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The Railway Forum

THE WIDER IMPACTS OF RAIL AND ROAD INVESTMENT

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CONTENTS

EXECUTIVE SUMMARY

With the recent increase in the number of people travelling by rail and the quantity of freight transported by rail, there has been a railway revival. This revival will support new rail services and ease the pressure on Britain's congested roads. In response, plans are being developed which will give greater capacity of track and stations, expanded timetables, and new and faster trains. However, there is a need to assess the wider environmental, economic and social benefits of these plans.

This paper has been commissioned by The Railway Forum from OXERA Environmental to provide a short introduction to the appraisal of the environmental impacts of rail schemes. It draws together The Railway Forum's previous work, and the work of academics, government and others, in a single work of reference. It is designed to be of value to government, regulators, railway managers, local government and planners, with the aim of contributing to the debate about the appropriate level of public support to rail services. The paper presents an introduction to future transport problems, provides a guide to the main methods of assessment of public support for new transport services, and collates published estimates of the financial and environmental costs of road and rail passenger transport.

The challenge for government and industry is to debate the pattern of future public investment in transport, leading to decisions about total investment and priorities. Within this debate, there could be a review of:

- the social, economic and environmental impacts of recent major government expenditure on the road programme and in support of rail; and
- the scale and effectiveness of current approaches to the taxation of road use.

There are challenges for the shadow Strategic Rail Authority (sSRA) as it negotiates new rail franchises and makes decisions about grant funding of rail projects. These include:

- making funding decisions transparent;
- assembling cost data for the railway industry in order to facilitate policy analysis;
- debating the appropriate level of public investment in rail; and
- facilitating an efficient solution to the allocation of investment between passenger and freight capacity to relieve road and rail congestion.

The industry is also challenged to identify priorities for investment and the means of financing and funding these priorities, and to secure the most efficient solutions. The most beneficial investment is likely to be at the most congested points, using integrated solutions. For rail, consideration should be given to choice and access (long-distance and inter-city), and environmental benefits (urban commuter services, freight, and competition with road and air alternatives).

An analysis has been undertaken of the marginal costs of travel by road and rail in the long run, which is the appropriate measure of the cost of meeting future demand. This collation of published data shows that in general road users do not face the full marginal cost of their journey, including the costs they impose on other road users and the environment, despite the fuel duty they pay. In contrast, the analysis shows that rail users face a price that lies between short- and long-run marginal cost.

- This analysis arrives at the important policy conclusion that investment in rail is likely to provide as much benefit, pound for pound, as investment in road capacity.

- In some circumstances investments in rail capacity will be more cost effective than road capacity. For example, rail solutions are likely to be cheaper for journeys terminating in urban areas, especially during the peak when the external costs of road traffic are high.

- Not only is rail favoured on social cost grounds, but also because of its lower environmental cost, and the lower private cost of making a journey (11.7 pence/passenger km for road and 8.5 pence/passenger km for rail). Overall, under the long-run marginal cost analysis, which is appropriate for considering pricing and investment, rail offers an efficient alternative to road.

- Furthermore, the analysis demonstrates that quantification is valuable in developing policy conclusions that would have been difficult to determine qualitatively. This suggests that policy and project appraisal could benefit from a more quantitative methodology.

- An assessment of long-run marginal cost for rail freight is not available. Such an assessment would contribute to the ongoing debate about the UK freight strategy.

- It is incumbent on all concerned to develop the analysis so that conclusions can be drawn about the best way to meet future transport demand across all modes.

These conclusions come at a critical time in transport policy development, as the DETR is developing a ten-year strategy for transport, Railtrack is undergoing its periodic review with the Rail Regulator, and the sSRA carries forward the process of franchise replacement. Now is the time to give consideration to a rigorous analysis of public support for rail that, as far as possible, quantifies and values the wider environmental and social impacts of transport.

1. INTRODUCTION

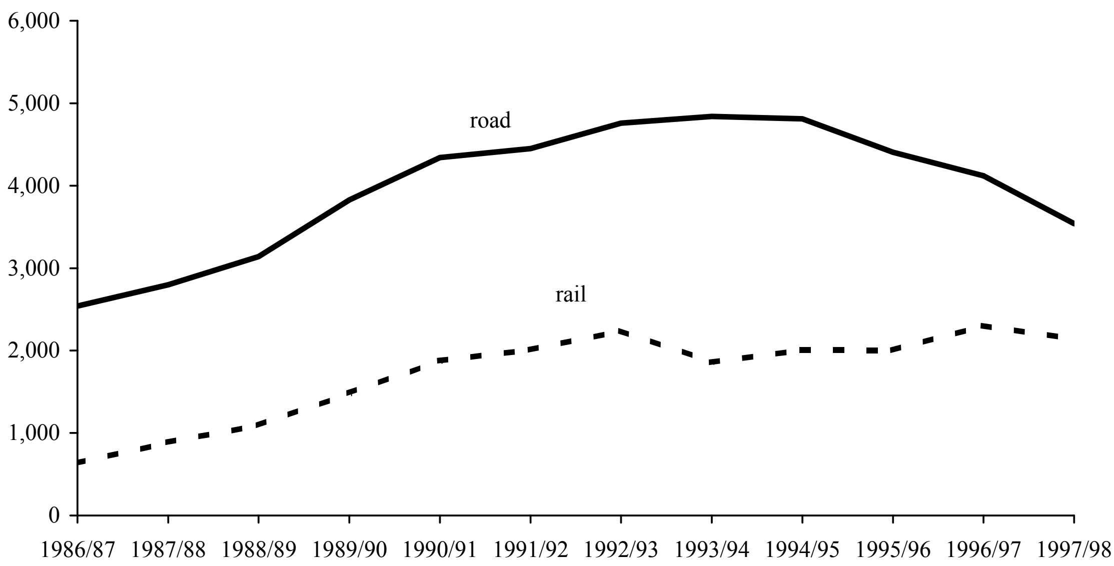
This paper has been commissioned by The Railway Forum from OXERA Environmental to provide a short introduction to the appraisal of the environmental impacts of rail schemes. It draws together The Railway Forum's previous work, and the work of academics, government and others, in a single reference. It is designed to be of value to government, regulators, railway managers, local government and planners, with the aim of contributing to the debate about the appropriate level of public support to rail services and the value delivered by that support. The paper presents an introduction to future transport problems, provides a guide to the main methods of assessment of public funding for new transport services, and collates published estimates of the financial and environmental costs of road and rail passenger transport.

This section provides an introduction to future transport problems.

1.1 Background

In July 1998, the DETR presented a new transport strategy, 'A New Deal for Transport' and identified congestion and pollution as priority policy targets. There are indications that the new strategy may be accompanied by an increase in investment in road and rail transport, reversing recent trends. For example, the DETR has modelled a future rail investment scenario with an increase in annual expenditure up to £1,000m per annum.[1] However, these figures do not prejudge the findings of the DETR's Transport Task Force that is charged with developing a ten-year transport strategy.

Figure 1.1: Recent road and rail infrastructure investment (£m)



Source: DETR (1998), 'Transport Statistics Great Britain', Central Statistics Unit, 1998 edition, Table 1.16.

Government policy is to strike a balance between expenditure on public and private transport, and between road and rail. This balance will have to be struck in various arenas, including national

[1] DETR (2000*c*), p. 28

policy discussion; Scotland and Wales; regional development agencies; PTAs and local planning authorities; and the Mayor of London's office. This paper aims to support the participants in that debate.

1.2 Challenges

The transport strategy is needed to address significant growth in travel. The forecasts for road and rail traffic used by the government and Railtrack are shown in Table 1.1.

Table 1.1: Road and rail passenger traffic forecasts

Mode	Source	Forecasting period	Approximate average annual rate of growth (%)
Road	DETR	1996–2031	1
Rail	DETR high estimate	1996–2011	4
Rail	Railtrack low estimate	1999–2011	2

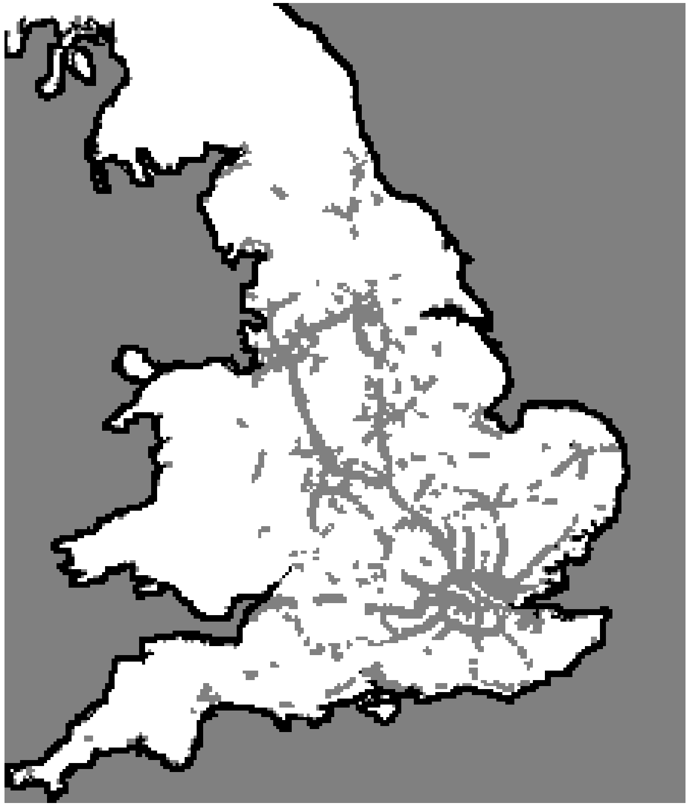
Sources: Railtrack (2000), '2000 Network Management Statement'. DETR (1997), 'National Road Traffic Forecasts', Table 1, and DETR (2000), 'Tackling Congestion and Pollution: The Government's First Report under the Road Traffic Reduction (National Targets) Act 1998'.

Even with the most optimistic scenarios for the management of new demand, the consequences of growth in the above scenarios will be much greater congestion on the transport networks, unless the network capacity is expanded. The effect of greater congestion will be increased air pollution and noise, longer journey times, more crowding, and may result in more accidents. Time delays on motorways are forecast to more than double by 2010, and to increase by 40% on A roads.[2] However, total road transport emissions are predicted to fall because of improved vehicle performance.

The forecast capacity constraints are not uniformly distributed, as illustrated in the maps below. Even so, by 2016, traffic levels are expected to have increased to maximum road capacity on 75% of the motorway network between the hours of 8am and 4pm.

[2] DETR (2000*c*).

Figure 1.2: English motorway and trunk road network in 2016, mid-growth scenario, showing greater than 80% stress—regular peak hour congestion and some congestion outside peak hours



Source: DETR (1997), 'Roads Review Consultation Document—What Role for Trunk Roads in England?' http://www.roads.detr.gov.uk/roadnetwork/nrpd/hpp/trunk/general.htm#current

Figure 1.3: Rail network stress in 1999, network at greater than 70% utilisation of current capacity

Source: Railtrack (1999), ' Network Management Statement', http://www.railtrack.co.uk/corporate/99nms/gb/index.html

The maps do not show local congestion; however, some of the worst congestion is expected to be within urban areas and at peak commuting times, with London already experiencing seven times greater congestion delays per kilometre in the peak period than the average UK road.

The most beneficial investment is likely to be at the most congested points, using integrated solutions. For rail, consideration should be given to choice and access (long-distance and inter-city), and environmental benefits (urban commuter services, freight, and competition with road and air alternatives).

New investment is to be complemented by demand management. The government's adviser, the Commission for Integrated Transport (CfIT), has proposed an ambitious national target to reduce congestion to 1996 levels by 2010.[3]

The challenge is compounded by the need for integration of solutions across modes of transport and by the devolution of planning. Both need coordination and a common methodology, for which purpose new appraisal methods, described in Section 2, have been developed by the government.

1.3 Environment

Transport has a great impact on society and the environment, providing essential services to the economy, but also generating pollution and consuming resources. One of the greatest environmental priorities identified by the Royal Commission on Environmental Pollution (RCEP) is air pollution. In 2010, 35% of roads in London will fail to comply with European air quality legislation for some pollutants as environmental standards tighten, despite improvements in vehicle emissions standards.[4] Another environmental priority is climate change, where transport is a major contributor to global warming, see Table 1.2.

Table 1.2: Predicted CO_2 emissions from transport (MtC)

	1990	1995	2000	2005	2010	2015	2020
Road transport	30	30	33	35	38	40	43
Other transport	5	5	4	4	4	4	4
Other[1]	124	115	108	107	108	112	115
Total	**159**	**150**	**145**	**146**	**150**	**156**	**162**

Note: [1] Other refers to power stations, refineries, residential, services and industry

Source: DETR (2000), 'Energy Projections for the UK', working paper, March.

A set of indicators has been chosen by the government to reflect the range of impacts caused by transport—the cost of traffic congestion, CO_2 emissions, respiratory illness, noise levels.[5]

These will be discussed in section 2.

[3] DETR (2000*c*).
[4] DETR (1998*c*).
[5] DETR (1999*a*).

1.4 Timing

Five strands of planning activity are taking place over the next few months:

- the sSRA is to produce its first strategic document in May;
- the government is developing a ten-year transport strategy;
- TOCs are competing to operate services under new franchises, which will be determined by the sSRA, the Treasury and the DETR;
- some of Railtrack's investment programme will be shaped within the conclusions of the Rail Regulator's periodic review; and
- local transport plans are being prepared by 150 local authorities for submission to the DETR.

At the same time, the government will publish its guidance for assessing multi-modal projects, and the Union Internationale des Chemins de Fer (UIC) will publish a report on environmental costs. This paper has been produced as a contribution to these various activities.

The challenge for government and industry is to debate the pattern of future public investment in transport, leading to decisions about total investment and priorities. Within this debate, there could be a review of:

- the social, economic and environmental impacts of recent major government expenditure on the road programme and in support of rail; and
- the scale and effectiveness of current approaches to the taxation of road use.

2. APPRAISAL

2.1 The wider impacts of transport

This section defines and presents values for the wider impacts of transport, before introducing recent methods for appraising projects. The same data is used to make a policy appraisal in Section 3.

The term 'wider impacts' is used interchangeably with the technical term 'externalities'. When a journey is made, travellers by public transport pay a fare, and motorists pay the fuel and the costs of running a car. However, the journey also has an impact on the community owing to noise, exhaust emissions, risk of accident, and, for cars, increased journey times for other drivers. These other impacts are referred to as external costs, or 'externalities'. Sometimes passenger benefits are referred to as externalities—this is not strictly correct.

Public and private transport differ in the magnitude of externalities created by additional trips. If an additional trip is made using public transport, the externalities are very small, because it is probably not necessary to run additional services. If, however, an additional trip is made by car, it is quite likely that a completely new vehicle journey will be made, generating the full set of externalities described above. This relationship will be explored further in Section 3.

At the predicted level of growth of travel in the UK, additional capital investment in new network will be required. The externalities of the capital investment may include land-take, disruption and construction nuisance. Hence, the potential externalities include congestion; air pollution; accidents; global-warming effect; noise and vibration; and construction externalities.

The potential externalities are highlighted below in the sSRA's checklist of impacts.[6]

Table 2.1: sSRA criteria and checklist of impacts

Criteria	Sub-criteria	External costs of major increment (investment) in demand for road or rail	External cost for additional passenger journey	
			Road	Rail
Environment	Noise and vibration	✓	✓	none
	Local air quality	✓	✓	none
	Global atmospheric emissions	✓	✓	none
	Land and water pollution	✓	none	none
	Landscape	✓	none	none
	Biodiversity	✓	none	none
	Heritage	✓	none	none
Safety	Accidents	✓	✓	none

Note: The sSRA also applies three other criteria economy, accessibility and integration.
Source: Adapted from OPRAF (1999), 'Rail Passenger Partnership—Bidding Guidance', Table 1. The annotation '✓' and 'none' have been added by OXERA Environmental.

[6] OPRAF has now been subsumed within the sSRA.

2.2 Environmental costs

To avoid confusion about the labelling of externalities, definitions are given in the box below. The monetary valuation of unit changes in their impact is described in Sections 2.3 and 2.4.

Definitions

Congestion

Congestion results from competition for road or rail space. High levels of demand relative to the capacity of the road result in longer journey times, and a multiplication of other environmental costs, such as emissions. The effect of congestion is not linearly proportional to traffic—it is much greater at high levels of traffic. This can be modelled, and is usually reported as journey time lost owing to increased traffic. The other environmental costs should be inflated appropriately.

Air pollution

Cars and diesel trains produce exhaust emissions that contain dust and gases (carbon monoxide, SO_2, benzene, particulates (PM10), volatile organic compounds, and nitrogen oxides). About 40% of particulates in the air come from transport. These act as a respiratory irritant, especially for those with existing respiratory conditions, so air pollution reduces the health of these sensitive groups in particular. The estimates of the effect of air pollution on health vary widely depending on the assumptions made by the researcher. The Committee on the Medical Effects of Air Pollution states that, each year in Britain, air pollution may bring forward deaths from respiratory disease up to the following extents: ozone 12,500 deaths; PM10 8,100 deaths; SO_2 3,500 deaths.[7] These deaths may not be brought forward by much, possibly only a few days.

Accidents

Road, rail and air accidents cause damage to property, injury and death. The cost of damage to property is met privately through insurance, but the reduction in quality of life and loss of life resulting from injuries and fatalities is not usually compensated. The relationship between accident rates and traffic levels is disputed; some argue that the accident rate rises with increased traffic levels, others that it falls.

Global-warming effect

Most vehicles use energy that is derived from fossil fuels, and some trains use electricity that is generated partly from non-fossil-fuel sources. The combustion of fossil fuels releases CO_2, a gas that contributes to global warming.

Noise and vibration

Noise and vibration from traffic reduce the quality of life of people exposed to them. They affect house prices, and, in the case of noise, necessitate insulation of properties. 32m UK inhabitants are exposed to road noise in excess of 55dB.[8]

Construction externalities

Construction of new infrastructure generates all the above externalities during the construction phase.

[7] DETR (1998*c*).
[8] The Railway Forum (1999).

2.3 Valuation estimates for the external benefits and disbenefits of rail

Externalities may be valued in monetary terms so that they can be included in a project's financial appraisal. If this is to be done, it is helpful to have some understanding of the origin of the value estimates to be applied.

2.3.1 Value of time

The valuation of time is used extensively in rail and road planning to calculate the benefit of reduced congestion. It is normally used in the calculation of passenger benefits, but can also be used for the calculation of congestion externalities. The working time rates are valued at the employer's labour cost, and non-working time is valued using figures obtained from surveys of people's preferences.

Table 2.2: Values of time

Traveller	Value £/hour (1998/99 prices)
Business	
Car driver	14
Rail passenger	18
Underground passenger	18
Non-working time	3

Source: DETR (1997), 'Highways Economics Note No. 2', http://www.official-documents.co.uk/document/ha/dmrb/vol13/index.htm.

There is argument about the use of different values for journeys of different types and purposes. The standard practice is to differentiate only between working and non-working time. However, survey work has shown that passengers' stated valuation of journey time varies geographically, and between bus, rail, light rail, car and air journeys. It can be political sensitive to differentiate rates regionally or between modes, although there are also pragmatic reasons for using a standard value to make the analysis easier. For the purpose of project appraisal, a standard value of time is usually applied.

2.3.2 Accidents

An accident may result in some or all of the following consequences; medical treatment, time off work, reduced quality of life following permanent injury, and fatality. The cost of medical treatment is well known because it is recorded in health service statistics. The value of time off work is usually equated to the wage cost, and again, statistics of time off work are collected nationally. The human costs of injury and death are much more difficult to value; nevertheless, many people make decisions about their exposure to risk of injury or death involving an implicit valuation through their choice of occupation and pay, and other aspects of lifestyle or the products they buy. Some studies have examined these choices for statistical links between cost and risk of injury or death; other studies have asked people for their own valuations. The values range fairly widely. The DETR's 'Highways Economics Note No. 1' suggests a value for preventing a statistical road fatality at £0.75m–£1.25m. Values in this range are often used in policy analysis. The Department of Health derived a figure of £2m for air pollution, after multiplying by a scaling factor for involuntary risks.[9]

[9] Department of Health (1999), p. 65.

Table 2.3: Average value of prevention per casualty by severity and element of cost (1998/99 prices)

Accident severity	Total, £m
Fatality	0.75–1.25
Serious	0.1
Slight	0.01

Source: DETR (1997), 'Highways Economics Note No. 1', September, Table 1.

2.3.3 Noise

Exposure to noise is regulated by environmental standards. The cost can be valued as the level of compensation set as precedent in the courts, or the cost of insulation against noise. The value attached to noise has been estimated both by relating property prices to ambient noise levels, and through surveys of willingness to pay.

2.3.4 Air quality

The impact of air pollution on health has been modelled, and the consequent change in health status has been valued. The main uncertainty is the relationship between health and air quality. The Department of Health estimates the health costs of particulates in urban areas in Britain to be up to £500m per annum.[10]

2.3.5 Climate change

Climate change is predicted to alter the pattern of rainfall, raise sea levels, cause more frequent storms, and increase temperatures. The consequences are changed agricultural practice, drought, flooding, damage to property, and changed incidence of disease. The valuation estimates are built up from these elements and from estimates of the cost of reducing emissions.

2.4 Unit values

Using these valuation approaches, researchers have estimated unit values for the impacts of each of these externalities. Table 2.4 and 2.5 list average unit values for passenger and freight travelling by road and rail.

[10] Department of Health (1999), p. 7.

Table 2.4: Passenger road and rail external costs (unit values in pence per passenger km, 1998/99 prices)

Criteria		Road			Rail	
		High	Central	Low	High	Low
Environment	Noise and vibration	0.58[1]	0.47[2]	0.26[3]	0.3[3]	*0.27[8]
	Air quality	1.1[4]	0.83[5]	0.61[3]	0.18[10]	*0.13[8]
	Climate change	0.56[5]	0.35[1]	0.19[5]	0.26[3]	*0.2[9]
	Water pollution	0.56[7]	0.56[7]	0.56[7]	n/a	n/a
Safety	Accidents	2.9[3]	1.3[2]	0.81[1]	0.24[3]	0.1[11]
Economy	Congestion	2.7[4]		1.1[6]	0.05[6]	0.05[6]

Note: Calculations courtesy of Railtrack and by OXERA Environmental (indicated *). Newbery's figure (see [7]) represents 15% of the total cost of sewage treatment, estimated in 1995/96 as £3 billion per year. It is then divided by the total road kilometres and half is apportioned to road freight and half to road passenger. Noise values vary between urban and rural services. Congestion also varies greatly between urban and non-urban areas: Peirson and Vickerman (see [6]) estimate inter-urban car congestion at 0.9p/passenger km, compared with a London peak at 16p/passenger km.
Sources: Railtrack calculations using [1] RCEP (1994, 1997). [2] Maddison *et al.* (1996). [3] European Conference of Ministers of Transport, ECMT (1998). [4] Newbery (1995). [5] ExternE (1998). [6] Peirson and Vickerman (1996). [7] Newbery (1998). [8] Tinch (1995). [9] Calculated using Pearce (1994) and ECMT (1998). [10] INFRAS/IWW (1994). [11] Calculated using DETR (1999), 'Transport Statistics', and DETR (1997), 'Highway Economics Note 1'.

Table 2.5: Freight road and rail external costs (unit values in pence per net tonne km, 1999 prices)

Criteria		Road			Rail
		High	Central	Low	
Environment	Noise and vibration	1.2[1]	0.79[2]	0.25[1]	0.53[2]
	Air quality	2.0[2]	1.0[3]	0.51[1]	0.06[2]
	Climate change	0.88[2]	0.42[1]	0.19[3]	0.09[2]
Safety	Accidents	1.9[2]	1.1[4]	0.75[1]	0.07[2]
Economy	Congestion	2.8[4]	2.8[4]	2.8[4]	n/a

Note: Calculations courtesy of Railtrack. A range of estimates for rail freight was not available because of a lack of published rail freight statistics and valuation estimates.
Sources: Railtrack calculations using [1] RCEP (1994, 1997). [2] ECMT (1998). [3] ExternE (1998). [4] Newbery (1995). [5] Maddison *et al.* (1996). [6] Pearce *et al.* (1993).

These are average figures, and the unit values for noise, air quality, accidents and congestion vary greatly according to location and time.

2.5 Future technologies

In the future, rail could benefit from lower-emission diesel engines, and from electricity generated with fewer greenhouse gas emissions. Similarly, road vehicles could benefit from low-emission engine technology, which is expected to reduce all engine emissions by at least 10% over the next decade, and may reduce them by as much as 50–80% in the future. The current appraisals do not reflect these developments, but sensitivity analysis could be carried out to show their possible effect.

2.6 Appraisal methods

The sSRA suggests that the level of appraisal used should be appropriate to the complexity of the scheme and the quality of information available. For small schemes, simple approximations are available; for urban areas, sophisticated models have been developed, such as the London Transport System model; and for inter-urban schemes, complex bespoke models may be needed.

Both a qualitative and a quantitative approach can be employed when assessing the social and environmental benefits at any of these three levels. These are described below.

2.6.1 Qualitative method

This approach records external costs descriptively and is in common use in the transport sector. Sometimes the external cost assessment is structured by scoring the project against qualifying criteria (multi-criteria analysis). Behind the analysis, there may be a quantitative element, but it is not given prominence in the project summary.

An example of this approach is Arthur D. Little's appraisal of Regional Eurostar services to Manchester and Newcastle. A selection from the appraisal summary is shown in Table 2.6.

Table 2.6: Selection from the appraisal summary of Regional Eurostar Manchester/Newcastle option

Criteria	Sub-criteria	Qualitative Impacts	Quantitative measure	Assessment
Environment	Noise	Small increase of noise on rail network mostly daytime and on some station access roads, and corresponding reduction at airports and on access roads to airports.	None	Neutral
	Local air quality	Small marginal reduction at airports and small marginal increase at fossil-fuel power stations.	None	Neutral
	Climate change	Slight net increase in CO_2 emissions owing to small reduction on air services, minimal changes on access modes and additional emissions for Regional Eurostar train, and no change in INTER-CAPITAL emissions.	About 8,000 tonnes of CO_2 annually.	Slightly negative
Safety	Accidents	Some transfer from air and coach will have a minimal impact on overall safety. At current levels for UK, rail is statistically safer than coach or car.	Numbers killed and seriously injured	Slightly positive
Economy	Wider economic impact	Overall, very little economic benefit is expected to result from through services.	None	Neutral

Source: DETR (2000), 'Review of Regional Eurostar Services: Summary Report', independent report by Arthur D. Little, February 2000, Table 31, p. 85.

2.6.2 Quantitative method

This approach records the physical impacts of external costs *and* quantifies them. The analysis usually requires more detailed modelling, and the study therefore typically uses more resources than a qualitative approach. For any study, the modelling assumptions should be clear, and the analysis should be made available to make the process and transparent as possible.

Quantification can be taken further by valuing the physical impacts in monetary terms—cost–benefit analysis. This forces an explicit judgement of the value to society of physical impacts, and thus reveals the assumptions made within the final judgement of benefits and costs. The merit of valuation is demonstrated in the analysis in Section 3.

The extract in Table 2.7 below shows the cost–benefit analysis summary for the Thameslink 2000 project. The example is interesting because the quantification and valuation of the wider (external) benefits, as well as the direct passenger benefits, determined the overall outcome of the analysis, although the published appraisal does not provide details of the valuation stage.

Table 2.7: Thameslink 2000 cost–benefit appraisal

Item	£m (present value)
Direct costs	
Total costs (A)	–1,081
Total incremental revenue (B)	467
Avoided costs (C)	51
Total financial effects (A+B+C)	**–563**
Passenger benefits	
Net public transport passenger time savings	697
Net public transport overcrowding relief	350
External costs and benefits	
Net road congestion relief	193
Construction disbenefits	–21
Total wider benefits (D)	1,219
Net present value (A+B+C+D]	656
Benefit to cost ratio (B+C+D]/A	1.6:1

Note: Discounted to end of 1995 at 6% discount rate, 1995/96 prices.
Source: sSRA (2000), 'Official Case of the Director of Passenger Rail Franchising Transport and Works Act 1992 Applications for The Railtrack (Thameslink 2000) Order, and The Railtrack (Thameslink 2000) (Variation) Order', January 2000, Table 6.11.1.

Valuation techniques are often time-consuming and expensive, and the results are therefore frequently transferred from one study situation to another. This, and the variation in estimates between studies owing to methodological differences, has attracted criticism of the use of values. However, over time, the application of values to aspects of transport appraisal has become generally acceptable, and robust assessments can be made. In an attempt to encourage environmental valuation to be more explicit, Railtrack has published the unit values it uses in its 2000 Network Management Statement.

In order to facilitate the consistent and appropriate use of values, their more extensive use in rail appraisals could be championed by the sSRA.

2.7 Economic regeneration

Transport services have a catalytic effect on the economy, reducing the cost of travel. This improves access to labour and to product markets. Economic regeneration is one of the main aims of the national transport strategy.

Economic regeneration is often included in the description of the benefits of a project by its sponsors, but is rarely quantified and proven. The government therefore asked the Standing Advisory Committee on Trunk Road Assessment (SACTRA) to consider the relationship between investment in transport infrastructure and economic growth. SACTRA concluded that better methods of assessment are needed to measure local and regional economic impact. The balance between new growth and displacement is critical. Economic growth resulting from reduced costs in the economy creates a real increase in wealth; the displacement of employment and employees from one area to another may not.

In conducting an appraisal, it is therefore not sufficient to assume that economic regeneration benefits will occur. Two types of model may be used: one models the cost relationship between travel and land use, the other models the generalised cost of travel in a model of the economy. Their merits are discussed in SACTRA's report. It might be possible, with research, to develop standard models for use in quick desk-top analysis in order to establish approximate multiplier factors.

According to the Guidance on the Methodology for Multi-Modal Studies (which is introduced in Section 2.7.2), consideration should be given as to whether:

- a proposal is significantly beneficial for designated regeneration areas (such as Assisted Area, Single Regeneration Budget, European Structural Fund); and
- there are significant developments within, or adjacent to, the regeneration area that are likely to be dependent upon the proposal being approved. These development sites must form a key part of the pre-existing regeneration strategy.

Two examples of post-investment appraisal of economic regeneration are the Jubilee Line Extension study, conducted by the University of Westminster, and the University of Salford's work on the Manchester Metrolink.

2.8 Methods for appraisal of external costs in practice

There is an overall approach to the assessment of transport investment supported by public funds, known as the New Approach to Transport Appraisal (NATA). This is the umbrella approach for a suite of more specific guidance:

- the Guidance on Methodology for Multi-Modal Studies;
- the Design Manual for Roads and Bridges;
- the guidance on the Freight Facilities Grant; and
- the planning criteria for the Rail Passenger Partnership scheme.

Most of these appraisal guidelines emphasise qualitative analysis, so there is no comprehensive guide to the quantification and valuation of impacts. Qualitative analysis is often sufficient for regulatory purposes, but when major infrastructure projects go to public inquiry, quantification of environmental and social effects might provide a more rigorous case.

2.8.1 New Approach to Transport Appraisal

NATA introduces five policy objectives—accessibility, safety, economy, environment and integration—and was initially applied to roads. The environmental assessment is exactly as described in *Design Manual for Roads and Bridges* (Volume 11, Section 3). NATA provides a protocol for categorising impacts into orders of magnitude, and presenting them in a standardised tabular form. It does not attempt any valuation for air pollution, although it does attach values to time and to accidents.

2.8.2 Guidance on the Methodology for Multi-Modal Studies

The Guidance on the Methodology for Multi-Modal Studies is to be published shortly by the DETR. It provides a systematic methodology for recording the wider benefits or costs of transport investments. It structures the impacts according to the five government criteria, and assesses each in non-monetary and often qualitative terms, valuing only accidents and 'economy' effects such as time savings in monetary terms. The methodology requires the results to be presented on a single sheet of paper—the 'appraisal summary table'—where some impacts are reduced to descriptors such as 'slight' or 'adverse'. Partly because of this prescriptive final presentation, it is a limited approach. Unfortunately, it does not attempt to extend the boundaries of cost–benefit analysis, or to quantify the overall impact of investments in a single measure.

2.8.3 Freight Facilities and Track Access Grants

When assessing applications for the Freight Facilities Grant[11] and the Track Access Grant[12], the DETR uses standard values for lorry miles that would be displaced by proposed new rail freight services. The Freight Facilities Grant offsets the capital costs of new rail freight-handling facilities and of upgrades to existing rail freight facilities. The Track Access Grant offsets part of Railtrack's costs for access to the rail network. Both grants are about the benefits—public, environmental and social—arising from freight being moved by rail rather than by road. In practice this means the environmental benefits of removing lorries from the roads.

The DETR determines the grant potential based on the environmental benefits of the scheme using rates per lorry removed from the road, valued at £0.12–0.93/lorry mile, depending on the type of road. These figures have been derived by the DETR from a more detailed unpublished analysis.

2.8.4 Rail Passenger Partnership

Announced in the Integrated Transport Policy White Paper, rail passenger partnership funding is available for capital and revenue support to cover revenue shortfalls for schemes that are not self-financing. The applicant must demonstrate significant net benefits from the scheme. The awards are made on the basis of the highest net benefit per pound of funding, and the net benefits are assessed qualitatively.

Schemes are assessed against five criteria: accessibility, safety, economy, environment and integration, and prioritised on the net present value of benefits per pound of sSRA support. Mr Mike Grant, Chief Executive of the sSRA, has said that he will consider the magnitude of the value of impacts, not valued in monetary terms, necessary for the scheme to represent value for money.[13] In addition, he has said that he will be open to consider new measurement and valuation methodologies developed to assess these impacts.

2.9 Distribution of benefits

The distribution of benefits should not only be expressed in terms of regional economic priorities, but should also refer to the groups within society who benefit. There is little official guidance on

[11] Section 139 Railways Act 1993.
[12] Section 137 Railways Act 1993.
[13] OPRAF (1999*c*).

how to analyse the distributional impact. The data could be presented as the distribution of demand for the new services across these groups. This has to be undertaken as a largely qualitative analysis. Some of this data is available for current patronage of transport services (for example, the National Travel Survey and London Transport's Market Report).[14]

2.10 Conclusions

In the light of the externalities and the existing studies of their impact, consideration should be given to:

- the explicit valuation of externalities wherever possible, to provide accountability for public funding and allow knowledge to be shared in the planning of further projects;
- the merit of the sSRA explaining in the guidance for grant applications how it makes decisions on the public funding of projects;
- the development of a quick desk-top approach for the appraisal of economic regeneration.

Greater quantification would stimulate the debate about the level of public support for transport infrastructure, as well as the prioritisation of individual schemes within the road or rail programmes.

[14] For further examples of analysis, see Glaister (1999), and Institute for Fiscal Studies (1997).

3. PUBLIC FUNDING OF ROAD AND RAIL

3.1 The average cost debate

Data on the overall social costs of road and rail transport has only relatively recently become readily available, thanks to work by, among others, Maddison, Newbery, Pearce, Peirson and Vickerman, and Tinch. The figures will continue to be refined as further academic work is completed. Some work is currently in progress for the Union Internationale des Chemins de Fer and the ExternE[15] programme of the European Commission.

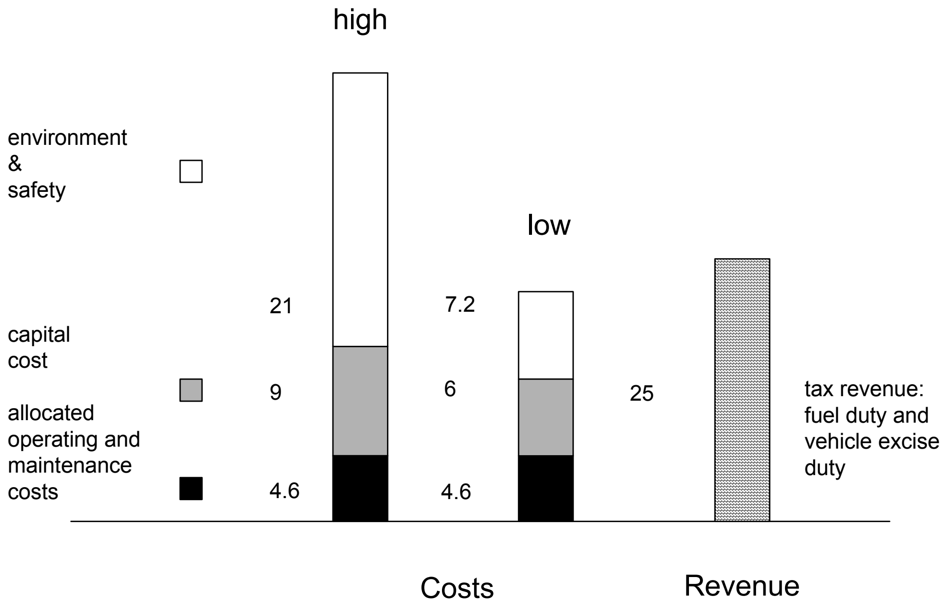
Newbery laid out a very powerful analysis of the public funding of the road network in 1998, showing the net contribution made to the Treasury by road users. He recognised that the public expenditure on roads provided in government figures for the allocation of road costs did not include the original capital cost of the network or the environmental costs, and provided estimates of both. It would be interesting to make a comparable analysis for the railway, to estimate the capital cost from the asset value and required rate of return, and to present industry figures for operating and maintenance costs, and revenues. It would shed light on potential economic distortions between the public road network and the privatised rail network, and their financing, and could inform the government's ten-year transport strategy.

Figure 3.1 shows estimates of the financial costs of the road network, together with a range for an estimate of environment and safety cost (which includes noise, air quality impacts, climate change and accidents). The payments of £25 billion[16] made by road users to the government compare with the expenditure by government of £6.7 billion[17] on services they receive; a ratio of 3:1. There is an additional capital cost of £6 billion–£9 billion[18] and an external cost of £7 billion–£21 billion.[19] The balance of revenues over total costs is estimated to fall between an annual surplus of £3.3 billion and a shortfall of £17 billion.

In comparison, the rail network received a subsidy of £1.6 billion in 1999/00,[20] an amount that is declining year on year. It generates external costs of about £1.1 billion.[21]

15 ExternE is a programme of research on the environmental costs of industrial activity.
16 HM Customs & Excise and DETR figures.
17 DoT (1995), an allocation of road costs.
18 Newbery (1998), estimate of the capital cost of the road network at a 6% rate of return.
19 Calculated using data from various sources, see Appendix.
20 DETR (2000).
21 Calculated using data from various sources, see Appendix.

Figure 3.1: Estimates of the average annual cost of passenger road travel, compared with the annual tax revenue from private motorists (£ billion), 1998/99 prices



Sources: See Table A1. Based on Newbery (1998 and 1995), capital cost; Department of Transport (1995), allocated operating and maintenance costs; external costs, various sources listed in Appendix and unit values shown in Table 2.4; DETR (1999) for transport volume statistics; DETR, vehicle excise duty; HM Treasury, hydrocarbon tax.

3.2 The marginal cost debate

Although the average costs above fuel a heated debate about 'fair payment', they are not relevant to the setting of an efficient level of investment in future capacity, nor are they of use in determining efficient pricing. These two questions have exercised the regulators and companies in the telecommunications, gas, electricity and water industries, where competitive access to networks and the need to manage demand through prices have triggered a detailed exploration of marginal costs.

The first conclusion has been that investments in network capacity should be prioritised on a least-cost basis, and that the level of investment should be the least that is sufficient to meet an efficient level of demand (ie, after demand management). Transferring these ideas to the transport debate, this can be applied to public spending on transport. First, using marginal costs to compare the priority for road and rail schemes to meet rising demand for transport, and, second, making investment in demand management by providing efficient intermodal interchange, public transport, and, where appropriate, road pricing.

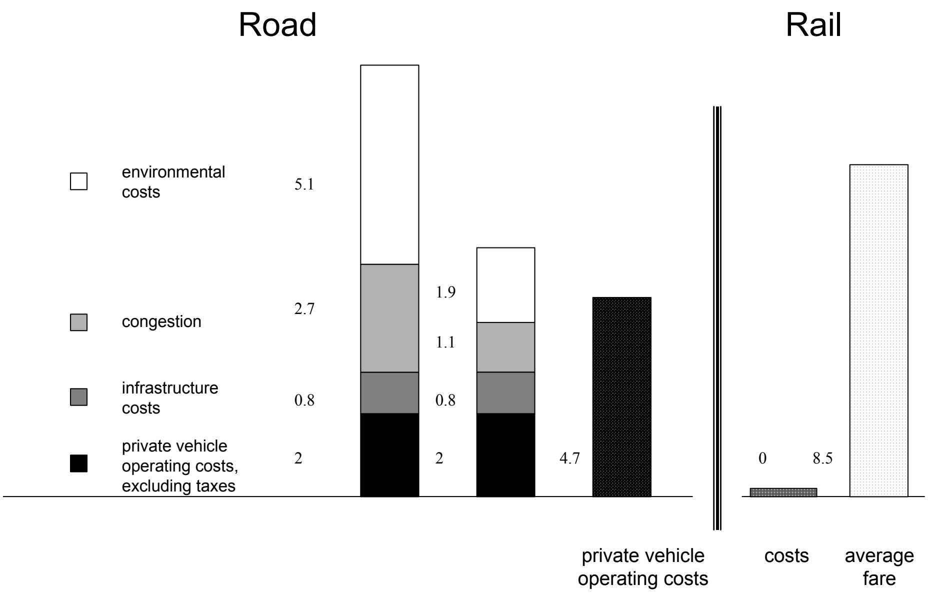
The second conclusion has been that the price should be set in line with long-run marginal cost (the cost of meeting additional demand in the future). The long-run marginal cost can be approximated by the discounted cost (including capital and operating expenditures) of an increment increase in capacity divided by the discounted volume of traffic to be carried by the new capacity.

The same message is given in the European Commission's Green Paper, 'Towards Fair and Efficient Pricing in Transport', which calls for member states to ensure that all transport users pay at least their allocated short-run marginal cost. Short-run costs are incurred in expanding output within current asset capacity—ie, existing road space and rail tracks. Data on short-run marginal costs has been collated, including external cost, showing that, for car users on the road, it is probably within the range of 6–11p/passenger km.[22] The road user faces a private cost of travelling of 5p/passenger km, including 2.8p/passenger km fuel duty.[23] These figures are for an average journey in the UK.

The conclusion is that, on average, the road user's private cost of travelling is lower than the marginal social cost.

An efficient level of pricing would necessitate raising the cost of road travel at the margin. There is a very important caveat—the variation in marginal costs from location to location will be great, and in locations where it is low, for example in rural areas, the private cost of motoring may be inefficiently high. The data is shown in Figure 3.2.

Figure 3.2: Estimates of the short-run social marginal costs of road and rail travel compared to the average price of road and rail travel (pence/passenger km), 1998/99 prices



Sources: See the Appendix Table A2 for a list of sources and calculation of the data. Vehicle costs are calculated from household expenditure and travel survey data on motor travel. Environmental and congestion costs are calculated from unit values in Table 2.4 and DETR transport statistics. Infrastructure costs come from a European Council of Ministers study, ECMT (1998). The average rail fare is calculated from DETR statistics on passenger revenues and distances travelled.

When the same analysis is made for rail services, a significantly different picture is seen. The marginal cost imposed by an additional passenger journey, including external cost, is virtually zero, but the passenger pays a considerable higher fare of 8.5p/km on average.[24]

[22] Data has been collated from DETR, ECMT (1998), Peirson and Vickerman (1996)

[23] Calculated from DETR Family Expenditure Survey data on household spending on motoring and transport statistics.

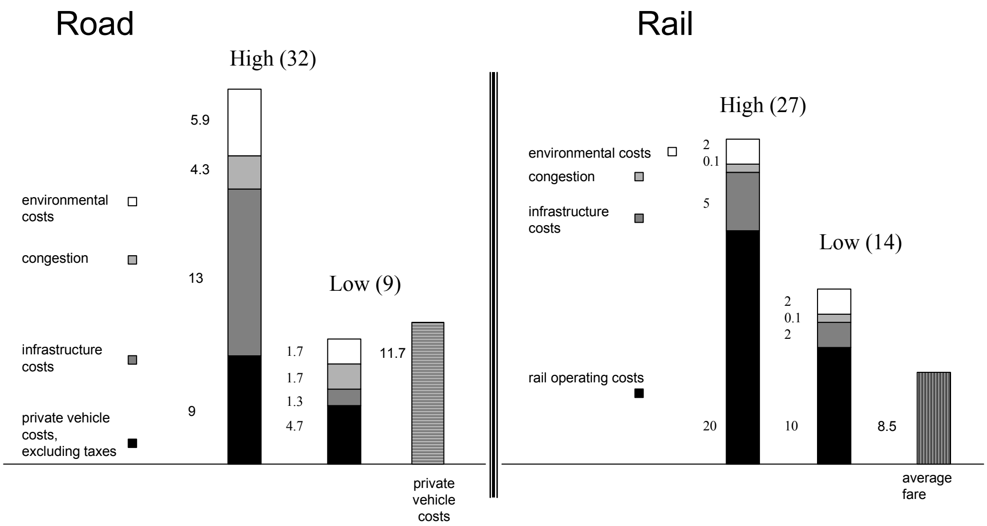
[24] Calculated from DETR, passenger revenues divided by passenger km travelled.

3.3 Long-run marginal cost

Long-run marginal cost should be used to compare the costs of different solutions for providing additional transport capacity, and to prioritise expenditure. Long-run marginal cost should be calculated using data on specific investment options analysed against demand forecasts over time. The experience of utility industries has been that such calculations can be informative, but the allocation of costs to new growth can be difficult to determine. Nevertheless, the role of long-run marginal cost is widely agreed.

For the UK road and rail network, Peirson and Vickerman have made estimates of the long-run marginal costs of travel. Their data on rail long-run marginal costs range from 20p/passenger km peak London, to 10p/passenger km inter-city. Road costs vary similarly over the range 28p/passenger km to 7p/passenger km. The benefits of additional road capacity may fall over time if the road becomes congested. To these figures have to be added the costs of operating trains and cars, including depreciation and maintenance. The rolling-stock and service operation costs are derived from company accounts and are therefore a crude measure of the appropriate long-run marginal cost. The external cost is added as before. The data is shown in Figure 3.3. Peirson and Vickerman observe that car congestion costs vary greatly, from less than 1p/passenger km on inter-urban (uncongested) routes to 15p/passenger km in the London peak.

Figure 3.3: Estimates of the long-run social marginal cost of road and rail travel compared to the average price of road and rail travel (pence/passenger km, 1998/99 prices): a range of estimates is given, reflecting a range of published estimated values



Sources: See the Appendix Table A3 for a list of sources and calculation of the data. Vehicle costs are calculated from household expenditure and travel survey data on motor travel. Environmental and congestion costs are calculated from unit values in Table 2.4 and DETR transport statistics. Infrastructure costs come from a European Commission study, ECMT (1998) and from an allocation of road costs made by the Department of Transport in 1995. The average rail fare is calculated from DETR statistics on passenger revenues and distances travelled. Rail infrastructure costs are taken from Peirson and Vickerman (1996) and the European Council of Ministers Study, ECMT (1998). Rail operating costs are taken from operating expenses per passenger km published in the last British Railways Board annual report and accounts, and checked against train operating company costs excluding track access charges published in *Transit*.

Figure 3.3 shows that the long-run marginal cost for passenger travel by road, 9–32p/passenger km is similar to the same cost for rail, 14–27p/passenger km.

3.4 Conclusions

The data in this analysis is based on historical patterns of expenditure, and does not necessarily equate to the efficient costs for providing future services. The figures have been drawn, wherever possible, from published authoritative sources, although some have had to be prepared from raw data, and for others only crude proxies were available. However, this analysis demonstrates that quantification is valuable in developing policy conclusions that would have been difficult to reach qualitatively. This suggests that policy and project appraisal could benefit from a more quantitative methodology.

To debate these issues in a public forum, a set of industry cost data is needed that is suitable for the estimation of long-run marginal costs.

The assessment of long-run marginal cost for rail freight is not available. This analysis would contribute to the ongoing debate about the UK freight strategy.

The long-run marginal costs of passenger and freight capacity are in practice tightly linked because the provision of an expanded service for one can affect the capacity of the other service. A joint passenger and freight strategy would provide the model from which it would be possible to assess the long-run marginal costs of both passenger and freight services, and the case for public support.

Road and rail have a similar cost for providing additional transport capacity. In some circumstances investments in rail capacity will be more cost effective than road capacity. For example, rail solutions are likely to be cheaper for journeys terminating in urban areas, especially during the peak when the external costs of road traffic are high.

Not only is rail favoured on social cost grounds, but also separately in both its lower environmental cost, and the lower private cost of making a journey (11.7p/passenger km for road and 8.5p/passenger km for rail). Overall, under the long-run marginal cost analysis, which is the most appropriate measure for considering pricing and investment, rail offers an efficient alternative to road.

APPENDIX

Table A1: Data for Figures 3.1, average costs

Element	Calculation and data sources
Road	
Capital cost	Calculation: asset value x rate of return
	Asset value = £100–£150 billion, 1996/97 prices. *Source*: Newbery (1998), Table 2.
	Rate of return = 6%. *Source*: Newbery (1998) and HM Treasury (1991)
	Result £6 billion–£9 billion per annum
Allocated operating and maintenance costs	Road costs excluding costs allocated to pedestrians, goods vehicles over 3.5 tonnes GVW = £4.6 billion. *Source*: Department of Transport (1995)
Environment and safety	Calculation: (passenger km travelled x unit values) + (freight tonne km travelled x unit values)
	Passenger km travelled = 246 billion km. *Source*: DETR (1999*f*)
	Freight tonne km travelled = 152 billion km. *Source*: DETR (1999*f*)
	Unit values (high): calculations courtesy of Railtrack, all in pence/passenger km
	Noise and vibration = 0.58. *Sources*: adapted RCEP (1994), Table 7.2, and RCEP (1997), Table 1.1
	Air quality = 1.1. *Source*: ECMT (1998), Table 11
	Climate change = 0.56. *Source*: ExternE (1999)
	Accidents = 2.9. *Source*: Peirson and Vickerman (1996), Table 1
	Unit values (low): calculations courtesy of Railtrack, all in pence/passenger km
	Noise and vibration = 0.26. *Source*: ECMT (1998), Table 11
	Air quality = 0.61. Newbery (1995*a*), Table A3
	Climate change = 0.19. *Source*: ExternE (1999)
	Accidents = 0.81. *Source*: ECMT (1998), Table 11
Tax revenue	Vehicle excise duty = £4 billion. *Source*: DETR communication.
	Hydrocarbon oil duty receipts (excluding gas oil) = £21.4 billion in 1998/99. *Source*: HM Customs and Excise Annual Report 1998–1999, Table k2

Table A2: Data for Figure 3.2, short-run marginal costs

Element	Calculation and data sources
Road	
Private vehicle operating costs, excluding taxes	Calculation: private vehicle operating costs excluding taxes = (weekly household fuel (less tax), insurance and servicing costs of motoring) / household occupancy / distance travelled by car per person per year = 2p/passenger km
	Total household avoidable weekly motoring cost: fuel, insurance and servicing = £19.3.
	Total household weekly motoring cost of fuel duty only = £11. *Source*: DETR (1999*f*), Table 1.15
	Distance travelled per person per year by car = 8,584 km. *Source*: DETR (1997*c*), Table 2H
	Average household occupancy = 2.4. *Source*: Office of National Statistics, ONS (2000), p.33
Infrastructure costs	Infrastructure costs = 0.8p/passenger km. *Source*: ECMT (1998), Table 96
Congestion	**High**: congestion cost = 2.7p/passenger km. *Source*: Newbery (1995*a*), Table A3
	Low: congestion cost = 1.1p/passenger km. *Source*: Peirson and Vickerman (1996), Table 1
Environmental costs	Unit values as used in Figure 3.1
Private vehicle costs	Calculation: private vehicle operating costs excluding taxes = (weekly household fuel, insurance and servicing costs of motoring) / household occupancy / distance travelled by car per person per year = 4.7p/passenger km
	Total household avoidable weekly motoring cost: fuel, insurance and servicing = £19.3. *Source*: DETR (1999), Table 1.15
	Distance travelled per person per year by car = 8,584 km. *Source*: DETR (1997*c*), Table 2H
	Average household occupancy = 2.4. ONS (2000), p.33
Rail	
Costs	For the marginal passenger journey, there are negligible additional costs from energy use or accident risk, assuming that no additional carriages or trains are run
Average fare	average fare = 8.5 p/passenger km. *Source*: DETR (2000*b*). Table 3 divided by Table 1

Table A3: Data for Figure 3.3, long-run marginal costs

Element	Calculation and data sources
Road	
Private vehicle costs excluding taxes	Calculation: private vehicle operating costs excluding taxes = (weekly household fuel, insurance and servicing costs of motoring) / household occupancy / distance travelled by car per person per year – fuel duty = 9p/passenger km
	Total household weekly motoring cost = £48, of which 85% is fuel duty. *Source*: DETR (1999*f*), Table 1.15
	Total household weekly motoring cost of fuel = £13. *Source*: DETR (1999*f*), Table 1.15
	Distance travelled per person per year by car = 8,584 km. *Source*: DETR (1997), Table 2H*c*
	Average household occupancy = 2.4. ONS (2000)
	Figures checked against Environmental Transport Association data.
Infrastructure costs	**High**: infrastructure costs = 13p/passenger km. *Source*: mid-point of range in Peirson and Vickerman (1996)
	Low: infrastructure costs = 1.3p/passenger km. *Source*: ECMT (1998), Table 96
	Checked against: non-HGV allocated road costs = £4.6 billion. *Source*: Department of Transport (1995)
	Passenger km travelled = 246 billion km. *Source*: DETR(2000*b*)
	Infrastructure costs = 1.8p/passenger km
Congestion	As for Figure 3.1
Environmental costs	As for Figure 3.1
Private vehicle costs	Calculation: private vehicle operating costs excluding taxes = (weekly household fuel, insurance and servicing costs of motoring) / household occupancy / distance travelled by car per person per year = 11.7p/passenger km
	Total household avoidable weekly motoring cost = £48. *Source*: DETR (1999*f*), Table 1.15
	Distance travelled per person per year by car = 8,584 km. *Source*: DETR(1997*e*), Table 2H
	Average household occupancy = 2.4. ONS (2000)

Table A3: Data for Figure 3.3, long-run marginal costs (cont'd)

Element	**Calculation and data sources**
Rail	
Rail operating costs	'Operating expenses per passenger km' = 14p/passenger km, 1995 prices. *Source*: British Railways Board (1995)
	Checked against TOC accounts in *Transit*
Infrastructure costs	Long-run marginal cost for:
	inter-urban services = 10p/passenger km
	London peak services = 20p/passenger km
	London off-peak services = 13p/passenger km. 1996 prices. *Source*: Peirson and Vickerman (1996), Table 1
	These figures can be compared with:
	the growth forecasts presented in Section 1 of this report, and the investment projections in Railtrack's 1999 Network Management Statement for Great Britain. Depending on the growth assumption chosen, these give a long-run incremental cost estimate of infrastructure of 3–6p/passenger km. OXERA Environmental calculation
	the long-run marginal cost estimate = 2.3p/passenger km. *Source*: ECMT (1998), Table 96
	the costs of passenger service operation calculated from TOC accounts published in *Transit*, which show a range of 10–20p/passenger km, although the accounting data is not sufficiently disaggregated or uniform to enable an industry average avoidable cost of train operation to be calculated. OXERA Environmental calculation
	It would be useful for central publication of data on rail industry costs
Congestion	Congestion cost = 0.05p/passenger mile. 1999 prices. *Source*: Peirson and Vickerman (1996), Table 1

Table A3: Data for Figure 3.3, long-run marginal costs (cont'd)

Element	Calculation and data sources
Environmental costs	Calculation: (passenger km travelled x unit values) + (freight tonne km travelled x unit values)
	Passenger km travelled = 35 billion km. *Source*: DETR (1999*f*)
	Freight tonne km travelled = 102 billion km. *Source*: DETR (1999*f*)
	Unit values (high): all figures pence/passenger km, some figures courtesy of Railtrack
	Noise and vibration = 0.3. *Source*: ECMT (1998), Table 11
	Air quality = 0.18. *Source*: INFRAS/IWW (1994) in Tinch (1995)
	Climate change = 0.26. *Source*: ECMT (1998), Table 11
	Accidents = 0.24. *Source*: ECMT (1998), Table 11
	Unit values (low): some figures courtesy of Railtrack
	Noise and vibration = 0.27. *Source*: Tinch (1995)
	Air quality = 0.13. *Source*: Tinch (1995)
	Climate change = 0.2. *Source*: calculated from Pearce (1994) and ECMT (1998)
	Accidents = 0.1. *Source*: calculated using DETR (1999*f*) and DETR (1997*a*)
Average fare	As for Figure 3.2

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