of the economic value of the project. At this stage it is not possible to recommend a simple procedure to correct this overestimation. It is, therefore, recommended that the ratio of change in consumer surplus to income is calculated (at a household level) for all schemes where large cost changes are expected (>33%). When these proportions are large (as they are for residents in the Berneray causeway example) this will serve as an indicator that the change in consumer surplus may include a significant overestimation. Also, it is recommended that further research in this field is undertaken, with a specific interest in developing rules that relate the level of error with the size of the expected consumer surplus accruing to an individual and their income.

## 5 WIDER ECONOMIC BENEFITS

- 5.1 Transport schemes are expected to have impacts in markets other than transport (e.g. the labour market, product market, land market, etc.). These impacts are only additional to changes in transport user benefits, in a welfare sense, if a market failure occurs. An additional welfare impact occurs if:
- An impact is felt in markets other than transport (e.g. employment expands or output expands) and
  - Price does not equal marginal social cost in the market where the impact occurs. That is if employment expands and there is a failure in the labour market an additional welfare impact occurs.
- 5.2 If markets are perfect the economic value of all the wider economic impacts (e.g. increased employment) are captured in the change in transport user benefits. Thus the value of increased output is captured through the change in consumer surplus of business and freight traffic, whilst the value of increased employment is captured through the change in consumer surplus of commuter traffic.
- 5.3 Following DfT (2005; 2008) STAG identifies four wider economic impacts: agglomeration (WB1), pro-competitive effects (WB2), imperfect competition (WB3), and labour supply effects (WB4). These are discussed below with specific relevance to the rural environment.

### Concepts and evidence

#### ***Agglomeration (WB1)***

- 5.4 Agglomeration economies have been the main focus of attention in the literature on the wider economic impact of transport interventions (van Exel *et al.*, 2002; Laird, Nellthorp and Mackie, 2005; DfT, 2005; Eddington, 2006; Venables, 2007; Graham, 2007a; 2007b; 2009). They arise as a consequence of the positive consumption externalities that occur when economic agents in transport using sectors of the economy are brought closer together by a transport improvement. By bringing these agents closer together labour productivity is raised above and beyond what would be expected from the transport efficiency saving alone. Where agglomeration economies exist, and where as a consequence of the transport intervention employment increases, Venables (2007) shows that two measures additional to transport user benefits, are in theory needed to capture the full welfare impact of the intervention. The first of the two additional measures relates to the productivity increase that occurs to existing and new workers. The second arises as a consequence of the distorting effects of taxation. There exists a substantial literature on the variation in worker productivity with agglomeration size (see Rosenthal and Strange 2004 for a review), though much of this data is international rather than from the UK. Rice, Venables and Patacchini (2006) and Graham (2007a; 2007b; 2009) present recent UK evidence on such relationships.

- 5.5 STAG, along with NATA, utilises Graham's research on the relationship between productivity and population mass in deriving estimates of changes in productivity as a consequence of improved accessibility. Graham's research, and Rice, Venables and Patacchini's research, mainly relates to urbanisation economies – that is where the agglomeration economies are driven by pure economic mass (e.g. city size) rather than specific linkages between firms within a city. By definition urbanisation economies are those which are external to the firm and the industry but internal to the city (or region). Clearly such economies are of little relevance to sparsely populated rural areas, as it is difficult for a transport scheme to increase the effective economic mass of a remote or very remote small town much beyond what it is prior to the intervention. However, urbanisation economies are of relevance to accessible rural areas and accessible small towns. This is because better accessibility to urban centres can have significant impact on the productivity of businesses in say the accessible small town. Furthermore, Graham (2007b) identifies diminishing marginal returns to agglomeration. The benefits of improved accessibility on economic mass are greatest when employment densities are low. This again points to urbanisation economies as being highly relevant to accessible rural areas and accessible rural small towns.
- 5.6 Localisation economies are a different form of agglomeration economy and, in contrast to urbanisation economies, may prove of some importance to the appraisal of certain transport projects in very remote areas. Localisation economies are those that are external to the firm but internal to the industry. They are, therefore, driven by proximity of firms to firms within the same sector or related sectors and to the size of the industry specific workforce. Of the industries Graham (2004 Table 1) identifies as exhibiting strong tendencies towards localisation (or clustering) several of them are prevalent in the remote or very remote parts of Scotland. These include textile manufacturing, oil and gas extraction, fishing, fish processing and food and drink processing. In terms of the spatial distribution of these industrial clusters of the top 30 local authorities exhibiting industry localisation 6 of them are in remote or very remote regions of Scotland (Graham, 2004 Table 4). These regions include the Shetland Islands (oil) and the Scottish Borders (textiles). Fishing is the main clustered industry in Eilean Siar (Western Isles) and Argyll and Bute. The other two areas that exhibit industrial clustering are the Orkney Islands and Dumfries and Galloway. Some of the clustering arises as a result of comparative advantage (e.g. inshore prawn and lobster fishing). No localisation economies would be expected for such clusters. Other observed clusters (e.g. the capital intensive deep sea fishing and the oil and gas sectors) could well be subject to localisation economies due to, for example, linkages in the supply chain and the sharing of knowledge between businesses.
- 5.7 Whilst an international literature on localisation economies exists this mainly focuses on the manufacturing sector (see Rosenthal and Strange, 2004). Graham (2009) presents new evidence on localisation economies in the UK, and, importantly, he does not confine his analysis to the manufacturing sector. Amongst the industries in which Graham finds statistically significant localisation economies are the food and drink sector (which includes fish



processing) and the paper and pulp sector - both of which are important employers in the remote and very remote areas of Scotland. He reports an elasticity of productivity to industry employment of 0.074 and 0.059 respectively for these industries. With respect to other industries in remote and very remote areas exhibiting localisation (fishing, oil extraction and service activities and textiles) he does not find any statistically significant localisation economies. For the primary sector industries this may have arisen as these industries are treated as a single sector. Graham also finds that localisation economies tend to attenuate quite rapidly with distance. Almost all localisation externalities are found within 10km of a firm.

- 5.8 How localisation economies will impact on the appraisal of a transport project in a remote or very remote area is uncertain, as, to date, the data on elasticities of productivity to localisation have not been used in this context. It is expected that localisation economies will have a positive impact on the economic benefit of a transport intervention where they exist, but will probably be more muted than the effect of urbanisation economies. This is for several reasons: the elasticities of productivity to localisation are much smaller than the corresponding elasticities of productivity to urbanisation (Graham, 2009); the effect of localisation economies dissipates quite rapidly with distance (a quite limiting factor in an area where populations are dispersed); and the proportion of the population that work in the clustered industries is small. For example, only 6% of the population work in the fishing sector in the Western Isles and 5% in the Shetland Islands, whilst only 3% of the population work in the mining and quarrying sector (includes oil extraction) in the Shetland Islands (GROS, 2008 Table UV77). This view is supported by the fact that Bråthen (2001) found no evidence of external economies affecting the growth of four firms located near to recently constructed fixed link crossings.
- 5.9 In the main, therefore, localisation economies are probably not going to be of significant relevance to an 'average' transport scheme in a remote or very remote area. Clearly, there will be exceptions to this, such as where a transport intervention specifically targets a known cluster (e.g. improving road links to/from Peterhead an important fishing cluster in Aberdeenshire). To understand the full relevance of localisation economies in these exceptional cases, further work is needed to expand the evidence base on the elasticities of productivity and to disaggregate it further (e.g. identify elasticities of productivity for known clusters in remote and very remote areas). Even here it will be necessary to consider the 'two-way road effect' in the location of economic activities (see paragraph 5.35 below).

### ***Imperfect competition (WB3)***

- 5.10 If a market failure occurs in the product and services market then a transport induced expansion of output will give rise to an additional welfare impact stemming from this market. This is because in the presence of a market failure output is not at its socially optimum level. Two sources of market failure can be identified; that associated with taxation on final products (i.e. indirect taxation) and that arising through the market power of firms. Since transport appraisal practice in the UK already takes account of the additional welfare impacts associated with indirect taxation (Sugden, 2002 pp.8-10;

2005) indirect taxation is not considered further. With respect to the second source of market failure, firms may hold market power as they engage in product differentiation or become large relative to their market. The latter is particularly true in geographically isolated areas as exemplified by very remote rural areas, where as a consequence of geography firms can act as local monopolists.

- 5.11 Venables and Gasiorek (1999 Table 2) using synthetic data estimate that in a two region one sector economy with imperfect competition the additional welfare impact from an expansion in output is between 30 and 40% of the change in consumer surplus derived by business and freight users. This result relates to a partial equilibrium analysis, in that changes induced in other sectors of the economy (the general equilibrium effects) are of no net social value – that is price equals marginal social cost in all other sectors of the economy. Davies (1999) and Newbery (1998) who undertook reviews of the Venables and Gasiorek research consider the 30-40% figure to be an upper limit.
- 5.12 For the UK as a whole the Department for Transport estimate that, on average, the additional impact of an expansion in output is 10% of the change in consumer surplus derived by business and freight users. This is based on a UK wide price-cost margin of 0.2 and an elasticity of demand for goods and services of 0.5 (DfT, 2005 p.49). These data are sourced from a range of studies on price-average cost and price-marginal cost margins for the UK plus an estimate of the elasticity of demand for goods and services<sup>7,8</sup>.
- 5.13 Market isolation in rural areas mean that firms can hold more market power in these areas than they do in urban areas. Prices are certainly higher in rural areas of Scotland. In 2003 petrol prices were on average 9.7% higher than in urban areas whilst food was 11.0% higher (Sneddon Economics, 2003 p.1). Not all of this price difference can be attributed to differences in market power as the cost of transporting goods to the locality and differences in economies of scale in production (if goods are produced on-site) and economies in retailing account for some of the difference. Identifying the component of the price differential attributable to market power and the component attributable to differences in operating costs is difficult.
- 5.14 There is a notable lack of evidence on price-cost margins specific to rural areas of the UK. As part of this review we have contacted all those academics involved in the 1999 SACTRA study (Professors Vickerman,

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<sup>7</sup> An assessment of imperfect competition should be based on price-marginal cost margins as the market failure occurs when prices do not equal marginal costs. Price-cost margins and price marginal cost margins are only equivalent when industries exhibit constant returns to scale.

<sup>8</sup> It should be noted that this calculation rests on the assumption that the monopolist does not price differentiate. If a monopolist is able to discriminate between consumers they will expand output towards the socially optimum level and convert some of the surplus under the demand curve to producer surplus. In this scenario there will be a lower, and at the limit zero, additional welfare impact in the product market. With a price differentiating monopolist average price-cost margins will not be a good indicator of market power. To date this issue has not been explored in the literature, and we will not return to it, but we note that such an argument undermines the general case for wider economic benefits in the product market.

Harris, Davies and Newbery). None of them have undertaken any further work in the area since 1999, though Newbery has an interest in pricing in the energy sector. The evidence base is, therefore, restricted to that reported in SACTRA (1999) and DfT (2005). The most disaggregate data, at a geographic scale, separates Scotland and Wales from the English regions (e.g. Harris, 1999) but does not disaggregate further. This is too coarse, as in a Scottish context there needs to be a distinction between North West Scotland and the islands and the rest of Scotland (i.e. between remote/very remote areas and accessible rural and urban areas. The lack of research of on price cost margins at an appropriate level of geographic disaggregation has arisen in part because of the difficulty in obtaining good quality data on prices and marginal or average cost (long or short run). David Newbery has made us aware that there has been a recent research effort to derive marginal cost estimates by estimating production functions to data contained in input-output tables. Given that input-output tables exist for Scotland as a whole, the Western Isles and the Shetland Isles, such a research project may assist our understanding of regional variations in price-cost margins.

- 5.15 As a consequence our best understanding of the market conditions in rural areas is probably the Office of Fair Trading (OFT) studies into the supply of petrol (OFT, 1998; 2000). The OFT has the power to examine companies' financial transactions to identify if excessive margins are made, a power that other researchers do not have. In their view the petrol industry is competitive across the UK as a whole because of the proximity of consumers to many different suppliers. This competitive argument breaks down in very remote rural areas where they concluded that a lack of competition in some localities gave rise to higher prices (OFT, 1998 p.73). By implication this implies higher price-marginal cost margins in very remote areas compared to elsewhere.
- 5.16 A more detailed OFT study examining petrol and diesel pricing in the Highlands and Islands identified a wide variation in prices across the region (OFT, 2000). Typically prices rise as one moves north west from Inverness and the Inner Moray Firth area. The OFT found no evidence of a failure of competition in the Inner Moray Firth area. Margins increase the more remote a mainland petrol station is (see Table 5.1). The OFT also found that the increase in margins is principally associated with increases in retail margins, as, for example, wholesale margins are 0.1p less in the Western Isles than elsewhere (once transport costs have been accounted for). These remote petrol stations with the high margins can have a captive market, but also tend to have higher operating costs per unit of output. The OFT found that the five petrol stations with the highest prices sold less than 180,000 litres of fuel a year (i.e. < 10% of the average in the Inner Moray Firth area). Of the islands investigated (Western Isles, Orkney Islands and Shetland Islands) the OFT had serious concerns about excessive pricing in only the Western Isles. For the Orkney Islands and the Shetland Islands they found that, whilst prices were similar to the Western Isles, average volume throughputs were smaller.

**Table 5.1: Regional comparisons of petrol prices, margins and volumes**

Area	Average pump price for unleaded petrol (ppl)*	Average combined gross retail/wholesale margin (ppl)	Average annual site volume (petrol and diesel) litres
UK	62.9	5.3	2,800,00
Highlands and Islands	66.2	8.7	950,00
Inner Moray Firth	64.2	<8.7	2,170,000
Remote Highlands	67.0	>8.7	710,000
Western Isles	71.7	14.1	760,000
Isle of Lewis/Harris (Western Isles)	71.5		1,250,000

\*Between May 1999 and March 2000

Source: OFT (2000, Table 8)

5.17 A mixed picture, therefore, presents itself. Competition in the supply of petrol appears to work effectively in rural accessible areas (like the Inner Moray Firth) as it does in other parts of the UK, but can breakdown in some of the most remote locations (the Western Isles). A lack of intense competition in very remote parts, whilst not constituting a problem from the perspective of the OFT, can lead to higher price cost margins. Compared to the UK petrol industry as a whole, price-cost margins in the Highlands and Islands are 64% larger (= 8.7/5.3 see Table 5.1). Clearly margins in the rural accessible parts of the region are lower than this (comparable to UK wide levels), whilst margins in the remote and very remote parts are larger than this. Some of this difference is associated with differences in scale in operation, but the other reason for the difference is a lack of local competition.

### ***Pro-competitive effects (WB2)***

5.18 Transport improvements by bringing regions closer together increase the intensity of competition between firms, eroding dominant market positions and reducing price-cost mark-ups. Output prices, therefore, lower by more than the reduction in transport costs, increasing total output towards competitive conditions. This increase in output has a welfare impact that is additional to transport user benefits. This is for the same reasons that the WB3 wider economic impact arises.

5.19 We have not been able to identify any evidence on transport induced pro-competitive effects that has any added value to DfT (2005 pp.41-44). As mentioned above research in the area of imperfect competition has, as far as we can ascertain, been limited since SACTRA (1999).

5.20 Drawing from the petrol supply study, the petrol stations which exhibit the highest mark-ups are very remote and it is difficult to see how much more competition a 'realistic' transport project could expose them to. This would be the same for businesses in other sectors. The exception could be the introduction of Road Equivalent Tariffs across the whole ferry network. Close monitoring of the impacts of the Road Equivalent Tariff pilot to the Western

Isles would, we anticipate, be a useful piece of research on pro-competitive effects.

### ***Labour supply effects (WB4)***

5.21 STAG, following DfT (2005; 2008), identifies three labour supply effects which have consequences for welfare benefits. For each of these effects changes in employment have welfare impacts additional to transport user benefits as a result of a market failure in the labour market arising through the presence of an income tax. There is no evidence to suggest that elements covered here are any less important in urban compared to rural areas. The three effects are:

- WB4a: Changes in the number of people choosing to work (as a result of a change in commuting costs);
- WB4b: Changes in the number of hours worked (as a result of a change in commuting costs); and
- WB4c: relocation of jobs to higher-productive areas.

5.22 No advice regarding the calculation of these effects is given in STAG, though further guidance is being considered by Transport Scotland. Given that this remains under consideration it is not proposed to discuss these three effects further, though as just mentioned it is worth noting that they are as applicable to rural areas as they are to urban areas.

5.23 In addition to the above, the literature identifies two further labour supply effects that give rise to welfare benefits, the first is in relation to an excess supply of labour (i.e. involuntary unemployment), whilst the second is related to thin labour markets. The labour market failure that gives rise to the former effect is wages that are sticky in a downward direction, whilst the failure for the latter effect is the presence of job search costs which drive a wedge between the wage and the marginal product of labour. Following the notation used in STAG we term these effects WB4d and WB4e respectively.

### **EXCESS LABOUR SUPPLY EFFECTS (WB4D)**

5.24 If involuntary unemployment exists the market clearing wage lies below the actual wage rate, and the actual employment level is below the market clearing level. Inflexibilities in the labour market due to, for example, wages being sticky in a downward direction; or the existence of national minimum wages or industry specific minimum wages can lead to such a situation. As with other labour market failures, if employment expands as a consequence of a transport intervention the welfare benefits of the expansion are larger than the transport user benefits associated with the change in commuting costs (Elhorst and Oosterhaven, 2008; Laird, 2008 pp.188-191).

5.25 Elhorst and Oosterhaven (2008) show in their appraisal of four variants of a maglev<sup>9</sup> line that labour market effects in peripheral regions can have a substantial impact on scheme benefits. Depending on the route of the maglev

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<sup>9</sup> Magnetic levitation train

line under consideration, they found that wider economic impacts may change benefits as measured in a conventional transport cost benefit analysis by between -1% and +38%<sup>10</sup>. Their results are very interesting in a number of ways. Firstly, they demonstrate that including wider economic impacts into an appraisal can lower as well as increase economic welfare, and, secondly, they indicate that for what appear to be very similar projects (each project variant is a maglev line) very different levels of additionality can be obtained. The differences between the project variants arise as a result of the different impacts they each have on the labour market. The two variants that provide a high speed link between the four cities of the Randstad, that is the variants that re-enforce the Randstad agglomeration, have positive impacts for overall productivity of the Randstad region, however, these variants also have a negative welfare impact on the regions from which labour is extracted. The opposite is the case for the variants that link the periphery (Groningen) to the core (the Randstad). As the welfare gain from improving the efficiency of the labour market exceeds the productivity decrease from shifting employment from the core to the periphery, the maglev variants which link the Randstad (the core) to Groningen (the periphery) have more net positive additionality than the projects that link the four cities of the Randstad.

- 5.26 This example on the face of it suggests that there could be substantial additional economic impacts for transport projects in peripheral rural regions – i.e. remote or very remote rural areas. The results are, however, case dependent. In this instance they arise as a consequence of both the characteristics of the regional labour markets, the manner that the project variants re-distribute employment between regions, and the manner that national wages by industry prevail in the Netherlands. The latter point is extremely important. In the Netherlands there is a legal mechanism, the setting of national wages by industry, which means an excess supply of labour will prevail in peripheral regions when the market clearing wage is below the minimum industry wage. In contrast there is no legal mechanism in the UK that keeps the wage above the market clearing wage (unless that wage is below the national minimum wage). This combined with the fact that those losing jobs in rural areas are thought to have a higher propensity to migrate away from an area completely rather than remain in an area and search for a job (Monk and Hodge, 1995) mean that in the UK this market failure has less relevance to peripheral rural areas despite the evidence from the Netherlands.
- 5.27 Evidence for this position includes the fact that of the eight local authorities considered remote or very remote in Scotland only one (the Western Isles) has an unemployment rate in excess of the Scottish average. Furthermore, three of the lowest five local authority unemployment rates are associated with remote or very remote local authority areas. Falling population levels, as evidence of out-migration, are also evident for all the Scottish island groups<sup>11</sup> and the north and north-west coasts of Scotland (Sutherland, Caithness and Lochaber) (HIE, 2003 Table 2). The combination of low unemployment levels and propensity to migrate to other regions suggest that in rural areas of

<sup>10</sup> Oosterhaven and Elhorst (2003) report a wider range (-15% to +83%) derived from earlier versions of the model.

<sup>11</sup> The population of the Outer Hebrides (Eilean Siar) dropped by 10% between 1991 and 2001

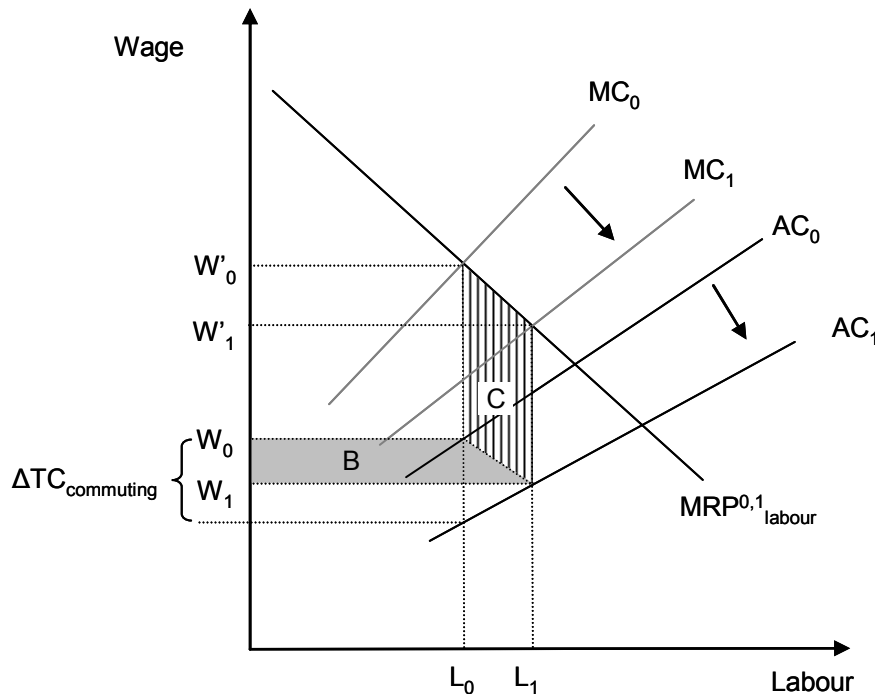
Scotland there is no significant discrepancy between the wage and the market clearing wage. It is, therefore, concluded that unlike the Netherlands there is no market failure in the rural labour market due to wage inflexibility. In the UK market failure from wage inflexibility is probably more relevant to urban areas where unemployment is high (e.g. Glasgow).

#### THIN LABOUR MARKET EFFECTS (WB4E)

- 5.28 Labour markets in rural areas are often viewed as thin as job opportunities are limited (Findeis and Jenson, 1998; Vera-Toscano, Phimister and Weersnik, 2004). The limiting case of a thin labour market is the monopsony case where only one employer exists for labour. This illustrative case is worth examining as, whilst it is not a realistic depiction of a modern labour market, the consequence of the market failure (a wedge between the marginal product of labour and the wage) is relevant to thin labour markets.
- 5.29 A monopsony employer faces an upward sloping labour supply curve. If it cannot discriminate then to recruit additional workers it needs to raise the wage paid to all workers. This implies that the marginal cost (MC) of labour supply to the firm lies above the average cost of labour supply (AC). This is illustrated in Figure 5.1. To maximise profits the firm will, therefore, employ  $L_0$  workers and pay them  $W_0$ . This is because when employment is at  $L_0$  profits for the firm are maximised with the marginal cost of labour equal to its marginal revenue product ( $MRP_{labour}$ ). Employment levels ( $L_0$ ) are, therefore, below those of full employment. That is the labour market is inefficient. In equilibrium a wedge, therefore, exists between the marginal revenue product of labour and the wage received by workers. A reduction in commuting costs shifts the labour supply curve downwards from  $AC_0$  to  $AC_1$ . A shift in the marginal cost curve experienced by the firm also occurs and a new equilibrium occurs at employment level  $L_1$  and wage  $W_1$ . The surpluses felt in the labour market from the commuting cost reduction are, therefore, given by Areas B and C. Area B is already included in commuter user benefits, whilst Area C, the welfare benefit of expanding employment, is additional to transport user benefits.
- 5.30 As already mentioned the limiting monopsony case of a single employer is not in itself of direct relevance to modern economies or rural economies. For example, only 73.8% of workers in the Highlands and Islands work in a firm with less than 100 workers (HIE, 2003). The modern monopsony literature in which (a lot of) competing firms have some market power over workers, is, however, of relevance to modern economies (Bhaskar, Manning and To, 2003; Manning, 2003a). In this literature it is argued that a large number of independent and competing firms are able to exert market power over workers due to: the presence of imperfect information on the part of workers and firms; the heterogeneous preferences of workers; and workers' mobility costs. Job search models (see Rogerson, Shimer and Wright, 2005 for a survey) encapsulate some aspects of this source of market power. In these models unemployed workers have difficulties in finding information on job vacancies, and even if there are many jobs within the workers' neighbourhood only a small percentage of them become vacant at any one time. From the

perspective of the employee labour markets are therefore thin, even if there are many firms.

**Figure 5.1: Welfare impact of a commuting cost reduction under monopsonistic competition (with no labour tax)**



- 5.31 The wedge between the wage and the marginal product of labour is critical to the estimation of the wider economic impact of a transport project in a thin labour market (i.e. Area C in Figure 5.1). The wedge itself depends on the elasticity of the labour supply curve faced by the firm (noting under perfect competition it should be perfectly elastic), however, a good estimate of this elasticity still eludes labour economics. On average what estimates that are available suggest that wages will, on average, be about 17% below the marginal product of labour (Manning, 2003a Chapter 4). With reference to Figure 5.1 this implies that the average difference between  $W'_0$  and  $W_0$  represents 17% of  $W'_0$ . This implies that if employment generation effects are significant (i.e. the difference between  $L_0$  and  $L_1$  is important) the size of Area C may well be substantial. This hypothesis is confirmed by Pilegaard and Fosgerau (2008) who implement a Pissarides (1990) type job search model into a spatial computable general equilibrium (SCGE) model populated with Danish economic data. The model is then used to evaluate a transport quality improvement that increases labour supply at a national level. They report significant additional benefits of around 30% of commuter user benefits arising from the labour market (for an economy with no labour tax) as a consequence of search imperfections.
- 5.32 Laird (2008 Chapter 8) uses commuting and income data from the Scottish Household Survey to investigate whether a labour market failure in remote and very remote Scottish labour markets occurs as a result of job search costs. If job search costs exist then theories on job search predict that



workers will only receive partial compensation for commuting costs (Manning, 2003b; van Ommeren and Rietveld, 2005; Rouwendal and van Ommeren, 2007). Laird finds that workers in remote and very remote labour markets are not compensated for their commute, implying a market failure exists. It is considered that this occurs as mobility costs are high in remote and very remote areas with low workplace densities and long commuting distances. Job search costs for workers and firms are also high in remote and very remote areas, as workers do not have ready access to job centres, vacancies are often not advertised, and successful job search is often attributed to contacts and networks (Monk and Hodge, 1995; Lindsay, Greig and McQuaid, 2005). Laird (2008) also finds that women and men with low skilled jobs do not, on average, receive compensation for their commute. We believe a market failure in these labour market segments occurs as a result of restricted geographic job search areas, arising either due to familial constraints or a lack of mobility in housing (Madden, 1981; 1985; Zax, 1991; Ihlanfeldt, 1992; McQuaid, Greig and Adams, 2001).

- 5.33 The presence of higher search and mobility costs in remote and very remote areas is, therefore, expected to lead to a larger degree of inefficiency in remote and very remote rural labour markets. The result is that an increase in employment in remote and very remote labour markets will have an economic impact greater than that captured through commuter user benefits.

### ***Employment and GDP impacts***

- 5.34 Residents in remote and very remote rural areas and small towns typically have lower incomes and fewer job opportunities than those in accessible and urban areas. For policymakers in remote and very remote areas this leads to a strong focus on the income and employment effects of transport schemes. A good transport scheme in the context of a local stakeholder of a remote region is often one in which regional incomes and employment increase.
- 5.35 Transport schemes, whilst improving efficiency and wealth at a national level, will not necessarily lead to an increase in wealth or employment levels in the region in which they are located. This is due to what is known as the 2-way road effect. Essentially transport quality improvements, whilst making it cheaper for firms in a remote region to export goods and services, also make it easier for competitors based outside the region to import goods into the region. The net effect is that production becomes centralised. Neo-classical economics predicts that if a region holds a comparative advantage over other regions then the centralisation of economic activity will occur in that region. The New Economic Geography literature adds to this by theorising that the comparative advantage one region holds over another also includes economic mass. Economic activity that is mobile will centralise in the region with the largest economic mass. Thus when transport costs are so high that inter-regional trade is prevented, economic activity is split equally between regions. When transport costs fall mobile economic activity centralises in the region with the largest economic mass – the core. The other regions, the periphery, specialise in economic activities that are fixed in location (e.g. tourism, mining, forestry, fishing, agriculture, etc.). From a policy perspective this model is pessimistic, as it predicts improving transport quality increases spatial

inequalities. Production centralises in the core region, the region to which labour migrates, whilst the periphery increasingly specialises in activities that are fixed in location. Such effects have been observed in reality (e.g. the Appalachian region in the US where improved road infrastructure in the 1960s and 1970s accelerated the rate of de-population).

- 5.36 The model described above has its limitations. Historically we initially observe a centralisation of economic activity as transport costs fall, but this is then followed by dispersion as costs continue to fall. Hence, falling transport and communication costs are associated with a rise in spatial inequalities and then a fall. This is confirmed by the evolution of the spatial pattern of activities in France: taking 1860 as a benchmark benchmark, Combes *et al.* (2008) observe that manufacturing activities are more concentrated in 1930 and more dispersed in 2000 than in 1860. This is attributed several factors: (i) workers have different matches with regions (i.e. despite higher wages in large agglomerations some workers will choose to remain in their 'home' region), (ii) non-traded goods, especially housing, have higher prices in big agglomerations, (iii) firms belonging to the intermediate and final sectors compete for workers, and (iv) firms fragment their activities across spatially separated units. Graham (2007b) also demonstrates that in the UK there are diminishing returns to size of agglomeration, and at a certain point the returns become negative. This too points towards an ultimate pattern of dispersion should transport costs continue to fall.
- 5.37 How economic activity re-distributes in space following a transport cost reduction is dependent on the strength of the different push-pull factors between agglomeration and dispersion. No general rules can be developed as everything depends on the relative strengths and characteristics of the regions in question. What is clear is that improved transport quality will foster economic change in a spatial context. Furthermore, given the evidence that improved transport quality firstly increases concentration and then leads to dispersion (e.g. Combes *et al.* (2008)) it is anticipated that further improvements in transport quality in a mature economy, such as Britain, will ultimately lead to a dispersion of economic activity to regional centres, though some centralisation may occur in the first instance.. Whether agglomeration or dispersion is the outcome of a transport intervention is of course case dependent. We, therefore, confirm the importance of the EALI component of a STAG appraisal in determining the economic outcome of a transport intervention – particularly when an underlying aim of the transport intervention is regional economic growth.
- 5.38 It is clear from comments made by stakeholders during the consultation exercise that the link between the EALI impacts, the TEE and the STAG planning objectives is perceived to be weak (if an underlying aim is regional economic growth). Despite the inclusion of EALIs in STAG a gap still remains in the metrics that a rural policymaker uses to judge a scheme (the EALI) and those a welfare economist uses (the TEE and WEBs). We consider that cost effectiveness analysis is a useful tool that could be used to bridge this gap. The two cost effectiveness indicators that stand out as tools for linking

economic growth and employment growth into an appraisal are cost per job created and/or cost per local GDP impact (see equations 1 and 2 below).

$$\text{Cost per job} = \frac{PVC}{\text{Discounted change in number of jobs over project life}} \quad (1)$$

Where 1 job is defined consistently with the STAG guidance on the EALI analysis.

$$\text{Cost per unit increase in regional GDP} = \frac{PVC}{\text{Discounted change in regional GDP over project life}} \quad (2)$$

- 5.39 A third indicator that is relevant when the NPV of a project is negative is the net cost per job (see equation 3). This is analogous to indicators such as the net cost per tonne of carbon in recent Department for Energy and Climate Change (DECC) guidance.

$$\text{Net cost per job} = \frac{PVC - PVB}{\text{Discounted change in number of jobs over project life}} \quad (3)$$

Where 1 job is defined consistently with the STAG guidance on the EALI analysis.

It is considered that these three indicators would form useful cost effectiveness analysis instruments when the employment and/or wealth creation are underlying objectives of a transport intervention.

- 5.40 There have been a number of studies of the willingness to pay by government for job creation (see English Partnerships, 2003 for a review). As can be seen from Table 5.2 the range found by English Partnerships varied from £7,700 to £32,400, in 2003, with an average of £17,200.

**Table 5.2: Gross Cost per Gross Job (£)**

Total Public sector cost/total gross jobs	Gross Cost per Gross Job	Indicative Description
Minimum	£7,700	⇒ Small, low risk projects with significant private investment OR large programmes with fewer/lower costs of remediation e.g. premises provision or environmental improvements only
Average	£17,200	
Maximum	£32,400	⇒ Small, high risk projects with little or no private investment OR large programmes with high remediation costs (high contamination) or significant infrastructure investment required

Source: English Partnerships (2003 Table 1)

- 5.41 The use of cost effectiveness indicators as a replacement for the Net Present Value or Benefit Cost Ratio economic indicators is not recommended. This is because the cost effectiveness measures are too narrow to capture all the impacts of the project. The strength of the cost effectiveness measures are in the ability to assess the performance of the project against its economic objectives and, therefore, to provide a better link between the different elements of the economic appraisal (i.e. between the TEE and the EALI).

## **Relevance to transport appraisal**

### ***Using the research evidence base***

#### **AGGLOMERATION (WB1)**

- 5.42 The principal source of UK evidence on elasticities of productivity to effective density (both urbanisation and localisation economies) is Graham (2007a, 2007b, 2009). STAG already refers to this research. It should be noted that to fully capture the impacts of urbanisation economies on accessible rural areas and accessible small towns it is necessary to use the productivity elasticities that demonstrate variable returns to agglomeration (Graham, 2007b) rather than average elasticities by industry (e.g. as presented in DfT (2005 Table 2).

#### **IMPERFECT COMPETITION (WB3)**

- 5.43 There is limited evidence on price marginal cost margins as a whole let alone at a detailed geographic level. Any application of the evidence that does exist is, therefore, subject to a reasonable degree of uncertainty. Theory points towards higher price marginal cost margins in remote areas where competition is less intense, compared to areas where competition is more intense. Evidence from the petrol supply sector supports this position, where margins across the Highlands and Islands are 64% higher than across the UK. The higher on average margins in the region disguise wide variations in local margins: from margins that are comparable to the rest of the UK in the urban and accessible rural area of the Inner Moray Firth to high margins in the very remote parts of the region. It, therefore, seems reasonable to infer that margins in the very remote parts of the region are more than double those in the more accessible parts.
- 5.44 Taking the petrol supply sector as a barometer for price-cost margins in other sectors leads us to consider that the added value of additional output in the very remote areas of Scotland is larger than in the less remote parts of Scotland. That is the wider economic impact WB1 is larger in very remote parts of Scotland than in other parts *ceteris paribus*. How much larger is an open question, that, ideally, future research would help answer.
- 5.45 To summarise, it is, therefore, considered that there is a valid argument that the uplift to business and freight user benefits used to capture the added value of increased output should be higher in very remote areas. For transport schemes in the Central Belt where competition is intense an uplift of 10% is used in STAG. For very remote rural areas an uplift of double this, i.e.

20%, is considered reasonable, though it is based on very limited evidence that price cost margins are double those in more accessible areas. The rationale for doubling the uplift in very remote rural areas compared to urban and accessible areas is that on average petrol and diesel margins in the Highlands and Islands are 64% higher than the UK average. This average disguises large variations between the accessible area surrounding Inverness, where margins are comparable to national averages, and the very remote parts of the region where margins can be almost three times larger than the UK average. An uplift of 20% means that in an appraisal increased economic output has twice the added value in very remote areas compared to other areas *ceteris paribus*. It should be noted that where a scheme impacts on businesses in very remote areas and other areas (e.g. an upgrade to the A9 Perth to Inverness) only the user benefits of business and freight traffic originating / destinating in the very remote area should have the 20% uplift applied to them.

#### PRO-COMPETITIVE EFFECTS (WB2)

- 5.46 No further evidence on pro-competitive effects to that detailed in the DfT's guidance on wider economic impacts has been identified.

#### LABOUR SUPPLY EFFECTS (WB4)

- 5.47 We have argued that wider economic impacts WB4a, WB4b and WB4c are as applicable to rural areas as they are to urban areas. As STAG guidance on measurement of these effects is being considered no further comment is made on them. It has also been argued that excess labour supply effects (WB4d) are not relevant in rural context, and, therefore, confine our comments to the issues associated with applying the existing evidence base on thin labour market effects (WB4e) in an appraisal.
- 5.48 From the perspective of measuring thin labour market effects the key issue is the size of the wedge between the marginal product of labour and the wage. It is this that determines the additional welfare benefit associated with the creation (or loss) of employment. As discussed earlier there is a lack of evidence on the size of this wedge, though Manning argues that on balance the evidence indicates it to be 17% below the marginal product of labour on average. That is on average the marginal product of labour is 20% higher than the wage. For highly mobile labour market segments we would expect this wedge to be a lot smaller than 20%, whilst for the segments of the labour force that experience high mobility costs the wedge will be larger.
- 5.49 The limited evidence that is available indicates that high skilled male workers in accessible rural and urban areas experience low mobility and job search costs, whilst women, those with low skills and those in remote and very remote areas experience high search costs and high mobility costs. It is suggested that this evidence can be used in an appraisal by taking the added value of employment creation (displacement) over the change in transport user benefits to be:

- Zero if the job created (or displaced) is held by a male worker in a high or medium skilled occupation (manager, professional or technical occupation);
- Equal to 20% of the wage if the job created or displaced is held by a worker in a remote or very remote area, a women or someone in a low skill occupation.

5.50 It should be noted that the limited evidence referred to above relates to evidence on compensation for commuting costs through the wage. There is a substantial literature on the disadvantages faced in the labour market by low skilled workers and by women, and whilst it may therefore seem controversial to distinguish by gender and occupation this finding and recommendation is entirely consistent with other labour economic literature on this subject (e.g. Madden, 1981; 1985; Zax, 1991; Ihlanfeldt, 1992; McQuaid, Greig and Adams, 2001)

5.51 To calculate the net welfare impact of displaced employment it is, therefore, necessary to calculate both the welfare benefits of job creation and the welfare costs of the jobs that are displaced.

### ***Case study 1 (contd) – Berneray Causeway and Sound of Harris Ferry***

#### **AGGLOMERATION (WB1)**

5.52 The populations on Berneray are too small and too dispersed for urbanisation economies to have an effect. Localisation economies may, however, be relevant. Graham (2004) identifies the Outer Hebrides as an area in which the fishing sector is clustered. The proportion of the working population employed in the fishing sector on Berneray and North Uist is 21% and 10% respectively (GROS, 2008), though the absolute numbers are small – 8 people on Berneray and 38 people on North Uist. This comprises of about 7% of those working in the fishing sector in the Outer Hebrides. The main fishing industry in the Outer Hebrides is based in the Isles of Lewis and Harris, which between them have about 50% of those employed in the fishing sector in the island group. The main deep water harbour in the island group is also located on Lewis. As the Berneray causeway does not impact on transport costs of businesses in Lewis (the location of the main cluster), and the fishing sector in Berneray and North Uist is small, the Berneray causeway is not expected to enlarge the existing cluster. This view is supported by the evidence gathered by Halcrow Fox who did not identify any employment impacts of the Berneray causeway for businesses in the agriculture or fishing sectors (Halcrow Fox, 1996 Table 3.1). Furthermore, there is no evidence to date that the fishing sector experiences positive elasticities of productivity to economic mass (e.g. Graham, 2009). The Berneray causeway is not, therefore, expected to generate any wider economic impacts due to localisation or urbanisation externalities.

## PRO-COMPETITIVE EFFECTS (WB2)

- 5.53 As has been argued earlier, there is no evidence on the pro-competitive effects as a consequence of a transport intervention. This effect has therefore not been evaluated.

## IMPERFECT COMPETITION (WB3)

- 5.54 A wider economic impact arising from imperfect competition in the product market can only occur if there is an expansion in output. There is only indirect evidence that such an expansion in output occurred as a consequence of the Berneray causeway. Halcrow Fox found evidence that businesses on and off Berneray expected turnover to increase, whilst a real cost of living reduction was also anticipated by Halcrow Fox. If households experience a cost of living reduction then the surplus can be used to purchase other goods that were not previously available (i.e. expand output). The SQW (2004) ex-post study confirms that such a cost of living reduction did occur, as it finds that households through reduced transport costs and lower prices were £407 better off per year (in 2003).
- 5.55 A wider economic impact of £15,000 (1996 resource prices and 2000 values) attributed to imperfect competition is estimated for the first full operating year (2000). This is 20% of the sum of time savings accruing to businesses. This is based on an assumption that 56% of time savings is attributable to business benefits (SACTRA, 1999 paragraph 3.55).

## THIN LABOUR MARKETS (WB4E)

- 5.56 If the wage does not equal the marginal product of labour then changes in employment lead to wider economic impacts in the labour market. Once again wider economic impacts will only be felt if employment levels change. Halcrow Fox estimate that construction of the Berneray causeway leads to a net increase of 38.5 full-time equivalent (FTE) jobs. If it is assumed that:
- Employment does not increase at the national level as a consequence of implementing the project. That is all the jobs created by the project are re-distributed from other parts of the UK;
  - The additional jobs in Berneray and North Uist are re-distributed from accessible rural and urban areas;
  - 22% of the 38.5 full time equivalent jobs created by the causeway will be held by men in medium to high skilled occupations, and 78% will be held by men in low skilled occupations or by women. These proportions derive from the Scottish Household Survey dataset (2000-2004); and
  - The wage of all jobs created (and destroyed) by the transport intervention is £263 (1996 prices and 2000 values). This is based on a median gross weekly wage in the Western Isles for all full time employees of £445 in July 2008 (Scottish Government, 2008).

5.57 This gives an estimate of the wider economic impact due to efficiency gains in thin labour markets in the first full operating year of £23,000 (1996 prices and 2000 values). The calculation behind this is summarised in Table 5.3.

**Table 5.3: Welfare benefits of employment creation in the Western Isles (£1996 prices and 2000 values)**

Location	Occupation	FTE jobs	Wage per week	Total change in regional incomes per annum	Additional welfare benefit as proportion of wage	Welfare benefit
Jobs created in Western Isles	All occupations	+38.5	£263	£527,000	20%	£105,000
Jobs displaced from Accessible rural and urban areas	Male high and medium skilled	-8.5	£263	-£116,000	0%	£0
	Low skilled and female high and medium skilled	-30.0	£263	-£411,000	20%	-£82,000
						£23,000

## COST EFFECTIVENESS ANALYSIS

5.58 The two cost effectiveness measures calculated are public sector cost per regional job and public sector cost per £1 of regional GDP.

5.59 The causeway construction and ferry enhancement are expected to create 38.5 FTE years of employment for every year of the appraisal period. This gives a present value of 881 years of employment<sup>12</sup>. Following STAG (section 9.4.5.7) 10 years of employment are treated as equivalent to 1 job. The project, therefore, creates 88.1 jobs over the appraisal period. With a Present Value of Costs of £8,023,000 this gives a public sector cost per job of £91,000.

5.60 Halcrow Fox do not provide any estimate on the change in regional GDP as a consequence of the intervention. It is, therefore, necessary to develop our own estimates of changes in GDP. From Table 5.3 we estimate that additional employment increases regional GDP by £527 thousand pounds in 2000. Assuming zero real growth in GDP per annum this gives a present value<sup>12</sup> of GDP impacts of £17.2 million pounds (1996 prices and values). The public sector cost per regional GDP pound is, therefore, £0.47.

## SUMMARY

5.61 The revised economic impact of the Berneray causeway and re-cast of the Sound of Harris ferry is summarised in Table 5.4. As can be seen from this table, the inclusion of scheduling costs (see Chapter 2) and wider economic impacts increases the overall benefit of the project by 55% (from £200,000 in 2000 to £310,000). Wider economic impacts (£38,000) form a substantial 19% of user benefits (measured as the sum of time and cost savings). If,

<sup>12</sup> Cost effectiveness measures calculated using current appraisal period (60 years) and discount rates (3.5% for first 30 years and 3% for second 30 years).



however, user benefits are measured so as to include scheduling costs then the wider economic impacts form 14% of user benefits. This is a relatively significant sum.

- 5.62 The project is estimated to create 38.5 FTE jobs locally and increase regional GDP by just over £0.5 million. The cost effectiveness indicators for these economic impacts are estimated as £91,000 of public sector expenditure per FTE job and £0.47 of public sector expenditure per £1.00 of regional GDP. With a positive NPV (see below) there is no need to calculate the third cost effectiveness indicator net cost per job.
- 5.63 With a 55% increase in PVB due to the inclusion of scheduling costs and wider economic benefits we estimate the NPV of the project would go from (negative) £1.4 million to (positive) £1.8 million and the BCR from 0.8 to 1.2.

**Table 5.4 Benefits of the Berneray causeway and Sound of Harris ferry service enhancement in first full operating year (2000)**

	Economic impact (£)	
	Existing approach	Extended scope
User Benefits	200,000	200,000
Scheduling costs (see Table 2.3)	N/A	72,000
Agglomeration effects(WB1)	N/A	0
Pro-competitive (WB2)	N/A	Not estimated
Imperfect competition (WB3)	N/A	15,000
Labour supply (WB4)		
No. of people working (WB4a)	N/A	Not estimated
Hours worked (WB4b)	N/A	Not estimated
Relocation of jobs (WB4c)	N/A	Not estimated
Excess labour supply (WB4d)	N/A	0
Thin labour markets (WB4e)	N/A	23,000
Single year benefits	200,000	310,000

Note: 1996 resource prices and 2000 values

### **Case study 8 – A82 Tarbet to Fort William**

- 5.64 The A82 trunk road between Glasgow and Fort William is the principal road link to the west of Scotland. The 108 kilometre section of the route between Tarbet and Fort William is single carriageway and passes through some of Scotland's most spectacular scenery. The route action plan (Scott Wilson, 2006) identifies four sections of the route for improvement:
- Loch Lomond: Tarbet to Inverarnan;
  - Crianlarich Bypass;
  - Loch Tulla climbing lane; and

- Corran Ferry to Fort William (part of).
- 5.65 The estimated cost of the improvements including optimism bias is £99.3 million (2006 prices). A phased implementation plan over 10 years is envisaged. The PVB of the project is estimated to be £94 million and the NPV is estimated to be £8 million (2002 prices and values). The BCR is 1.09. The benefits of the project are driven principally by time savings, though accident savings are also important.
- 5.66 The strategic nature of the road means that the economic impact of the route action plan is felt over a very wide area that encompasses the whole of the Western Isles, Skye and Lochalsh, Lochaber and Lorn and the Isles. Tribal (2005 Table 1, Table 2 and Appendix B) estimate that under their full investment scenario 1,040 jobs will be created. However, this estimate is based on a substantial enhancement to the route between Ballachulish and Fort William of which only 4km is appraised in the Scot Wilson route action plan. The additional jobs and income estimated by Tribal are, therefore, on the high side. We, therefore, use the Tribal 'low' scenario. In this scenario economic growth is assumed to be half of that in the central scenario. That is 520 jobs are created of which 185 jobs are additional at the national level. They also estimate that between 2010 and 2039 the project will generate additional income in the region of £378 million (undiscounted).

#### AGGLOMERATION (WB1)

- 5.67 It has not been possible to estimate any agglomeration impacts associated with the A82 Tarbet to Fort William road. The detailed level of analysis that such an estimation would involve is beyond the scope of this work, though a preliminary analysis would suggest that the potential for such effects are low. The majority of the jobs and additional income brought about by the route enhancement are expected to arise in the tourism sector (200 jobs), manufacturing sector (70 jobs) and fishing sector (65 jobs). Of this, in this region, we would expect only the manufacturing jobs to lead to some agglomeration benefits. However, even for that to occur the additional manufacturing jobs need to be located in proximity to manufacturing clusters. The Tribal report does not attempt to identify the precise locations of the new manufacturing jobs and given the large study area (the whole of the Western Isles, Skye and Lochalsh, Lochaber and Lorn and the Isles) it is expected that the route enhancement will not lead to any substantial changes in employment density.
- 5.68 Without further evidence, the A82 Tarbet to Fort William route enhancement would not be expected to generate any agglomeration benefits – either through localisation economies or urbanisation economies.

#### PRO-COMPETITIVE EFFECTS (WB2)

- 5.69 As has been argued earlier, there is no evidence on the pro-competitive effects as a consequence of a transport intervention. This effect has therefore not been evaluated.

## IMPERFECT COMPETITION (WB3)

- 5.70 The business interviews conducted by Tribal (2005) clearly demonstrate that businesses within the region expect output to expand, thereby ensuring that one of the conditions for additionality in the product market occurs. Whilst the study area includes some parts that are classified as remote (i.e. Tarbet to Crianlarich) the vast majority of the economic impact would be expected to occur in the remainder of the study area which is classified as very remote. A 20% mark-up on all business time savings to calculate the wider economic impact of increased output in imperfectly competitive markets has, therefore, been used.
- 5.71 It is estimated that the present value of WB3 to be £10.5 million (60yr discounted). This is based on an assumption that 56% of the PVB is attributable to business time savings<sup>13</sup>. This assumption has had to be made because Scott Wilson (2006) do not break the PVB down into its constituent parts.

## THIN LABOUR MARKETS (WB4E)

- 5.72 The summary employment impact of the low scenario is an additional 520 jobs are created in the study area – a predominantly remote rural area – of which 185 of the jobs will be additional at the national level. That is 335 jobs will be displaced from other areas (accessible rural and urban areas).
- 5.73 With an average gross wage of £367 per week (HIE, 2003) and 78% of employees either having low skills or being female this gives an estimated welfare benefit of £1.0 million in a single year in the appraisal period (see Table 5.5). With no real growth in wages the 60 year present value of this benefit is £15.7 million (2002 prices and values).

## COST EFFECTIVENESS ANALYSIS

- 5.74 Under the Tribal (2005) low scenario the A82 route enhancement is expected to create 520 FTE years of employment in the study area in each appraisal year. This gives 60 year present value of 8,290 years of employment at the regional level (i.e. a present value of 829 jobs, where 1 job equals 10 years of employment). With a PVC of £85.65 million (including optimism bias) this gives a public sector cost per job of £103,000.
- 5.75 Tribal estimate additional income in the study area of £378 million (undiscounted) over the 30 year period from 2010 to 2039. Assuming the additional income is the same in each appraisal year (£12.6 million) and extrapolating to a 60 year appraisal period gives a 60 year present value for additional income (GDP) of £201 million (2002 prices and values). The public sector cost per regional GDP pound is, therefore, £0.43.

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<sup>13</sup> This is likely to be an overestimate as on average 56% of the total time saving benefits is attributed to business traffic. The PVB also includes safety savings and vehicle operating cost savings.

**Table 5.5: Welfare benefits of employment created by the A82 Tarbet to Fort William (£2002 prices and values)**

	Location	Occupation	FTE jobs	Wage per week	Total change in regional incomes per annum	Additional welfare benefit as proportion of wage	Welfare benefit
Jobs created	Study area (remote rural)	All occupations	520	£367	£9,900,000	20%	£2,000,000
	Sub-total		520				£2,000,000
Jobs displaced	Accessible rural and urban areas	Male high and medium skilled	-74	£367	£1,400,000	0%	0
		Low skilled and female high and medium skilled	-261	£367	£5,000,000	20%	£1,000,000
	Sub-total		-335				£1,000,000
Total (net)			185				£1,000,000

## SUMMARY

- 5.76 The enhanced economic impact of the A82 Tarbet to Fort William route enhancement is summarised in Table 5.6. As can be seen from this table, the inclusion of wider economic impacts increases the overall benefit of the project by 28% from £94 million to £120 million.
- 5.77 The project is estimated to create 520 FTE jobs locally and increase regional GDP by £378 million over 30 years (i.e. increase regional GDP by £12.6 million per year). The cost effectiveness indicators for these economic impacts are estimated as £103,000 of public sector expenditure per FTE job and £0.43 of public sector expenditure per £1.00 of regional GDP. With a positive NPV (see below) there is no need to calculate the third cost effectiveness indicator net cost per job.
- 5.78 With a 28% increase in PVB due to the inclusion of wider economic benefits it is estimated that the NPV of the project would increase from £8.1 million to £34.4million and the BCR from 1.09 to 1.40.

**Table 5.6 A82 Tarbet to Fort William economic appraisal summary (£ million, 60 year present values, 2002 prices and values)**

	Economic impact	
	Existing approach	Extended scope
User and safety benefits	93.78	93.78
Agglomeration effects(WB1)	Not estimated	Not estimated
Pro-competitive (WB2)	Not estimated	Not estimated
Imperfect competition (WB3)	Not estimated	10.50
Labour supply (WB4)		
No. of people working (WB4a)	Not estimated	Not estimated
Hours worked (WB4b)	Not estimated	Not estimated
Relocation of jobs (WB4c)	Not estimated	Not estimated
Excess labour supply (WB4d)	N/A	0
Thin labour markets (WB4e)	N/A	15.75
PVB	93.78	120.03
PVC	85.65	85.65
NPV	8.13	34.38
BCR	1.09	1.40

## Recommendations for STAG

- 5.79 There is limited evidence on wider economic impacts and for this reason the WEB analysis is only recommended as a sensitivity test in STAG. This

approach is considered appropriate. The limited evidence base means the existing WEB guidance is based on only a limited number of studies. This is in direct contrast to say travel time savings, where there is an extensive evidence base collected over many years. Clearly the WEB evidence base becomes smaller as one tries to disaggregate evidence between rural and urban areas and between different types of rural area. Theory and what evidence is available point towards a larger degree of imperfect competition in very remote rural areas than in the urban areas, accessible rural or remote rural areas (Scottish Government definitions) and to the existence of thin labour markets in remote and very remote areas. From a practical perspective the two case studies conducted demonstrate that market failures in very remote rural areas can lead to significant economic benefits additional to transport user benefits.

5.80 Three market failures already set out in STAG have been reviewed in this chapter. Additionally two new market failures (in the labour market) have been identified from the international literature as well as a set of indicators that could act as a link between the EALI and TEE analysis. With respect to each of these it is considered that the following recommendations are appropriate – whilst noting that the economic impact of WEBs is only used as a sensitive test in developing the STAG economic indicators (PVB, NPV and BCR):

- Agglomeration. This market failure is already well covered in the STAG guidance though the guidance could possibly be enhanced through an improved discussion as to when agglomeration economies will be relevant in rural areas (e.g. when linking a remote small town to a large agglomeration or addressing particular industrial clusters).
- Imperfect competition. It has been argued that the product and services markets are, as a result of geographic isolation, more imperfect than the equivalent markets in more accessible areas. Evidence from the supply of petrol in the Highlands and Islands would suggest that price-cost margins in very remote areas are double those in more accessible areas. A mark-up to business user benefits of 20% (i.e. double the mark-up for accessible areas) is suggested for very remote rural areas and very remote rural small towns.
- Pro-competitive effects: As no further evidence on pro-competitive effects have been found, no recommendation is made regarding changes to the STAG guidance in this area.
- Excess labour supply effects: It is considered that out-migration from rural areas ensures that there is no excess supply of labour in rural areas. There is, therefore, no market failure and as a consequence no recommendation regarding this effect is needed.
- Thin labour market effects. Search costs in thin labour markets give rise to a market failure in remote and very remote labour markets. The creation of employment in remote and very remote areas therefore has a welfare impact greater than that captured through commuter user benefits. It is suggested this impact is equivalent to 20% of the gross

wage. When incorporating these benefits into an appraisal it is also necessary to take into account the welfare costs of displaced jobs.

- Finally, it is considered that the link between the EALI component of the appraisal and other aspects of the appraisal (the planning objectives and the TEE) could be improved through the calculation of cost effectiveness measures when the aim of the intervention is regional economic growth. The measures we suggest calculating are the public sector cost per regional job and public sector cost per regional GDP £1.

5.81 The recommendations for wider economic benefits by area type are summarised in Table 5.7. Aside from the recommendation regarding imperfect competition these recommendations are more complex to implement than those suggested in earlier chapters. Saying that where an EALI assessment exists (as it did for the case studies) the recommendations concerning the assessment of thin labour market effects and the derivation of cost effectiveness indicators are straight forward. If an EALI assessment did not exist it would be difficult and expensive in resource terms to add these impacts to the economic appraisal. The assessment of agglomeration impacts in urban and peri-urban is well known to be resource intensive and this level of resource commitment is also expected to extend to rural areas – should they be relevant. It may, however, be possible to adapt the APARC model to make the assessment of agglomeration impacts in rural areas less resource intensive.

5.82 The limited evidence base on wider economic impacts means that almost any research is of value. The nature of the subject means that the research will be complex and that for some issues there is a risk the results may be inconclusive. It is considered that the following four research areas, from a rural perspective, are worth pursuing:

- (1) Agglomeration effects. There is a need to disaggregate the existing elasticities to distinguish between the industry clusters evident in rural areas;
- (2) Imperfect competition: The ferry Road Equivalent Tariffs pilot to the Western Isles could have a substantial impact on prices and price-cost margins. An ex-post study on the economic impacts of the ferry fare reduction with respect to prices and competition would be of value;
- (3) Imperfect competition. Applied economic research has attempted to derive marginal cost estimates by estimating production functions to data contained in input-output tables. The existence of input-output tables for Scotland, the Western Isles and the Shetland Islands means that such research could be considered in Scotland; and
- (4) Thin labour markets. Job search costs are the cause of the market failure in remote and very remote labour markets. The development of specific job-search models for these areas would add to the literature. If the models could be embedded into either a partial or general equilibrium model that included the transport sector this would have added value for transport appraisal.

**Table 5.7: Applicability of wider economic impacts by area type and mode (all modes)**

		Accessible rural / accessible small town (<30 mins from urban area with population>10,000)	Remote rural / remote small town (>30 mins and <60 mins from urban area with population>10,000)	Very remote rural/ very remote small town (>60 mins from urban area with population>10,000)
Agglomeration effects(WB1)		Applicable	Limited applicability <sup>(1)</sup>	Limited applicability <sup>(1)</sup>
	Pro-competitive (WB2)	Not-applicable <sup>(2)</sup>	Not-applicable <sup>(2)</sup>	Not-applicable <sup>(2)</sup>
Imperfect competition (WB3)		Applicable	Applicable	Applicable (higher mark-up to business time and reliability savings than for accessible and remote areas)
Labour supply (WB4)	No. of people working (WB4a)	Applicable - STAG guidance forthcoming	Applicable - STAG guidance forthcoming	Applicable - STAG guidance forthcoming
	Hours worked (WB4b)			
	Relocation of jobs (WB4c)			
	Excess labour supply (WB4d)	Not-applicable <sup>(3)</sup>	Not-applicable <sup>(3)</sup>	Not-applicable <sup>(3)</sup>
	Thin labour markets (WB4e)	Not-applicable <sup>(4)</sup>	Applicable	Applicable

Notes: (1) Agglomeration effects may have limited applicability in remote and very remote areas as (a) the industrial sectors prevalent in these areas may not exhibit significant agglomeration externalities; and/or (b) unless the transport intervention links small towns together or links small towns to urban areas there is unlikely to be a significant change in economic mass. (2) No evidence on pro-competitive effects additional to that detailed in DFT(2005) has been found. (3) Evidence indicates that involuntary unemployment is not a significant issue in rural areas. The response to unemployment is often inter-regional migration. Whilst this might be a policy issue, it does not constitute a market failure in the labour market. (4) The evidence suggests that labour markets in accessible rural areas are not uniformly thin.



## 6 CONCLUSION

- 6.1 Rural areas are different from urban areas. From an economic perspective it is the sparseness of the transport networks and the low densities of population that give rise to a set of issues not faced in more densely populated urban areas. In public transport networks there are often only a limited number of departures per day making scheduling costs important. The lack of alternative modes and opportunities to find employment combined with low traffic volumes can make option and non-use values more relevant than in urban areas. Additionally, the geographic isolation of very remote rural areas can lead to the market power of firms being of more relevance in rural areas than in urban areas. The latter implies that wider economic benefits are as applicable to rural areas as they are to urban areas.
- 6.2 There is a wide variation in the quality of the evidence base across these different impacts. It is most developed for scheduling costs and least developed for wider economic impacts. On the basis of the evidence that is available, the inclusion of scheduling costs, option and non-use values or wider economic benefits can be key for rural areas. It is, therefore, recommended that STAG is updated with regard to these different impacts.
- 6.3 It is considered that there is sufficient evidence for scheduling costs to be included in economic appraisals as a norm. It is believed that for some rail appraisals this already occurs and there appears to be no reason why it should not be formalised and extended to other modes. Scheduling costs are already included in Norwegian appraisals of fixed links under the term inconvenience costs. Inclusion of scheduling costs in the generalised cost of ferry services would improve demand modelling methods for fixed links. Another issue that is important to account for when estimating demand for fixed links is changes in car occupancy. It should of course be noted that demand estimates have impacts on the safety and environmental aspects of a STAG appraisal as well as the economic assessment.
- 6.4 The evidence base for option and non-use values is more limited and it is recommended that the STAG economic appraisal is only sensitivity tested to the inclusion of these values. Option and non-use values capture the value that improved accessibility has to households, and, therefore, naturally sits under the accessibility criterion in STAG. It is considered that only schemes which already score highly under the accessibility criterion would generate option and non-use values that could significantly affect the outcome of an appraisal.
- 6.5 Theory and the limited evidence that is available point toward imperfect competition effects being more relevant in very remote rural areas than in other parts of the country. This is because the product and services markets are, as a result of geographic isolation, more imperfect than the equivalent markets in more accessible areas. It is therefore recommended that STAG should be updated to include a larger mark-up on business user benefits in very remote areas than currently occurs. A mark-up double that used in accessible areas is suggested (i.e. 20%).

- 6.6 Theory and the evidence that is available point towards mobility and job search costs in remote and very remote labour markets as being an important market failure in some rural areas. It is considered that the importance that policy makers place on increased output and increased employment in remote and very remote areas is, in part, a reflection of the additional welfare value that such increases hold. The creation of employment in remote and very remote areas therefore has a welfare impact greater than that captured through commuter user benefits. It is suggested this impact is equivalent to 20% of the gross wage. When incorporating these benefits into an appraisal it is also necessary to take into account the welfare costs of displaced jobs.
- 6.7 As already mentioned increased output and employment in rural areas is typically viewed very positively. It is therefore important to confirm that STAG, through the Rule of Half, attributes the appropriate benefit to both existing traffic and induced traffic. This review has confirmed that position. It should also be noted that the Rule of Half convention actually overestimates the change in consumer surplus (i.e. the benefit) – albeit only slightly for small and medium sized changes in generalised cost. If induced traffic has added value in a rural area, this will be captured through wider economic benefits associated with imperfect competition effects and thin labour market effects discussed above.
- 6.8 It is well known that user benefits can be significantly overestimated using the Rule of Half convention if the change in travel cost is large and incomes are low. For example, where cost changes are >33% the error becomes >10%. For some transport schemes in rural areas cost changes in excess of 33% can occur. It is recommended that STAG specifically alludes to alternatives to the Rule of Half (i.e. numerical integration or direct integration) for calculating the change in consumer surplus when the change in generalised cost exceeds 33%.
- 6.9 Furthermore, where the change in consumer surplus is large compared to incomes the compensating variation should be estimated as the measure of the economic value of the project (rather than the change in consumer surplus). As the estimation of the compensating variation of transport projects is still an active research area, it is premature to make a recommendation regarding its calculation. It is, therefore, recommended that the ratio of change in consumer surplus to income is calculated (at a household level) for all schemes where large cost changes are expected (>33%). When these proportions are large this will serve as an indicator that the change in consumer surplus may include a significant overestimation.
- 6.10 The final recommendation concerns the use of cost effectiveness measures to improve the link between the EALI, the STAG planning objectives and the TEE. Discussions with stakeholders identified a perceived weakness in STAG where one of the objectives of the scheme is economic growth, as it often is in rural areas. The use of cost effectiveness measures, such as the public sector cost per job created and the public sector cost per unit increase in regional GDP, will assist in demonstrating how well the transport intervention achieves its objectives – when economic growth is one of the aims of a transport intervention. A third indicator that is relevant when the NPV of a

project is negative is the net cost per job. This is analogous to indicators such as the net cost per tonne of carbon in recent Department for Energy and Climate Change guidance. It emphasises that these measures are not a replacement for the NPV and BCR measures that indicate a project's net worth to society. This is because the cost effectiveness measures identified do not capture the full socio-economic benefits of a project.

- 6.11 There is plenty of scope for further research to help fill the evidence gaps identified. In identifying research priorities it is necessary to balance research budgets, transport investment priorities, the probability of a successful outcome and the academic merit of the research. On the basis that the priority for Transport Scotland is research that has a high probability of giving useable output with immediate policy relevance, the recommended research proposals needs are set out below. Opportunities to develop the evidence base will also come up as projects with particular features, relating to scheduling costs, option and non-use values and wider economic benefits, are appraised.

#### SHORT TERM EVIDENCE NEEDS

- 6.12 **Scheduling costs:** There is a reasonable body of evidence on the value of scheduling costs for the rail and bus modes, though this is limited to situations where frequencies are good (e.g. headways of less than 1 hour). There is much less evidence on the cost of long headways, short operating hours and the scheduling costs of ferry and air modes. Expansions to this evidence base in these areas (ferry and air modes and long headways and short operating hours) are needed. Stated preference surveys are probably the most effective method of surveying these data.
- 6.13 **Imperfect competition and pro-competitive effects:** There is a need for more evidence on the degree of imperfect competition in very remote areas, and the effect that transport projects can have on reducing the degree of the market failure. Given that the ferry Road Equivalent Tariffs pilot to the Western Isles could have a substantial impact on prices and price-cost margins, an ex-post study on the economic impacts of the ferry fare reduction with respect to prices and competition would be of value. This could be linked to the ongoing evaluation of the Road Equivalent Tariffs pilot. The study would need to collect data on the manner that prices change in response to the Road Equivalent Tariffs pilot and whether the change in prices is greater or less than would be expected from the change in transport costs alone. This would require business surveys.

#### MEDIUM TERM EVIDENCE NEEDS

- 6.14 **Option and non-use values:** There are a number of evidence gaps in the option and non-use value literature. These include how option and non-use values dissipate with distance from the transport service, how they vary with size of employment centre (e.g. Inverness versus Edinburgh, or Edinburgh versus Edinburgh and Glasgow), how they vary with quality of service. There is also a need to expand the evidence base from local bus and rail services to road infrastructure, ferry services, air services and mainline rail services (e.g.

high speed rail), as well as to the values that businesses may hold. Stated preference surveys are probably the most effective method of surveying these data;

- 6.15 **Agglomeration effects:** At this moment in time the elasticities of productivity to economic mass published by the DfT are difficult to apply to rural areas as some of the important industrial clusters in such areas (e.g. oil and gas, deep sea fishing) are not separately identified in the dataset. There is therefore a need to disaggregate the existing elasticities to distinguish between the industry clusters evident in rural areas. It is thought that this might be best undertaken through an extension to the econometric work previously commissioned by the Department for Transport;
- 6.16 **Measuring user benefits:** When changes in generalised cost are large (>33%) the use of the Rule of Half may lead to a significant overestimation of user benefits due to either the assumption that the demand curve is linear or that income effects are negligible. Alternatives to the Rule of Half (e.g. numerical integration or direct integration) may be appropriate in some circumstances, but it is likely that the number of applications of these methods will be limited due to computational difficulties. There is therefore a need to develop rules that relate the size of the overestimation associated with using a linear demand curve and secondly the change in consumer surplus as a measure of welfare benefit when cost changes are large. Research that develops rules giving the size of the overestimation as a function of the size of the expected cost change and the expected consumer surplus (to an individual/household) and their income would be of value. It is anticipated that such research would compare the user benefits calculated using several different mathematical forms and comparing these against output from a transport model. Survey methods (e.g. stated preference) could also be employed to as a further means of validating the analytically derived willingness to pay for transport improvements.

## LONGER TERM EVIDENCE NEEDS

- 6.17 **Imperfect competition effects.** As mentioned above there is an evidence gap concerning the degree of imperfect competition in very remote areas. Applied economic research has attempted to derive marginal cost estimates by estimating production functions to data contained in input-output tables. These estimates can be used to determine price-cost margins and therefore the degree of imperfect competition. The existence of input-output tables for Scotland, the Western Isles and the Shetland Islands means that such research could be considered in Scotland; and
- 6.18 **Thin labour market effects:** Job search costs are a cause of market failure in remote and very remote labour markets. There is a need to better understand the impact of this market failure on transport economic appraisal. The principal evidence gap concerns the wedge between the marginal product of labour and market wage. Empirically this 'wedge' is difficult to estimate. An alternative indirect approach to model the wedge would be to develop specific job-search models for remote and very remote areas and embed these in either a partial or general equilibrium model that included the transport sector.

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## APPENDIX A – CONTACT LIST

Organisation	Contact point	No response / Corresponded
<b>Regional Transport Partnerships</b>		
HITRANS	Dave Duthie, Frank Roach	Corresponded
NESTRANS	Kirsty Morrison	Corresponded
SWestTRANS	John Nelson	Corresponded
ZetTRANS	Michael Craigie	Corresponded
<b>Local authorities</b>		
Aberdeenshire Council	Ewan Wallace	Corresponded
Argyll and Bute Council	Nicola Debham	Corresponded
Dumfries and Galloway Council	(see SWestTRANS)	Corresponded
East Ayrshire Council	Alastair Wyper	No response
Eilean Siar	Murdo Gray	No response
Highland Council	Sam MacNaughton	No response
North Ayrshire Council	Jack McConnachie	No response
Orkney Islands Council	Naomi Coleman	No response
Scottish Borders Council	Graeme Johnston	Corresponded
Shetland Islands Council	(see ZetTRANS)	Corresponded
South Ayrshire Council	Neil Rose	Corresponded
<b>Other UK</b>		
Highlands and Islands Enterprise	Tony Jarvis	Corresponded
Department for Transport	Tom Worsley, Vicky Cadman	Corresponded
<b>Overseas</b>		
Norway	Svein Brathen - University of Molde	Corresponded
Sweden	Gunnar Lindberg - VTI research institute	No response
Sweden	Per-Ove Hesselborn - Swedish Institute for Transport and Communication Analysis	No response
Sweden	Peo Nordlof - Swedish Road Administration	No response
Sweden	Henrik Swahn - Swedish Maritime Administration	No response
Denmark	Tine Lund Jenson - Ministry of Transport and Energy	Corresponded
Denmark	Karsten Pedersen - COWI consultancy	Corresponded
Finland	Anton Goebel - Finnish Road Administration	Corresponded
Finland	Esko Niskanen - STAReasearch, Helsinki	No response



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