INTRODUCTION

1 Volume 2 set out the extent and performance of the UK transport system now and in 2025, under a range of scenarios. Particular focus was given to those journeys that support and drive economic growth. The volume made clear that there are several areas of the network where poor performance threatens to damage the long-term growth of the UK economy. The strategic priorities for transport policy identified were:

- growing and congested urban areas and their catchments;
- key international gateways; and
- key inter-urban corridors.

2 Volume 3 takes these strategic priorities and adopts an evidence-based approach to identifying the transport policies that are most likely to offer a cost-effective response to the challenges facing the UK and to contribute to GDP. It considers a wide range of transport policies including mechanisms to make better use of infrastructure, such as pricing; investment in ‘variable capacity’ – those short- and medium-life assets such as buses or longer trains that provide additional transport capacity without the need for more fixed infrastructure on the ground; and investment in fixed infrastructure – long-life transport capital assets such as roads or rail track.

3 Returns on investments are explored and compared by considering both the broadest possible range of impacts on which Ministerial decisions are made, including social, environmental and economic impacts; and a narrower GDP-only perspective. There is no attempt to make any conclusions or recommendations about specific schemes, but rather to inform a strategic view of the policy options most likely to deliver strong benefits for the UK economy.

---

1 Gross Domestic Product, as described in Volume 1, is currently the best measure of the size of the economy as it measures the total value of goods and services produced.
economy cost-effectively, and under what circumstances they would do so. The starting point has been that any transport intervention should offer benefits that exceed its costs, and that in a world of limited public resources, government will need to prioritise spending on those policies or investment options that offer the best value for money in meeting its social, environmental and economic objectives.

The volume is split into six chapters:

- **Chapter 3.1**: provides an overview of the key policy messages, conclusions and recommendations of this volume;
- **Chapter 3.2**: introduces the full range of policy options;
- **Chapter 3.3**: focuses on options that allow better use of the current networks;
- **Chapter 3.4**: discusses infrastructure options, both variable capacity and fixed infrastructure for enhancing those networks; and
- **Chapter 3.5**: discusses the evidence used for demonstrating and comparing the returns from each of the policy options; and describes how those returns have been assessed.
3.1 OVERVIEW OF KEY POLICY MESSAGES

Headlines

The case for targeted transport intervention is compelling, even after taking account of environmental effects. Some transport interventions offer very high overall returns on government spending.

- Transport schemes can deliver overall benefits averaging £4 per £1 of government expenditure.
- These figures have added in estimates of the missing GDP impacts identified in Volume 1 that are not captured in recent appraisals. Such impacts can be very significant, adding up to 50 per cent to the benefits in some cases.
- Environmental effects often reduce the returns available, but overall returns remain remarkably high in most cases once they have been factored in; and such effects increase the benefits of some urban public transport proposals.

A sophisticated policy mix of better use, carbon and congestion pricing and targeted infrastructure offers strong benefits.

- There is a strong economic and environmental case for ensuring users across all modes face the true costs associated with their journeys, be they environmental or congestion-related, in line with the Stern Review of the economics of climate change.
- Better use options – especially better pricing on the roads – have very considerable potential; infrastructure options are not always the most cost effective solution.
- But some infrastructure schemes do offer very high returns:
  - Interventions targeted on the worst problems and bottlenecks caused by competing demands on the transport system, such as surface access links and corridors close to major urban areas, are likely to offer some of the highest returns;
  - Small can be beautiful: small-scale interventions such as walking and cycling schemes, and junction improvements, are often the most cost-effective solutions. Although on their own they may not always be able to tackle the true scale of the problem faced; and
  - GDP returns from the interventions in urban areas on which evidence is available are surprisingly low, leading to concerns that high-return options may not be being generated.
- Even in a world with carbon pricing and widespread congestion-targeted road pricing there seems to be a good case for more transport infrastructure. Beyond 2015, without road pricing there would be an economic case for a rate of strategic road capacity enhancement over 50 per cent higher than the baseline rate; with road pricing, there would still be a case for additional investment but significantly below current rates of build.
- Step-change measures intended to provide a transformation to the transport system are unlikely, in a world of constrained resources, to be a priority especially when they use new and untested technologies.

But it is not only through government funding that transport delivers strong welfare and GDP benefits: private sector investment has a key role to play.
INTRODUCTION

1.1 As a whole, Volume 3 seeks to identify the transport policies that are most likely to offer a cost-effective response to the challenges facing the UK transport system. In doing so, the volume sets out the available evidence in real detail. This overview sets out the key overarching messages from that evidence. In part, this chapter therefore acts as a summary for the detailed chapters that follow. However, it also combines the evidence in this volume with the discussion in earlier volumes, because only by taking a considered view of all the evidence can conclusions be drawn with real confidence.

1.2 The chapter:

• provides a brief introduction to the evidence, and what it can and cannot show;
• reports the headline analysis of the returns available from transport schemes;
• provides a series of headline conclusions that can be drawn from the data and evidence summarised here (and which is set out more fully in subsequent chapters);
• takes a look beneath the headlines to explain some of the cross-cutting findings in more detail; and
• summarises the conclusions and recommendations of this volume.

INTRODUCTION TO THE EVIDENCE

1.3 This volume presents available evidence on the costs and benefits of a wide range of transport interventions, incorporating the best available estimates of the economic, environmental and social impacts. The range of interventions considered can be broadly defined as:

• better use: interventions that lead to more efficient use of the existing transport system;
• variable capacity: investment in relatively short- and medium-life assets that increases the effective capacity of the available fixed infrastructure, for example additional bus services or longer trains and platforms; and
• fixed infrastructure: investment in additional, very long-life capital assets such as roads, rail lines, and ports etc.

1.4 The evidence presented is based on information on over 170 business cases and appraisals of real schemes across the UK, with a combined cost to government of well over £100 billion. To complement this information, modelling has been undertaken to explore the returns of some illustrative interventions both at the national level and in some local case-study areas; and the study has also drawn on modelling which estimates the overall benefits provided by private sector developments in the port and airport sectors.

1 There is a mixture of schemes which have been implemented, or which have been recently proposed.
In doing so, the aim is not to create a wish list of specific schemes that should be funded; that is not the purpose of a strategic study of this kind. Instead the available evidence has been used to help identify the types of interventions that are most likely to offer a high value for money contribution to GDP and wider welfare. Existing interventions have been categorised to the strategic economic priority (as identified in Volume 2) they most closely match, though it is likely that some urban interventions in the database are not, in reality, in areas that are growing and congested.

There is a long history of using cost-benefit analysis to guide decision making towards the highest value for money projects. Indeed, the UK is seen as a world-leader in the development and use of these techniques. This history shows that as valuation techniques become more sophisticated, so the range of impacts measured and valued by cost-benefit analysis can expand, leading to better-informed and more transparent decision making.

This study has made an important first attempt to estimate some of the ‘missing’ GDP impacts identified in Volume 1, using recent new evidence. Similarly, emerging evidence on the values that can be ascribed to important environmental impacts (carbon emissions, noise, air quality and landscape impacts) have also been used to enrich the analysis in many areas. It is likely that some environmental effects would be highly scheme specific, as would their true valuations. Available evidence does however allow an aggregate approach to be taken to provide an indicative estimate of their order of magnitude. For example, by relying on generic values for different landscape types, an estimate can be made of the potential scale of this effect to be incorporated into the assessment of welfare in a consistent way across schemes.

The different measures which are used to capture these valuations, and to report the evidence on costs and benefits are summarised in Figure 1.1, while Chapter 3.5 provides a fuller explanation of cost-benefit analysis, including the new GDP and environmental estimates that have been added into the value for money assessments.

It is important to interpret the results carefully as the assessment of the wider economic benefits and reliability effects has for the most part been undertaken at an aggregate and indicative level. While the effect is likely to be representative of different types of policies, it may lead to over- or under-estimation on particular schemes. Impacts on trade, globally mobile investment and several dynamic effects have not been possible to estimate given the current state of knowledge on these impacts.

As always, developing ‘state of the art’ estimates is challenging and innovative. These new estimates are presented to provide high-level insights into transport’s effect on our economy and quality of life, not to inform decision making and appraisal on individual schemes. They are presented as ‘order of magnitude’ estimates for different types of scheme, in order to guide policy makers towards those policies that are likely to offer good returns. They are no substitute for the full-blown, location-specific appraisals of the most promising options, which are needed when making funding decisions.

---

1 The notion of welfare is used throughout this volume to encompass the overall net benefits to society including economic, environmental and social impacts.

2 Transport, wider economic benefits and impacts on GDP, DfT, July 2005. This is used to provide an estimate of the GDP effects, which is a new and emerging field. This methodology is currently being applied in the context of schemes coming forward for the Transport Innovation Fund.
When interpreting the analysis in this volume it also important to recognise that, in some areas, only a small sample size is available so care must be taken not to over-extrude the conclusions that can be reached. Similarly, existing schemes were developed without a full understanding of some of transport’s impacts on the economy (e.g. agglomeration impacts); if that knowledge had been available different schemes may have emerged. Nonetheless, even where the sample size of evidence is relatively small, the potential offered by some interventions is evident, so areas for further investigation are identified.

In short, the results presented from the database and strategic modelling are representative of the ‘average’ impacts of different types of schemes for which evidence is available, and cannot be interpreted as providing precise answers on the impacts of individual schemes. There may also be ‘better’ schemes on which the study does not have information, either because they have not been developed or because the information was not known to be available. Nonetheless, the evidence provides important new insights into transport’s contribution to the UK’s economy and quality of life, and has some important implications for future policy.
To reflect the evolving nature of transport appraisal, four cost-benefit measures are referred to throughout this study, all of which express estimated benefits of a proposal per pound of government expenditure.

The main difference between the metrics set out below is the extent to which benefits are counted and given monetary valuations (monetised). The view taken in this study is that the conventional Benefit:Cost ratio (BCR) as generated from the NATA process (New Approach to Appraisal) is the most certain measure, but that it is incomplete. The value for money assessment is the most complete ‘single measure’ of transport’s impact on the UK, as it incorporates the fullest possible estimate of a proposal’s economic, social and environmental impacts. However, those estimates are more uncertain than the conventional BCR because the evidence base is relatively new, and some of the effects are inherently hard to monetise. Metrics used are as follows:

- **Conventional benefit:cost ratio (NATA BCR):** the benefit:cost ratio set out in DfT’s appraisal guidance. Captured and monetised within this BCR are: changes to the overall costs of travel, the value of changes to travel times, safety benefits, and the financial costs of doing the project including impacts on taxation revenues. This does not yet include a number of GDP impacts, and here does not put a monetary valuation on environmental benefits. Instead, the BCR sits within a broader assessment framework that uses qualitative estimates of environmental and social impacts.

- **GDP per pound:** the contribution to GDP that can be achieved per pound of government money spent on the intervention. It is a narrower metric than welfare because it only focuses on the impacts on the economy. It does not therefore include benefits for non-work/leisure travel, for example. In addition to the GDP impacts already captured in appraisals, such as changes in the costs of travel to business and freight, this assessment also includes impacts on the wider economy that are not currently estimated as part of conventional appraisals, such as agglomeration, labour market effects, competition impacts and reliability. Such effects have been indicatively estimated for this study based on developing ‘state of the art’ guidance on how to assess these impacts from DfT.

- **Wider benefit:cost ratio (BCR):** this adds the ‘missing’ GDP effects into the conventional NATA BCR.

- **Value for money (VfM) BCR:** the most complete metric used in this analysis. For decision making, all impacts on society should be considered but only some can be presented in money terms. The value for money assessment goes broader than the three previous metrics by incorporating most significant environmental effects into the monetised assessment by relying on recent valuation evidence. Environmental effects estimated in this way are carbon (using current Defra guidance), air quality, noise and landscape (all from published academic and government research).

The DfT guidance, New Approach to Appraisal, can be seen at [www.webtag.org.uk](http://www.webtag.org.uk).

Though recent developments in appraisal guidance will lead to future appraisals capturing the value of the change in carbon emissions and noise.
Figure 1.2: Understanding the distribution data

The box and whisker charts in this and later chapters demonstrate the range and distribution of returns to allow a comparison across different interventions in different areas.

In the type of chart shown below (known as a ‘box and whisker’ chart), the full range of returns from the available evidence is reflected by the length of the vertical line. The top point of the vertical line marks the return offered by the best scheme; the bottom point marks the return of the lowest-performing. In some cases, the extreme values at the top and bottom will be outliers so must be interpreted with caution.

The ‘box’ in the centre of the line is in many ways more informative as its vertical length marks out the range of returns from the middle-performing 50 per cent of schemes. So, for example, if the top line of the box is at wider BCR 4 and the bottom line of the box is at wider BCR of 2, the middle 50 per cent of the schemes offers wider BCRs in the range 2 to 4. The line across the middle of that box shows the ‘median’ average return.

Schemes whose returns lie on the vertical line above the ‘box’ are the top-performing 25 per cent schemes in terms of their returns; likewise, those below the ‘box’ are the lower-performing 25 per cent of schemes.

The figure at the top of the line is the sample size (in this case 59)

Understanding the data

- Highest value
- Median
- Lowest value

- Top 25% of schemes are in this range
- 50% of schemes fall within this box
- Bottom 25% of schemes are in this range

Source: Eddington Study.
Good returns across the strategic priorities

1.14 On the basis of these metrics, there are some overall messages that can be drawn from the evidence.

Figure 1.3 shows that there are very good returns across the strategic priorities with some very high returns offered in each. More detailed analysis suggests that the very highest returns are from those interventions that are well targeted on particular pinch points on the network and that serve all of the strategic priorities. In addition, although not shown in this chart, walking and cycling schemes can offer some very strong welfare returns with wider BCRs well in excess of 10.

1.15 Figure 1.3 shows that there are very good returns across the strategic priorities with some very high returns offered in each. More detailed analysis suggests that the very highest returns are from those interventions that are well targeted on particular pinch points on the network and that serve all of the strategic priorities. In addition, although not shown in this chart, walking and cycling schemes can offer some very strong welfare returns with wider BCRs well in excess of 10.

And across different types of policy option

1.16 When considering the possible returns by policy type, as in Figure 1.4, it is evident that the returns from fixed-infrastructure options are much more varied than for other policy types. In part, this will reflect the number of schemes on which evidence is available to this study, but it does highlight the need to ensure interventions are well targeted because some very low returns are possible.
Figure 1.4 shows the returns of the interventions grouped according to policy type. Utilisation refers to those better use measures that allow more effective use of the transport system. This captures urban traffic control and active traffic management schemes. Variable capacity refers to interventions such as improved bus services, and fixed capacity incorporates road or rail infrastructure along with, for example, junction improvements.

These returns are based on a combination of current schemes and a strategic assessment of future schemes. Over time some benefits would be expected to rise, as continued economic success increases demand for travel and increases people’s value of time. Set against that, increased values put on social protection, higher values for local and international environmental protection, and increasing costs of land and technologies may force the cost of interventions up. Given the scale of returns today, it seems likely that good returns will continue to be found from transport for very many years to come.

Owing to a small sample size, the distribution of utilisation schemes cannot be represented by a ‘box and whisker’ chart. The ‘dots’ represent the three schemes in the database and demonstrate that, of the evidence available, some strong returns are possible, so there is a clear case for exploring these types of schemes further.

Figures 1.3 and 1.4 demonstrate the wider BCRs of the interventions which include an estimate of the benefits to the wider economy that are not captured within conventional appraisals. Figure 1.5 demonstrates the magnitude of these ‘missing’ GDP effects relative to the benefits that would otherwise be estimated.
The average of the wider BCRs is strong for each strategic priority, and the ‘new’ GDP benefits add considerably to the estimated returns, particularly for urban networks. This is largely driven by the agglomeration and labour market benefits to which interventions in these areas give rise.

The wider BCRs shown in Figure 1.5 are averages of the schemes on which evidence was available. These averages are therefore distorted by the returns from some of the very large schemes. For example, removing all large rail schemes for illustration would increase the average return from inter-urban corridor schemes from a wider BCR of 1.8 to just under 5.

However, the true returns are lower for most interventions after environmental costs are factored in, i.e. in moving from a wider BCR to a VfM BCR. The analysis in Figure 1.6 is based on those schemes for which monetised environmental impacts can be estimated – around a third of the schemes in the database. For the types of schemes represented, predominantly road and bus, these results are likely to be representative of the impact across all such schemes in the database, i.e. there is no reason to expect systematic biases in the types of schemes on which we have full environmental monetisation.
In addition, although not demonstrated in the charts, well-targeted small-scale walking and cycling schemes can have a beneficial impact on the environment owing to the mode shift from car to these non-polluting modes, but overall impacts would depend on the infrastructure requirements.

Figure 1.6 shows that starting from a narrow perspective of GDP only, as additional welfare effects are incorporated – i.e. looking at the wider BCR – there is a significant shift up in the average returns of public transport interventions, more so than the relative shift for road schemes. This is because the wider BCR incorporates impacts on non-work/leisure trips.

Taking the analysis further to include environmental impacts – i.e. looking at the VfM BCR – the average returns of the interventions are again affected. For roads there is a shift down, driven by landscape impacts, carbon emissions and local air pollutants. For public transport interventions, the impact is minimal but slightly positive. These positive effects are a result of the beneficial impacts on journey ambience from improved interchange facilities; and mode shift to public transport services allowing lower levels of congestion and hence emissions.

Looking in further detail at the environmental effects by strategic priority demonstrates the broad range of impacts. Figure 1.7 plots the estimated impact on the returns of interventions of such environmental effects for a sample of schemes for which this is possible.
Each point plotted in Figure 1.7 demonstrates the indicative impact on the wider BCR for an individual intervention. Where there are positive effects, many of these will represent public transport schemes. Road schemes are more uniformly negative, though there is a very considerable variation in the scale of the impact. This is shown in Figure 1.7 as the inter-urban corridor link is composed mainly of roads. Up to around 3.5 can be knocked off the wider BCR as a result of the adverse environmental effects, but of course others have very small environmental impacts. On average the inclusion of environmental costs knocks around 1 off these returns for road schemes, and adds slightly to the returns of bus and interchange schemes. Policy makers must be very careful not to generalise about the impacts of such policies.

Small can be beautiful

And small is beautiful: many of the very high return schemes are small projects, including walking and cycling schemes (for which the environmental returns may be positive owing to the mode shift from car to these non-polluting modes) and junction improvements. Some recent and proposed junction improvements on the strategic road network, for example, suggest possible wider BCRs in the range of 2-25 costing from £5 million to over £100 million. Returns drop off sharply beyond the £1 billion point. This is shown in Figure 1.8.
The reasons for the high returns are likely to vary according to the particular intervention. It may be that because lower-cost schemes tend to be smaller scale, they are more likely to be targeted on particular problems and pinch points that provide significant benefits for many travellers. In absolute terms, where a small and a large intervention offer the same wider BCR, the contribution of larger schemes is of a much higher magnitude for a much higher cost. However, small schemes may not be of sufficient scale to tackle the magnitude of future challenges. In some cases, the highest return option in the longer term for a given problem may be a large-scale and high-cost intervention.

Projects that overlap priorities offer high returns

Where there is a case for additional infrastructure, interventions that improve journeys where the ‘strategic priorities’ overlap, and there are many different users travelling at the same time, offer very high returns since they address multiple demands on the most heavily used section of the networks. For example, inter-urban corridors that are close to major urban areas are used by business passengers, freight, airport or port users and commuters, often at similar times of day. Projects in these areas can offer wider BCRs of around 10, sometimes with very low costs, although where additional infrastructure is required, the environmental implications can be significant.

Surface access routes to ports and airports are also often used by large volumes of travellers on different sorts of journeys, and the evidence demonstrates strong wider BCRs, many in excess of 3 with a few over 15 (before environmental effects have been accounted for).
Step-change measures

1.33 Step-change measures intended to transform the economy are not, in a world of constrained resources, likely to be a priority. The available evidence for step-change projects in the UK, such as a new high-speed North-South rail line, shows wider BCRs at the lower end of the distribution before accounting for landscape and carbon effects. Furthermore, BCRs of alternative options to solve these problems are not available. However, it is often argued that such measures miss transformational economic impacts, such as a radical shift in the economic geography of the UK brought about by new levels of connectivity. The evidence for transformational benefits is at best unproven, and Volume 2 has demonstrated that the UK’s urban areas and regions are already well connected. Another potential benefit (which should be included in the wider BCR) is that of freeing up capacity on existing rail lines. Whilst this is true, it is not at all clear that creating new networks is the most appropriate or cost-effective method to achieve increased capacity: high speed options should be assessed coldly alongside other polices for achieving the same objective. Other transport investments are very likely to offer superior returns compared to where projects rely on new and largely untested technologies.

1.34 Where new and untested technologies are relied on, or where demand for the new link is only speculative, expensive step-change transport measures are unlikely to offer the best value for money in delivering economic or environmental objectives.

Benefits of road pricing

1.35 The Stern Review argued that prices should be used to reflect the externalities associated with climate change. The same is true for congestion: users should pay the full costs of their journey, including a carbon price and a congestion price. The study has examined a number of pricing schemes and modelled a national distance-based scheme that prices both congestion and environmental externalities. Road pricing is certainly the most effective way of pricing for congestion. It is also one possible instrument for carbon pricing road users. However, this modelling should not be taken to suggest this study has taken a view of the best instrument for carbon pricing, only that the impact of carbon pricing on the demand for surface transport has been taken into account.

1.36 In the Road Pricing Feasibility Study (RPFS), the DfT explored the potential benefits of a national road pricing scheme implemented in 2010 using the DfT’s National Transport Model (NTM). This study has explored the impacts of that scheme in the longer term, namely 2025, again relying on the NTM.

1.37 The illustrative national scheme modelled for both the RPFS and therefore this study is a relatively sophisticated, distance-based scheme where prices are based on the marginal social costs of the journeys that take into account costs of congestion and environmental damage, including a carbon cost of £95 per tonne in 2025. Charges are capped at 80p/km with 75 different levels of charges, varying by time of day, by area and road type.

1.38 Clearly, this is only one of many options, and has been chosen only to make comparisons with the present day more straightforward. The evidence suggests that before considering the costs of setting up and running such a scheme, total benefits estimated at around £28 billion a year in 2025, including GDP benefits of £15 billion a year. The costs of such a scheme are not known at this stage, and pilots should be used to provide a better assessment. Clearly, costs would have to be extremely high to outweigh the benefits of £28 billion.
billion a year, and in that scenario it would not be cost effective to implement a scheme. The analysis of this particular scheme and other road pricing schemes are described in more detail in Chapter 3.3.

1.39 If widespread pricing were introduced, the nature and location of challenges on the roads would be altered. This has implications for the economic case for additional infrastructure across modes. A national scheme is estimated to reduce the case for inter-urban road build beyond 2015 by some 80 per cent. The reduced case for additional infrastructure and the accompanying environmental damage means proper pricing can therefore have significant environmental benefits when compared with other options. Without road pricing, beyond 2015 there would be an economic case for a rate of strategic road capacity enhancement over 50 per cent higher than the baseline rate.

1.40 Applying the principles of pricing to all modes, including roads, rail and aviation, offers significant potential to deliver welfare and GDP benefits, although the evidence is not available to quantify those benefits.

Private sector investment

1.41 This study has not sought to repeat the analysis of the Air Transport White Paper8 (ATWP) which suggests there are significant economic benefits from increasing runway capacity at Heathrow and other airports in the South East. Above a baseline of maximum use of existing runways, direct economic benefits of additional capacity at Stansted (2012) and Heathrow (2020) are estimated at some £24 billion. It is estimated that of this figure, some £6 billion9 accrue direct to business travellers, and these benefits would be higher still if reliability were accounted for. Other benefits not captured within this figure include the trade benefits of international connectivity and the benefits from increasing the attractiveness of the UK for foreign investors. Plus, there can be economies of scale from hub airports, through enabling a greater variety and frequency of onward connections, and from greater efficiencies in the provision of support services and fixed costs.

1.42 However, the gross benefits must be adjusted to reflect the impacts on the environment from additional runway capacity. The main environmental impacts of aviation that can be quantified are noise from aircraft and the effects of aircraft emissions. Air Transport White Paper analysis estimated that the cost of increased carbon emissions over and above a baseline of making maximum use of existing runways could be in the region of some £3-5 billion.10 In addition, there are likely to be impacts of increased noise and health impacts from reduced air quality but these are likely to be an order of magnitude lower than these carbon impacts, leaving very substantial net benefits.

1.43 The ATWP also assessed the benefits of additional fixed runway infrastructure at other airports and suggested that an additional runway at two other UK airports could each provide overall benefits that are much lower than for expanding major airport in the South East, with the highest benefits at some £1.6 billion over the period to 2060. The benefits of capacity enhancement at other regional airports are therefore likely to be of a much smaller magnitude than for other major airports, given the lesser magnitude of pressures faced.

---

9 Present value benefit over the period to 2060.
10 Present value over the period to 2060.
1.44 This study identifies international gateways as a key strategic priority for the future, and the vital role of aviation in supporting the international competitiveness of the UK’s high-tech manufacturing and financial services sectors. This is in line with the analysis from the ATWP set out above, which demonstrated that the potential economic benefits from further expansion of aviation capacity are significant, running to tens of billions of pounds. However, any growth in aviation needs to be sustainable, and must take full account of its environmental costs. One of the most effective mechanisms for achieving this is by ensuring that air travellers pay the full environmental costs of their journey, including their climate change costs. The principle of ensuring users pay their full external costs was supported by the Government in the Air Transport White Paper and was strongly supported by the Stern Review of the economics of climate change.

1.45 The ATWP passenger demand forecasts assumed the introduction of some form of pricing mechanism to ensure air travellers faced the full external costs of their climate change impacts. This was based on the Defra central cost of carbon estimate of £70 per tonne of carbon (in 2000 prices). With this pricing mechanism in place, the analysis demonstrated that demand would continue to grow, and that there would be significant economic benefits from some additional runway expansion. It is important to understand the impact of a range of carbon pricing scenarios on the case for aviation expansion, and the forthcoming ATWP Progress Report will test a wider range of carbon price scenarios.

1.46 Provided economic analysis shows that there is a net benefit from increased airport capacity, even after users pay the full environmental costs of their journeys, there will remain a strong economic case for additional runway capacity.

1.47 The evidence also suggests that the expansion of ports capacity in response to capacity constraints, subject to environmental considerations, can deliver benefits. Full assessments of costs and benefits were not available to this study. However, the available evidence suggests that under a scenario of full construction of Felixstowe South, Bathside Bay and London Gateway deep-sea container ports, shipping costs could be reduced by around £200 million per annum or up to 10 per cent by 2025. These gains arise because the extra UK capacity reduces the need for a good deal of transhipment which adds to delivery costs. Without further expansion in capacity, it is also likely that capacity constraints will start to bite sometime between 2020 and 2030. In this scenario, additional capacity expansion could reduce costs by a further £140 million per year. These estimates do not account for wider benefits such as impacts on trade, globally mobile investment and reliability.

1.48 If additional ports infrastructure is added, there are likely to be adverse environmental impacts. Ports are mainly located in estuaries where they compete with birds for sheltered locations and coastal habitat such as mudflat and saltmarsh; there are knock-on effects on surface modes (road and rail); and air quality and carbon emissions.

1.49 While this study does not have detailed evidence on these impacts, recent port capacity planning approvals demonstrate that in some circumstances there remains a case for additional capacity, once environmental impacts have been factored in.

1.50 The implication for government of the gains to the economy from such private sector investment is that providing a clear policy framework, which prices environmental externalities, will incentivise the private sector to bring forward appropriate infrastructure proposals which deliver economic and welfare benefits while meeting environmental objectives.
1.51 This section looks beneath these headlines, to explore where the highest returns can be found, including by location and by mode. Using current standard appraisal methods to assess welfare, high returns are evident across all priority links and all demonstrate average returns in excess of the minimum rate of return for government investment of 1.3,\footnote{For more detail see Transport demand to 2025 and the economic case for road pricing and investment, DfT, 2006.} as illustrated in figure 1.3.

**Where are the highest returns to be found?**

1.52 The evidence in Figure 1.5 suggested that targeted improvements to surface access links are able to offer the highest average welfare return on investment. This includes access to ports and airports, both of which support the UK’s international competitiveness by improving travel conditions for freight and international business travellers. Although this area of investment has not been specifically targeted in the recent past, if chosen well, such interventions are able to make a significant contribution to GDP and welfare.

1.53 Taking all interventions on which evidence is available suggests the average BCR of interventions in growing and congested urban areas exceeds that for inter-urban corridors. This finding should be interpreted with caution, however, because the inter-urban average includes some very expensive and relatively low performing interventions, such as some rail schemes. These act to constrain the average return on inter-urban routes. Looking at Figures 1.3 and 1.4, it is clear that there are both very high-performing and very low-performing inter-urban schemes.

1.54 For illustration, if the expensive low-performing interventions are removed, the average BCR in Figure 1.5 for inter-urban corridors increases from 1.8 to 4.9; for growing and congested urban areas it changes from 3.2 to 4.2; and with international gateways it increases from 6.7 to 7.2. Hence inter-urban corridors are actually likely to offer some schemes with higher returns than in growing urban areas. Further issues around the returns from interventions in urban areas are explored in Figure 1.9.
Underlying Figure 1.6, the evidence suggested that, using current appraisal values, public transport performs relatively less well on average than roads. However, there are some good value schemes offering over £3 of welfare for every £1 of government spend, such as some bus service enhancements in large urban areas. Careful targeting and scheme design is critical to the success of public transport interventions.

In addition, as will be further highlighted in Chapter 3.4, even after accounting for environmental effects, road investment is able to offer among the highest returns if it is well targeted on the key inter-urban corridors (especially near major urban areas) or surface access links to ports and airports where traffic volumes are very high and congestion is a persistent problem. Chapter 3.4 discusses the case for additional strategic road capacity in more detail, including the impacts that road pricing can have on the returns from investing in infrastructure.

Not all schemes improve economic performance

Some interventions offer relatively poor returns in terms of GDP per pound. For variable capacity this mainly reflects those public transport schemes that have low business use and no freight use, although decongestion benefits will indirectly affect all road users. This may also reflect that many public transport schemes for which the evidence is available are designed to focus on leisure travellers or social and accessibility outcomes, rather than economic outcomes. Clearly, it is right and proper that government makes transport investments aimed at social and environmental goals – the data simply highlight that the economic gain in some projects can be very low.
What difference do the missing GDP impacts make?

A significant proportion of the benefits has previously been missing

1.58 Although current appraisal methodologies capture a significant proportion of a project’s economic impact, some effects are not captured at all. These missing elements have been estimated for the purposes of this study, using the developing DfT guidance on the assessment of wider economic benefits, and appear in the figures above. These may be a small proportion of the total benefits but the magnitude varies significantly by scheme and location and in some cases can be substantial in absolute terms. They can be particularly important for some schemes and areas with this analysis suggesting some 30-40 per cent, and potentially up to 50 per cent could be added to the benefits. In effect, this means that traditional appraisal has been significantly understating the benefits of some interventions. As noted above, the benefits to trade and globally mobile investment are still unmeasured but would provide additional uplift, where they are demonstrated.

Figure 1.5 demonstrated the relative contribution of the GDP impacts that are currently ‘missing’ from standard appraisals and business cases. Given the potential significance of these missing impacts, it is important that formal appraisal methodologies should evolve to incorporate these impacts as the evidence around them firms up.

The inclusion of these impacts will have implications for relative priorities. For example, for growing and congested urban areas, the average addition to the BCR is the highest, at 0.7. The addition is lower for other priority links at around 0.4 for international gateways and 0.1 for inter-urban corridors. Again, these are averages for all evidence available so must be interpreted in that context; there are likely to be significant variations at the individual scheme level.

However, this is only one new addition to conventional cost-benefit analysis. The other important development is on environmental and social valuations.

Accounting for environmental impacts and accessibility when assessing value for money

1.62 As outlined in Figure 1, some of the impacts of transport improvements are inherently difficult to monetise. Such impacts – notably environmental impacts – play a fundamental role in broader welfare and sustainable development priorities. Such impacts affect government’s broader objectives and issues that the public value and, as the Stern Review has convincingly demonstrated, they can also affect economic growth.

1.63 In order to assess how emerging evidence on the monetary valuation of these impacts would alter priorities, roughly a third of the schemes discussed in this chapter were reviewed and best judgements made of the value of many of the currently non-monetised impacts that are not included in the wider BCRs using available valuation evidence, for example using Defra values for carbon and air quality impacts. This analysis can only be carried out in an aggregate way so the figures need to be interpreted with care and are to be regarded as indicative (the value for money assessment is not normally intended to be so precise). The estimated impacts were illustrated in Figure 1.6.

Despite some transport interventions having adverse implications for the environment, such as road widening and airport expansion, many still offer very good returns. This is particularly likely to be the case where the most severe of transport problems are being addressed.

13 In October 2006, DfT issued new guidance on how the value of greenhouse gas emissions should be monetised and incorporated in the appraisal. See www.webtag.org.uk.
Accounting for social and environmental effects tends to increase the relative returns of public transport interventions, as might be expected. Indeed, in value for money terms the average public transport scheme is broadly equivalent to roads, though there is a much greater spread of returns on roads (with some very high and some very low returns).

Environmental impacts are highly location specific so it is difficult to generalise on their magnitude for any given type of intervention. For example, the same scale of road in one area could be broadly neutral in terms of environmental effects, but in a different location could be severely adverse to the extent that the overall value for money is poor.

In the majority of cases, the impacts of public transport interventions are less adverse and in some cases will be beneficial. Often, this stems from the higher incentive for mode shift from cars and the fact that they tend to have lower impacts on the ‘footprint’ of fixed infrastructure. However, large new public transport fixed infrastructure, such as new rail lines, would be expected to have an adverse impact on landscape and possibly on emissions (depending on mode shift).

Some types of schemes that show good welfare returns, such as public transport, utilisation, walking and cycling, will also have environmental benefits due to their low requirements for land and infrastructure, and their impacts on congestion reduction. Pricing also has the potential to have positive air quality benefits by providing for freer-flowing traffic and it reduces the need for new infrastructure build, as will be discussed in Chapters 3.3 and 3.4.

The key conclusions from this overview, and from the following chapters, are as follows.

1. **The case for targeted transport interventions is compelling:** very high returns are achievable even after environmental costs are factored in.
   - Some very high returns on government spending are possible from well targeted transport policies with welfare returns often offering more than £5 of welfare for every £1 invested and sometimes over £10.
   - Returns are likely to be particularly high when targeted at relieving pinch points and bottlenecks arising where there are competing demands from large volumes of different users.
   - Whilst well-targeted, small-scale interventions can often deliver the highest returns, they may not be sufficient to tackle the full scale of the problems facing the UK.

2. **Policies that raise the performance of the current transport networks stand out above other interventions in offering the potential to deliver for GDP and minimise environmental and social impacts; but the challenges and risks must be well managed.**
   - There are strong economic and environmental arguments for ensuring users across all modes face the full external costs of their journeys, be they environmental or congestion related. This could be done through appropriate fiscal, regulatory, pricing or trading instruments.
3.1 Overview of Key Policy Messages

- Introducing well-targeted pricing on the UK transport system, and in particular road pricing, offers enormous potential for improving network performance by spreading demand, lowering congestion and overcrowding, improving reliability and delivering GDP benefits.

- Making road pricing happen has risks that are real and there is significant uncertainty over costs, behavioural responses and long term impacts that will all need to be carefully managed.

- Better use measures could significantly reduce the economic case for additional road capacity – and hence avoiding associated environmental damage – and strengthen the case for improved public transport; complementary policies are likely to be worth considering.

3. The economic case for targeted new transport infrastructure and variable capacity is strong and offers high returns.

- Small-scale interventions such as walking and cycling schemes can deliver some very good returns and, in some cases, variable capacity such as bus services can potentially offer a higher return than high-cost new fixed infrastructure solutions.

- Private sector investment in container, feeder and ro-ro ports capacity, and in airports, is very important for the UK economy and, subject to full consideration of all environmental costs, prevents capacity constraints dampening trade and growth; very high returns from targeted surface access schemes are possible.

- Targeted investment in strategic roads is able to offer among the highest overall welfare returns, even after accounting for the environmental effects. Additional urban road capacity could, in some circumstances, be the highest-return solution to urban transport problems.

- Even with widespread road pricing, there is likely to be a case for additional strategic road capacity, given the magnitude of pressures facing the UK.

- Step-change measures intended to transform the economy are not, in a world of constrained resources, likely to be a priority. The UK is already well connected and the demands for new links are uncertain.

- Where new and untested technologies are relied on, or where demand for the new link is only speculative, expensive step-change transport policies are unlikely to offer the best value for money in meeting economic or environmental objectives.
Recommendation 3

To meet these challenges, Government needs to: get the prices right across all modes – especially congestion pricing on the roads and environmental pricing across all modes; make best use of existing networks:

(i) In line with the Stern Review, prices across all modes should reflect the true cost to society, including congestion, overcrowding and environmental impacts – through appropriate fiscal, regulatory, pricing or trading instruments.

(ii) Use road pricing as the most appropriate way to tackle congestion: introduce wide-spread, congestion-targeted road pricing to deliver the potential benefits cost-effectively.

(iii) In order to sustain a successful economy, the UK needs to decide between: a very significant road build programme, or widespread road pricing with much more moderate road build. Congestion-targeted road pricing is the most cost-effective and flexible way to deliver the benefits of reducing unreliability and to tackle congestion. Stop the debate on whether to do this, and move on to debating how to do it.

(iv) Government should take steps now to make sure widespread road pricing becomes a reality within the next ten years, provided it can be implemented in a way that preserves the very high potential net gains to society.

(v) Government needs to provide the pathway to widespread road pricing on this timescale, setting out the key decisions needed to unlock the vast potential of road pricing.

(vi) The early part of that pathway must involve the use of local pilots to test issues of scheme design and technology, in a way that can inform the transition to widespread road pricing.

(vii) Government should explore ways of extending the principles of congestion pricing to other modes.

(viii) Given the growth in emissions from the sector, Government needs to find a way to ensure aviation pays its full environmental costs.

(ix) Explore the potential for high value for money better use measures that encourage changes in travel choices or which exploit the opportunities provided by new technologies.

... and together with the private sector deliver sustained and targeted investment, reflecting the high returns available from some transport investment:

(x) After considering the potential for pricing and better use, deliver sustained infrastructure investment where it delivers strong returns in the three strategic economic priority areas. This is likely to include targeted investment in walking and cycling schemes, commuter links, urban buses, roads, and surface access improvements. Even with road pricing the UK needs to continue investing in transport infrastructure. although the need for investment will be considerably reduced.

(xi) Do not be seduced by grands projets with speculative returns, for example:

- Pursue high speed rail options only where they have been demonstrated to be the highest value for money option to relieve congested corridors;
- Do not pursue untested technologies, nor links for which demand is highly speculative.
Government should provide the policy framework to ensure that the private sector can bring forward proposals to expand capacity at key ports and airports, where it is sustainable to do so:

- Implement proposals for additional runway capacity where the case is robust, having accounted for the environmental costs of emissions.
- Provide clear statements of strategic objectives to enable the private sector to continue to bring forward appropriate additional capacity at ports that are important for the UK economy.
3.2 Opening up the full range of policy options

Headlines
- A good option generation process is crucial to ensure that the transport interventions that offer the highest returns can be found.
- This means starting with a good understanding of the strategic priorities and the challenges that need to be addressed, before considering potential solutions.
- At present some propositions start by suggesting a ‘single solution’ rather than defining the problem.
- Unless a wide range of appropriate options is considered, there is a risk that the best options are overlooked and money could be wasted.
- The full range of options should look across all modes and include: making better use of the existing transport system, including better pricing; investing in assets that increase capacity without the need for additional fixed infrastructure; investment in long-life fixed infrastructure; and combinations of these options.

Introduction

2.1 The impacts of transport interventions can vary significantly. Their location-specific nature means that it is not possible to identify a policy option that is effective in one area and assume that, if implemented elsewhere, it would have the same impacts and cost the same to deliver.

2.2 The choice of intervention to implement is, therefore, very complex and requires consideration of a wide range of factors if particular problems are to be tackled effectively and the highest levels of welfare return are to be achieved.

2.3 In order to build an understanding of the interventions that are able to contribute effectively to welfare, it is first necessary to identify the range of possible policy options that could deliver on the strategic priorities identified in Volume 2. This chapter first sets out some overarching issues for consideration before going on to identify a menu of policy options.

The range of policy options

2.4 Volumes 1 and 2 have shown that in the long term, the characteristics of the transport system that business, freight and commuters value are speed and reliability of journey times, cost, connectivity and comfort. These transport outcomes directly support economic activity, so options that deliver on these counts are likely to deliver GDP benefits.

2.5 It may not be possible, or necessary, for a policy option to deliver all these transport outcomes at once. Some transport policy options may not deliver any of these outcomes, but may be considered good value for money because they contribute to other government objectives such as safety, accessibility or environmental protection – all of which are assessed as part of transport appraisal. In designing policies targeted at a particular objective, such as GDP, policy makers should recognise that there are likely to be implications for other objectives, such as social inclusion or environmental protection. More fundamentally, policy makers need to be aware that some options help to meet multiple goals.
2.6 In undertaking this study, it has become clear that some schemes are promoted as solutions without having defined the problem, and without having considered a range of options. Often, interventions are promoted as catch-all schemes without being closely targeted to deliver specific outcomes as identified above. So, the first step towards transport policy that supports sustainable growth better is to understand which links are underperforming and on what counts. Only then can options be generated that will best tackle those problems and deliver the best returns for the economy and to society more widely.

2.7 There will be more than one way to meet most transport challenges, and not all will be equally cost-effective. In a resource-constrained world, with many competing demands on government funds, it will never be possible for government to fund all good schemes. Prioritisation must be carried out, and carried out well. Government can do most for GDP, and for social and environmental objectives, by backing those policies and schemes that offer the highest returns across these objectives.

2.8 To be confident of finding the best returns, the option generation process is crucial: the right problems need to be tackled, and a sufficient range of alternatives considered from the option menu (though the extent of an appraisal needs to be proportionate to the size and scale of the problem).

2.9 Interventions across modes, across the country, and from the very large to the very small have been examined in this volume. A spectrum of different types of intervention has emerged, which can be broadly described as:

- better use: interventions that lead to more efficient use of the existing transport system;
- variable capacity: investment in shorter- and medium-life assets that increase the capacity of the transport system without the need for additional fixed infrastructure, for example additional bus services or longer trains and platforms; and
- fixed infrastructure: investment in additional very long-life capital assets on the ground, such as roads, rail lines, ports etc.

2.10 In very general terms, scale, cost, delivery time and complexity will tend to increase going down the list. There are exceptions to this rule: while many better use schemes are small, cheap and relatively quick to implement, some are not. For example, depending on the technology chosen, implementing widespread road pricing could be very complicated. Likewise, some options that increase variable capacity could be very expensive. In addition, infrastructure options may still present challenges in terms of the cost and complexity of taking them through the planning process and mitigating potential social and environmental impacts.

2.11 This spectrum of options is explored more fully below. All of the options on the menu improve effective performance of the network by focusing on the key characteristics of speed and variability of journey times, cost, connectivity and comfort.

**Better Use**

2.12 The UK transport network is a vast asset that, as Volume 2 demonstrated, has the right connections in place and is able to support a high volume of movements. However, as was also shown, the performance of the network in some places and at certain times of day is relatively poor with significant scope for taking action to make better use of the assets.
Better use can be divided into four types of measures:

- **supply-side measures** that make the movement of users already on the network more efficient, including maintenance;
- **demand-side measures** that make the network more efficient by changing traveller behaviour; and
- **regulation**.

These better use options are further explored in Figure 2.1.

**Figure 2.1: Better use measures**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Impact on the network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic management</td>
<td>Throughput of traffic is actively managed to increase flow. Examples include ramp metering, hard-shoulder running or speed control.</td>
</tr>
<tr>
<td>Incident management</td>
<td>Throughput of traffic is improved by making the network more resilient to disruptions. For example, the Highways Agency Traffic Officer service aims to get traffic moving again as quickly as possible following an incident.</td>
</tr>
<tr>
<td>Reallocation of capacity</td>
<td>Available infrastructure capacity is reallocated for particular users or purposes. For example, reallocating road space (e.g. to bus lanes or cycle ways); allocating rail paths or landing slots at airports to priority users. Or, capacity could be removed, as with workplace or city centre parking.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Regular maintenance regimes prevent future disruption and extend asset life.</td>
</tr>
<tr>
<td>Pricing</td>
<td>Better pricing of transport to spread demand can, if well-targeted, allow the system to be used more effectively.</td>
</tr>
<tr>
<td>Soft measures</td>
<td>Behavioural change is brought about by increasing public awareness of travel options and taking small practical steps to make travel ‘easier’. Examples include workplace travel plans or car-sharing schemes that often rely on improved information provision.</td>
</tr>
<tr>
<td>Regulation</td>
<td>Improvements in transport performance are the objective of regulation that specifies minimum service levels. Examples include rail franchises that penalise train operating companies for late running, and bus franchising in London. Regulation is also one way to manage the impact of transport’s externalities, e.g. noise impacts on other people. Delivery restrictions help to mitigate such impacts, while also impacting on how fully available capacity can be used.</td>
</tr>
</tbody>
</table>

Better use measures can have very significant environmental benefits through reducing or eliminating the need for additional capacity, that can often have significant adverse environmental implications (for example, the landscape impacts of road widening or airport expansion).

The policy options discussed later in this volume suggest that there is significant scope to implement better use policies in a wide range of circumstances. The relative lack of evidence available on these interventions suggests that they may not be adequately considered as part of the option generation process. Chapter 3.3 sets out the evidence on better use, and takes an in-depth look at the potential offered by better pricing.
VARIABLE CAPACITY

2.17 Better use options are concerned with taking the transport system as it is and using it more effectively to improve its performance. But in some cases, there may be an economic case for adding capacity to the transport system. Additional variable capacity involves investing in those assets that deliver an increase in effective capacity of the transport network without the need for significant additional fixed infrastructure. Examples of additional variable capacity are set out below:

- Bus services: this captures a range of options including new routes, higher service frequency, investment in new vehicles to increase onboard capacity, or better signage.
- Train capacity: this could involve investment in new rolling stock to increase onboard capacity, and longer trains to increase the capacity available on each train service. In some cases the distinction between variable and fixed infrastructure as discussed next, may be somewhat blurred e.g. when longer trains mean longer platforms.
- Signalling: upgrading rail signalling can allow a reduction in the gap between trains that increases the effective capacity of a given rail line. This may require significant investment but would have the potential to improve journey times and reliability.

2.18 Chapter 5 sets out the evidence on variable capacity options.

FIXED INFRASTRUCTURE

2.19 Investment in fixed infrastructure refers to investment in long-life capital assets that increase the geographical scope of the transport network and create a larger ‘footprint’ on the ground. It is costly and generally non-reversible, so is only likely to be an option where a sufficiently high level of demand can be guaranteed over the long term. Additional fixed infrastructure can, if delivered well, improve journey time and reliability, and new links may improve connectivity. Examples of fixed infrastructure options are set out below:

- walking and cycling infrastructure: providing dedicated walkways and cycle-ways to improve journeys by these modes;
- additional rail capacity: new or longer platforms, new or enhanced stations, line extensions, dual tracking, rail gauge enhancement, bridges and tunnels can all be implemented to significantly increase capacity;
- additional road capacity: new roads, upgrades to trunk road or motorway standard, on-line or off-line widening, bridges and tunnels;
- junction improvements: junctions that are the cause of many congestion problems can be upgraded to improve traffic flows thereby improving journey time and reliability;
- additional port and airport capacity: additional runways, quayside capacity, and airport facilities; and
- public transport interchange facilities: where travellers need to change from one mode to another such as from bus to rail or rail to the underground network, interchanges impact on the overall journey time and reliability.
2.20 The majority of these fixed infrastructure options are likely to have long lead delivery times and require significant investment so it is even more important to make sure the right option is pursued. Such options are also most likely to have negative environmental or social consequences so, as always, a full value for money assessment needs to be carried out to establish the case for investment.

2.21 Alongside the evidence on variable capacity, Chapter 5 also sets out the evidence on fixed infrastructure options for each of the strategic priorities identified in Volume 2, namely congested and growing cities, key inter-urban links and key international gateways.

WHICH OPTIONS TO PURSUE, AND WHEN

2.22 Choosing the highest return combination of better use, additional variable capacity or new fixed infrastructure solutions first requires a full understanding and definition of the problem to be addressed. The options from the policy menu that are most likely to be cost effective will, of course, vary according to the particular circumstances in which they are implemented. Good quality appraisal is, therefore, needed so that options can be compared and the most effective options identified.

2.23 In many cases packages of better use and variable or fixed infrastructure options could be most effective. The potential for synergies and complementarities between policy options should be considered as they may be able to deliver benefits that exceed the returns offered if implemented separately. In some circumstances, it may make sense to implement better use options while, at the same time, work on delivering a major fixed infrastructure enhancement. It is of course possible that some policy options would not work well together. One of the most important interactions in this regard is the impact of better pricing in reducing the need for more road infrastructure, which is explored in Chapter 5.

2.24 In looking at the policy options, the Study’s starting points have been as follows:

- where congestion and overcrowding problems are significant, there is a strong presumption that better use and better pricing options, and their impact on investment needs, should be considered;
- enhancing variable infrastructure can in some cases be more flexible than providing fixed infrastructure;
- better use and variable capacity options have a smaller ‘footprint’ so may have lower landscape and biodiversity costs than fixed infrastructure projects; and
- packages of options offer important choices in their own right.

2.25 The next chapters set out the evidence available to this study on the returns from a wide range of interventions across the policy options, and identify the conditions under which a high contribution to welfare and GDP is likely.
INTRODUCTION

3.1 The options menu identified a wide range of policy interventions that can be implemented to solve transport problems cost-effectively and deliver strong welfare and GDP returns. This chapter focuses on the options for making better use of the transport system.

3.2 This chapter is structured by the type of intervention with the implications for the strategic priorities highlighted throughout. There are two main parts to the chapter. First, the relevance of better use options to the UK is set out. The available evidence on the following is then discussed:

- supply-side measures such as traffic management and maintenance;
- demand-side measures that provide incentives to change travel behaviour; and
- regulatory policy and the role it has in improving the operation of the transport system.

3.3 Second, given the wide range and potential impacts of pricing options, a closer look at these measures is provided in the later part of this chapter.
CONTEXT: WHY IS BETTER USE RELEVANT TO THE UK

3.4 The UK possesses an extensive transport system that represents an extremely valuable national asset. Adding to this network is expensive and the UK is already relatively well connected, as the analysis in Volume 2 revealed. One of the key strategic challenges for transport policy, is therefore, to improve the performance of the existing network; better use measures will be a key component of this.

3.5 The transport network is often characterised by periods of peaky demand, outside of which there is often spare capacity. One of the advantages of better use measures is their ability to relieve capacity constraints when it would be particularly beneficial around the peak periods. This may be through spreading demand to less congested periods or switching demand to alternative networks. Many better use measures rely less on new fixed infrastructure so can often be implemented more quickly, and with more flexibility, than other measures. For example where additional and better information is provided to travellers by making use of existing communication systems.

3.6 As will be demonstrated in the rest of this chapter, evidence on better use measures in the UK is an emerging field. This chapter presents the quantitative evidence on benefit:cost ratios (BCRs) that is available and supplements this with more indicative qualitative evidence (typically providing estimated impacts without reference to costs) where appropriate. Of course, only measures with wider BCRs appear in the full database of schemes available to this study. That there is relatively limited evidence is unsurprising, given that many better use measures are associated with new technological opportunities, or are relatively recent attempts to change behaviours.

3.7 In some cases, there is little quantitative evidence on the returns achievable from better use options because they are often introduced in packages, alongside infrastructure improvements, or implemented in small, potentially private sector, initiatives. This makes it difficult to identify the contribution of each element. The qualitative nature of the available evidence is only able to provide indications of the potential for such schemes to achieve welfare benefits.

3.8 While significant gaps remain, the quantitative evidence suggests very considerable promise for these measures, and the findings should be interpreted in this light. Nonetheless, to play their full role in the policy menu, much remains to be done to improve the collective understanding of the costs and benefits of many better use measures.

SUPPLY-SIDE MEASURES: ROAD TRAFFIC MANAGEMENT

3.9 Traffic management and capacity-use measures in dense urban networks in the UK have the potential to reduce congestion and increase the reliability of journey times. As Volume 2 set out, these have already been implemented in some form in various urban centres across the UK. Evidence available to this study on two traffic-management systems in large urban areas in the UK suggests strong potential for welfare benefits with wider BCRs in the range 6.3-7.6 and GDP per £1 spent of £3.80-£4.40. Over half of the GDP impacts are derived from the value of time saved to business travellers who are able to travel more quickly on a less congested network. Although the evidence sample size is obviously small, the returns look promising and merit further investigation.

---

1 These systems utilise detectors embedded in the road to monitor traffic flows, responding to fluctuations by automatically changing signal timings to allocate more junction capacity to traffic concentrated in particular directions, or, if the road is congested, to balance queue lengths.
3.10 The environmental implications of traffic-management measures are likely to be beneficial, given their objective of more efficient use of road space and lower congestion. On the basis that traffic should be able to travel in less congested conditions, harmful emissions of carbon and air pollutants are likely to be lower. However, if there is more traffic overall then this would at least partially offset these benefits.

3.11 Traffic-control measures can also play an important role in improving the utilisation of congested inter-urban corridors. Few traffic management schemes currently exist in the UK but there is evidence they can have a substantial effect on improving journey times and reliability. For example, the introduction of a peak time Higher Occupancy Vehicle (HOV) lane on the busy A4174 Avon ring road reduced the proportion of single occupancy cars during the peaks from 80 per cent to 69 per cent, achieving a 70 per cent reduction in journey times for HOVs and bus traffic, and over 40 per cent reduction along the rest of the road. It is likely that there were knock-on effects on surrounding roads however, as traffic was redistributed. Owing to smoothed traffic flows, these savings occurred alongside a 10 per cent increase in traffic levels on that route, as vehicles rerouted onto the road. The exact costs of such schemes have not been available to this study but there is a need in future to compare the costs of HOV lanes with their demonstrated benefits.

3.12 Traffic-management and capacity-use schemes on inter-urban corridors need to be carefully targeted otherwise they may produce distributional effects that limit their impacts. An HOV lane on the radial A647 road into Leeds, for example, successfully reduced journey times and the number of single occupancy vehicles on that link but this was achieved by simply ‘exchanging’ traffic with alternative routes.

3.13 These inter-urban schemes may also have substantial one-off implementation costs owing to the need for complex signalling and roadside enhancements. Strategic modelling of an illustrative active traffic-management scheme adopting hard shoulder running during the peaks on a major strategic motorway in the West Midlands,2 suggested estimated costs of over £900 million. The returns were therefore lower than other traffic management schemes with an estimated wider BCR of 2 and GDP per £1 of £1.80. If the costs of technology fall over time, the relative returns will be correspondingly higher.

3.14 For both urban and inter-urban roads, local enforcement is likely to be necessary for the majority of traffic management interventions to be most effective, as violation rates can be high. For example, the A4174 HOV lane had violation rates of 7-11 per cent and relied on enforcement through local police monitoring because it was considered that technological enforcement measures would have been too costly.

3.15 It is important to recognise that making better use of existing infrastructure through traffic management, for example, does not mean using the infrastructure to its maximum potential at all times, as this may in some circumstances lead to adverse reliability impacts outweighing decongestion effects. Lack of understanding over the potential for adverse reliability impacts, for example how one accident would have impacts on a larger volume of road users if the link were being more intensively used, means that this effect is difficult to capture when assessing the benefits of an intervention. Figure 3.1 discusses this further.

---

2 For more detail see the separate paper on this case study, M6 Hard Shoulder Running: Impact on the Economy, Mott MacDonald, 2006.
The option of making better use of existing capacity is not restricted to the UK’s road network. Measures can be applied, and should be considered, across all transport modes. Employing measures of capacity management, for instance, can increase the efficiency of the UK’s international gateways.

In 2005, Southampton Container Terminal reorganised its yard, upgraded IT systems and introduced a mandatory Vehicle Booking System (VBS). This system divided the port’s vehicle-handling capacity into a series of hourly time slots, each of which could accommodate a maximum of 120 bookings. Lorries bringing or collecting containers now have to pre-book into a specific and available slot, rather than bunching during peak periods.

By rationing the terminal’s capacity use, the VBS has helped to reduce congestion and improve reliability; average vehicle turnaround times have been reduced to under 30 minutes, even during peak periods, when they were previously running at an average of 114 minutes. This has improved productivity at the terminal, allowing it to reduce yard occupancy while increasing volumes, and provided wider benefits to freight hauliers, who benefit from more certain and efficient operations.

The Air Transport White Paper makes clear that airports should seek to make best use of their existing capacity. One way of doing this is for airports with more than one runway to make the most of their runway capacity by operating it in ‘mixed mode’, with flights taking off and landing on all runways.

Work is currently underway to understand whether, how and when mixed-mode operation could be delivered at Heathrow airport. Other airports using two runways could also explore this method of operation to allow them to realise the capacity and resilience benefits that mixed mode would deliver.
Importantly, plans to develop mixed mode at airports with more than one runway need to be carefully prepared to ensure that their consequences for safety, noise and emissions are fully understood and can be properly addressed. Leading issues include the need to ensure an adequate separation of craft in the air and on the ground, and changes to local noise contours coming from the introduction of mixed mode. But even after accounting for these, the large economic returns from the efficient use of existing capacity would allow a good overall net return. For instance analysis carried out for DfT suggested that employing mixed mode use at Heathrow could generate net benefits of £1.7 billion over the period to 2060.

**MAINTENANCE**

3.22 Transport infrastructure is capital intensive and has a long life. Many local roads are hundreds of years old and heavily used; and railways often date from the nineteenth century. To ensure their continued operation, all such assets need maintaining and periodically renewing, for example rail lines are typically renewed every 30 years or so. The extent to which these assets are well maintained can influence the performance of the network and impact on the reliability and safety of journeys. For example, poorly maintained roads could constrain speeds and contribute to congestion problems.

3.23 There are many factors that influence the degree and level of maintenance spending that is appropriate for any transport asset. These include the use of the asset and how this is likely to change over time; climate conditions; the particular design and materials used; plus, accompanying policies. This range of factors introduces uncertainty over the long-term costs of sustaining the operational capacity of the asset. In order to understand maintenance requirements, a comprehensive understanding of the UK’s full asset base is required, including its condition and the economic outcomes to which it contributes.

3.24 The evidence on the returns to maintenance expenditure is light, so it is possible to make only some generic statements based on the available information and experiences. Where maintenance is concerned, it is especially important to understand the impacts and costs of not taking action that in some cases could be particularly high. It would be expected that unless transport assets are maintained, there would be implications for the following:

- **Asset life:** at the most basic level, regular maintenance helps to ensure assets continue to function efficiently and have a suitable life span. For example, lack of maintenance could reduce the life of a rail line between 10 and 20 years. It is usually more cost-effective to maintain assets at a certain level, rather than wait until significant degradation sets in which risks premature renewal or replacement. There are also likely to be wider costs in terms of loss of connectivity if a link no longer exists or if it falls into disrepair. This would be particularly problematic for growth where few alternatives are in operation and the link is heavily used.

- **Journey speeds and reliability:** delays caused by poorly maintained assets could be significant, with direct costs to the economy, especially if corridors are heavily used by business, commuters and freight.

- **Safety:** adequate maintenance is necessary to meet obligatory safety standards. Accidents caused as a result of safety failures have knock-on effects in terms of disruption of journeys to users; and may have longer-term impacts from prolonged closure of links; and wider costs associated with addressing the damage caused.

---

3.25 However, it is important to have a sensible approach to maintenance. There is a balance to be struck between ensuring the asset is able to operate effectively and the costs of maintenance, including both the financial investment and the disruption from carrying out works. There is limited evidence available to this study on that balance.

3.26 To allow asset management and maintenance policy to contribute effectively to better use of the system, it is likely that it should:

- take a whole-life cost minimisation approach to the maintenance of assets;
- include an economic assessment of the impact on different users of the network, including disruption disbenefits when prioritising maintenance interventions;
- maintain strict safety standards; and
- be supported by up-to-date information on the condition of the relevant links of the transport system, and therefore the maintenance requirements and options.

3.27 Given the lack of information on the impacts on GDP and welfare of maintenance spending, and on how much should be spent to reduce the life cost of the assets, there remains an overarching need for government to build a stronger understanding of these issues. Only then can appropriate decisions be made and priorities properly assessed.

DEMAND-SIDE MEASURES: INFLUENCING TRAVEL CHOICE AND BEHAVIOUR

3.28 Transport interventions, such as pricing, improved interchange facilities, smartcards, and a wide range of smart measures, designed to influence choice and behaviour, can produce a wide range of effects on travel decisions. These are often concerned with improving the performance of existing networks or promoting mode shift by:

- allowing prices to reflect the level of demand, congestion and overcrowding;
- improving inter-network connectivity and supporting multi-modal journeys, for example by providing a smooth connection between intercity train services and those serving an urban catchment area or moving between modes; and
- changing attitudes and behaviours, for example by increasing the quality and attractiveness of modes such as walking or public transport.

Pricing to reflect demand

3.29 A greater degree of demand-related pricing has the potential to deliver substantial welfare and GDP returns. This way of allocating limited resources is seen in many sectors: mobile phone tariffs, concert tickets etc. Prices rise when there are greater demands for a good or service than is actually available, such as for peak-time telephone calls, and conversely fall when demands are lower such as post-season sales or pre-theatre dinner bookings. Prices also vary according to the quality of the good or service on offer: luxury goods are more expensive than basic standard goods, for example. However, these principles of pricing are often not currently applied widely to transport infrastructure and services.
As pricing is a fundamental part of any efficient market, it follows that better transport pricing would allow the networks to be used much more efficiently.

Travellers are then able to make choices depending on the value they place on a trip compared to the price being charged. Provided the pricing regime is well designed and prices are well targeted to reflect pressures on the network and the true costs of travel, there is the potential for significant benefits. Implementing better pricing in this way allows externalities to be priced in, with the real benefit of providing capacity for those travellers that value it most. The value a particular traveller places on a journey will depend on their reason for travelling, which will change regularly. For example, the same person would place a different value on their trip to get to a hospital appointment on time, than on their trip to the supermarket, and a different value again on a journey to get to a meeting when they are at work. Travel decisions will therefore be different in each case. Being able to make the journeys that are really valued in less congested and more reliable conditions, is a real benefit.

There would be distribution effects to consider with pricing, given the variation in the extent to which travellers have the flexibility to respond to the implementation of better pricing. Given the scale of benefits, the pricing issue is discussed in more detail in the second part of this chapter.

By improving the convenience and accessibility of public transport networks, interchanges can support labour markets and agglomeration effects. Providing a greater choice of onward journeys, interchanges can encourage and enable users, notably commuters, to travel further and widen catchment areas. The schemes on which this study has evidence, however, show low GDP returns per £1 spent in the range £0.2-£1.4, with the majority being less than £1. It is possible, though, that the full GDP benefits of interchanges are not being captured because, although such benefits are captured in the assessment of welfare, how they feed through into a GDP effect is not currently understood.

However, wider BCRs from the evidence are in the range 1 to 6. Quality factors form an important component of the welfare returns from improved interchange facilities. By way of illustration, Figure 3.2 sets out the value travellers place on various facilities at bus stops. Good interchange facilities are therefore able to contribute to quality of life, if not to GDP directly.

**Figure 3.2: Value of bus stop facilities (pence per trip 1995 prices)**

<table>
<thead>
<tr>
<th>Facility</th>
<th>Value (pence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelter with roof and end panel</td>
<td>5.6</td>
</tr>
<tr>
<td>Basic shelter with roof</td>
<td>4.5</td>
</tr>
<tr>
<td>Moulded seats at bus stop</td>
<td>3.4</td>
</tr>
<tr>
<td>Lighting at bus stop</td>
<td>3.1</td>
</tr>
<tr>
<td>Flip seats at bus stop</td>
<td>2.2</td>
</tr>
<tr>
<td>Bench seats at bus stop</td>
<td>0.9</td>
</tr>
<tr>
<td>Clean bus stop (compared with dirty)</td>
<td>11.8</td>
</tr>
<tr>
<td>Countdown (Real Time Information)</td>
<td>9.0</td>
</tr>
<tr>
<td>Payphones at bus stop</td>
<td>3.8</td>
</tr>
</tbody>
</table>

### Changing attitudes and behaviours: smartcards and smart measures

**Smartcards can provide a range of benefits**

#### 3.35
Intelligent smartcard systems are a technological solution that can help contribute to better use of the transport system by facilitating the implementation of other policies, such as different pricing schedules, and reducing many of the time costs associated with public transport travel, such as buying tickets. Combined, these can reduce the overall cost of making certain trips and encourage some travel to be made by public transport that might not otherwise have been made, or by changing the time of travel to less congested times.

#### 3.36
The ability of smartcards to collect data on travel patterns across the various parts of the network and at various times of day, makes it easier for operators to provide a flexible service and match supply to demand. As London’s Oyster card has demonstrated, smartcard technology also has the potential to enable the introduction of flexible pricing policies on public transport networks.

#### 3.37
In order to exploit economies of scale and the benefits to public transport users who are interchanging between modes, smart cards are more likely to be cost-effective over relatively wide areas where public transport demand is high. And on a national level, there may be wider network benefits from ‘inter-operable’ systems that are compatible across different locations.

**Smart measures offer potential for reduced congestion**

#### 3.38
Smart measures tend to be primarily targeted at problems during the commuter peaks on congested urban and inter-urban roads with the aim of facilitating better and more efficient use of cars; by promoting car pools or car sharing for example, or providing the incentive to travel using alternative modes of transport by highlighting the benefits of alternative means of travel. School buses can also play a role in this regard, and have been introduced in some areas, with the aim of easing pressure on the road system caused by the school run.

#### 3.39
Such measures are usually designed to provide greater transport choice, knowledge and accessibility. By attracting people away from private car use and onto alternative modes, smart measures may help reduce congestion, as shown in the example in Figure 3.3.

#### 3.40
Many smart measures rely heavily on various forms of information provision such as real time information on public transport; publicising services on the internet; and raising awareness of travel options to broaden the choices available for travellers and make journeys more efficient.
Measures that influence behaviour and choice will primarily be employed in major urban areas and their catchments, where peak-time congestion often considerably lengthens commuter journey times. There is also scope for their use on certain inter-urban routes. The new South Western train franchise, for instance, will test the extension of smartcards on certain inter-urban rail corridors and examine how these can be integrated with urban networks.

While there are indications that some measures might achieve good welfare benefits and that others have the potential to generate economic returns by releasing extra capacity, the lack of evidence to date on their likely impacts makes it difficult to estimate the potential of these schemes to have a large-scale effect on UK travel problems. But the evidence available suggests merit in exploring their potential further.

The efficacy of smart measures depends on the intervention, the type of change sought, and the particular circumstances. Analysis for DfT 4 provides some general assessments based on experience to date. It suggests the potential exists for good returns, but will depend on where and how a scheme is implemented. That report explicitly states that it is an assessment of the potential that may exist for such measures, rather than a forecast.

Encouraging cycling, walking and smarter choices has the potential to provide benefits to the economy and welfare through both reduced congestion and the associated likely reduction in greenhouse gas emissions and other pollutants, and improved health. Little evidence exists on benefit:cost ratios for such interventions, largely owing to the significant uncertainties around the costs. But the DfT analysis suggests that with high intensity uptake of smart measures, some 21 percent reduction in urban traffic could be achieved. This promise must be weighed against other factors, including the following:

---

**Figure 3.3: Individualised Travel Marketing**

Individualised Travel Marketing (ITM) schemes are one example of where some research has been carried out to look at the potential impact on urban car use of greater information provision. This research reflects a trial programme, so there remains uncertainty over the extent to which these impacts could be sustained over the longer term. In addition, the extent to which they can be implemented on a wider scale or replicated in other areas is also uncertain. Results from this trial should therefore be interpreted in this light.

Sponsored by the DfT and trialled in Worcester and Peterborough by Sustrans and partner Socialdata, ITM schemes involve making direct contact with households to offer people personalised travel planning and advice on the alternatives to car use. This can involve anything from bespoke bus timetables to information on where to obtain discounts on cycles.

The first stage of the ITM trials, reaching around 6,500 households in each city, achieved a reported 12-13 per cent reduction in car driver trips, concentrated during congested peak times. At the same time, public transport usage increased by between 13-22 per cent, whilst walking and cycling rates increased between 17-36 per cent. This represents the switching of around 60 car trips per person, per year to other forms of transport.

There was also an approximately 18 per cent increase in daily time spent using physically active forms of travel for the households involved, which will help to realise wider health benefits to both individuals and business. An ITM scheme is also being trialled in Darlington and Sustrans is working on a programme targeting 50,000 homes in Lancashire.

---

1 For more information see www.sustrans.org.uk

---

**Better use measures offer potential on inter-urban corridors as well as in major urban areas**

**Large uncertainties over their impacts and costs**

---

1 Smarter Choices: Changing the Way We Travel, DfT, 2004.
• the studies cover the initial impacts and have not fully assessed the permanence of the behavioural change. Without continuous reinforcement, promotion and investment, it is possible that utilisation of such measures could decrease by 40 per cent per year, after the first year;\(^3\)

• Whether these schemes can be implemented on a widescale is not fully understood: costs of these schemes and their nationwide implementation have not been accurately assessed. Many smart measures may require new technologies for which costs can be unpredictable and the risks may be significant. This is discussed further in Figure 3.4; and

• Even if these measures are sustainable and cost-effective in themselves, they are likely to require a package of complementary measures. For example, supporting traffic-limiting or calming interventions may often be needed to increase their effectiveness e.g. many businesses have set up workplace travel plans to reduce the amount of parking available to employees.

Uncertainties must be recognised

These uncertainties mean it is important to build an understanding of the conditions under which smart measures are able to offer welfare and GDP returns and, in particular, more evidence is needed to confirm the circumstances in which they are able to offer a high return solution to the transport problems in urban areas. The evidence that is available does however suggest good potential that merits exploring further.

May complement other policies effectively

These schemes may have a role as complementary measures, reinforcing other methods of better utilisation and capacity addition. London’s Oyster card is a good example of a smart measure complementing other interventions such as increased public transport services, dedicated public transport infrastructure and congestion charging to enable high public transport patronage and help reduce congestion and its problems.

\(^3\) Smarter Choices: Changing the Way We Travel, DfT, 2004.
REGULATORY POLICY

3.47 Where there are market failures in the operation or provision of transport services, regulatory policy may be the appropriate intervention to prevent wasteful use of resources, or to support the delivery of other measures for which the economic case has been proven.

3.48 It should of course be recognised that, if imposed ineffectively, regulation can have adverse effects on travellers, freight and the economy. This points to the need to build a better understanding of the costs and benefits of different regulatory options and to compare them with other solutions to find the most cost-effective policy to tackle a particular challenge. There are several examples in the transport sector where regulation plays a strong role in the market including road freight delivery restrictions, night time slots at airports and bus regulation. The latter will be discussed in more detail in Volume 4.

Road freight delivery restrictions

3.49 Road freight traffic plays an important role in allowing economic activity to take place in dense urban areas by ensuring that goods are delivered to outlets and production units on time and with controlled costs. Roads are by far the dominant mode used for such deliveries due to the need for flexibility of route, size of delivery and time of delivery.

3.50 Freight traffic competes for scarce road capacity with other network users. Various regulations exist to coordinate multiple transport demands in major cities and other catchments, some of which impose restrictions on freight traffic and deliveries. These are often driven by concerns over the contribution of freight to harmful carbon dioxide and...
particulate emissions or noise. Such restrictions, however, impose costs on retailers and freight operators, especially when there are no alternatives available. This is likely to feed through into economic efficiency because it adds to the cost of getting the goods and products to where they need to be. Conversely, in the absence of such restrictions, there are costs imposed on other road users, including business travellers and commuters, from the noise disruption and increased congestion caused by freight deliveries.

Night-time slots at airports

3.51 Another example is the regulation of night-time slots at airports. The movement of freight by air often involves transportation of goods at night. Night slots are particularly important to the express delivery and just-in-time freight sectors, which, as discussed in Volume 2, support high-value business. Freight aircraft currently use night slots at Gatwick and Stansted where controls are rightly imposed by the Government with a view to balancing economic interests with the interests of local residents. Other airports with significant use of night slots, such as Manchester and East Midlands, operate them under their own controls, liaising with, among others, local authorities and residents. Finding the balance between limiting night slots owing to noise impacts, and releasing some to support valuable economic activity means building an understanding of the full costs and benefits involved. This covers the economic, environmental and social impacts, particularly greenhouse gas emissions and noise. On that basis, appropriate regulatory decisions can then be made about the use of night slots.

3.52 For regulation in general, building a full understanding of the wider impacts involved and assessing and comparing the impacts may allow the relevant authorities to make better informed decisions as to which restrictions are welfare enhancing, and which are actually damaging in the wider sense. It is not only the new regulations that might be introduced that should be assessed in this way. For some, a review of existing regulations could prove beneficial. Targeted relaxation and better coordination of regulatory restrictions may have the potential to release scarce capacity for other users, while also improving freight supply chains and logistics.

Full CBA is needed

3.53 Regulatory policy will be more effectively decided if all costs and benefits have been appropriately assessed. Full cost-benefit analyses (CBAs) of regulatory interventions, including the wider impacts on the economy, environment and noise do not currently exist. Such analysis is needed if policies are to be appropriately and consistently compared.
A CLOSER LOOK AT PRICING

**Headlines on pricing**

- There are strong economic and environmental arguments for ensuring users across all modes face the full external costs of their journeys, be they environmental or congestion related. This could be done through appropriate fiscal, regulatory, pricing or trading instruments.
- Well-designed pricing stands out above all other interventions, given its substantial potential to contribute to welfare and GDP, particularly if roads are better priced.
- The risks of road pricing implementation are real and need managing, including through pilots.
- Ill-targeted pricing could impose costs on the economy so developing a well-designed scheme is crucial.
- Environmental effects such as carbon emissions from congestion pricing schemes would depend on the specific scheme design and pricing system used.
- Given the serious implications that aviation emissions have for climate change, there is a need to identify and implement an effective mechanism for ensuring that air travellers pay the full cost of their climate change impact.
- Better pricing will significantly impact on the economic case for additional transport capacity: most notably, road pricing would be expected to reduce the case for additional road infrastructure significantly; the impact on urban infrastructure needs further assessment.
- Distributional concerns may point to the need to consider complementary policies such as improved public transport to minimise the adverse impacts on some travellers; but there may also be ways to meet these concerns through other mechanisms or government policies.

**There are strong economic arguments for better pricing**

The first half of this chapter set out the options for making better use of the existing transport infrastructure. Among the options was better pricing and how, by changing the relative prices faced by transport users, it provides the incentive for them to change behaviour and use available capacity more efficiently. This chapter takes a more detailed look at transport pricing. It explores:

- the context for implementing better pricing;
- how pricing is currently used in transport and other sectors;
- the potential benefits of a relatively sophisticated illustrative national road pricing scheme;
- the potential benefits of local road pricing schemes;
- factors that affect the effectiveness of road pricing and distributional impacts;
- implications of better pricing on the case for additional capacity across modes; and
- pricing on other modes.
The context for better pricing

3.55 One of the most important policy levers for making more efficient use of existing capacity is to introduce better pricing across the transport system, particularly if prices are set so that travellers face the true costs of making a journey, including congestion and carbon impacts. These costs are higher when there are more travellers wanting to make a journey at the same time of day and on the same link.

3.56 By sending better price signals about the impact of each journey on other travellers and on the environment, often referred to by economists as the ‘marginal social cost’, it is possible to spread demand away from the peaks and increase the effective capacity and performance of the network. Travellers who value their particular journey most will generally be prepared to pay a higher price and will benefit from improved reliability and travel times. The value an individual places on a journey will vary throughout the day as they make trips for different reasons. For example, the value they place on improved travel conditions when they are late for a hospital appointment will be different to the value they place on improved conditions when travelling to the supermarket.

3.57 The Stern Review argued that prices should be used to reflect the costs associated with climate change. The same is true for congestion: users should pay the full costs of their journey, including a carbon price and a congestion price. Road pricing is certainly the most effective way of pricing for congestion. It is also one possible instrument for pricing the carbon effects of road use. However, the analysis in this chapter should not be taken to suggest this study has taken a view of the best instrument for carbon pricing, only that analysis commissioned by this study to explore road pricing takes account of the impact of carbon pricing on the demand for surface transport.

3.58 The benefits of better pricing are therefore:

- it leads to a more efficient allocation of transport capacity to those who value it most; and
- it allows ‘external’ costs to be priced in to reflect the true costs of making a journey, including congestion and carbon impacts.

3.59 A well-targeted pricing scheme can lead to direct and immediate benefits to business and freight travellers in particular because, given the nature of their travel, they are generally more likely to be willing to pay a higher price to travel where and when they most prefer. For them, the value placed on reduced congestion and more reliable trips will be worth more than the price paid for the journey. In addition, the benefits in terms of lower congestion, overcrowding and improved reliability will improve the productivity of firms, if the resources saved from the lower overall cost of the journey (as less time is wasted travelling in congestion for example) are used to increase operational efficiencies. When the value placed on making a trip at a particular time of day is lower than the price being charged, there is the incentive for travellers to look for lower-cost alternatives. For example, in the short term this will include exploring travel at a different time of day, or on a different mode, getting a lift with someone else, or even not making particular trips. In the long term, more dynamic effects are possible such as a shift in employment or household location.

3.60 Relying on congestion to affect behaviour and allocate road space is not efficient; yet this is currently the only mechanism. Pricing would be much more effective in providing the incentive for people to change their travel behaviour as they face the true costs of the journey.

3.61 This chapter discusses two key impacts of pricing transport differently. First, there are significant economic benefits from improvements to the performance of the road network. Second, by improving the performance of the network, the economic case for additional capacity is significantly altered, and for roads is substantially reduced.
Existing use of pricing

Pricing is a familiar part of everyday life

3.62 Markets exist for buying goods and services in a wide range of other sectors. Consumers are therefore used to paying the prices as determined by those markets. Prices are set on the basis of balancing the quantity of goods or services available against demand, with prices being higher when demands are greater. Consumers then make choices about the goods and services they are prepared to pay for. It is commonly understood that it costs more to use a mobile phone during peak hours, that cinema tickets are cheaper in the afternoon than in the evening, and that restaurants often offer cheaper set menus before 7pm or after 10pm.

It is already being used successfully on many parts of the transport network

3.63 Price signals, however, are already being used to a greater or lesser extent on many parts of the transport network, including in aviation, rail, public transport and central London roads.

3.64 Over the last two decades, the aviation industry has used yield management to great effect, utilising sophisticated software and internet sales to increase the load factor of planes. Figure 3.5 provides more detail.

**Figure 3.5: Yield management in the aviation sector**

Airlines are already using pricing very successfully through yield management, which involves a sophisticated and flexible approach to pricing. Using historical sales information to allocate some seats to price-sensitive, low-paying non-work/leisure travellers, while holding others for time-sensitive, high-paying business travellers, airlines aim continually to find the best product mix of differently priced seats, to gain the highest possible revenue from the fixed capacity of each airline flight.

Widespread use of yield management techniques allowed dramatic efficiencies to be achieved in the airline industry throughout the 1980s and 1990s. In 1984, UK airlines sold only 66 per cent of seats on each flight on average. By 2005, this figure had risen to 76 per cent.

In recent years, technological improvements have enabled airlines to continue improving their yield management.

**Load factors for scheduled UK airlines, 1984-2005 (percentage of seats used)**

![Load factors for scheduled UK airlines, 1984-2005](chart)

Source: Eddington Study analysis of UK airline statistics, 2005, Civil Aviation Authority.

* Chart produced from data published by the Civil Aviation Authority UK Airline Statistics 2005: 12 Table 2.2
3.65 In the rail industry, train operators have some scope to vary prices, but government regulates the prices of both commuter and long-distance ‘saver’ fares that can be used for travel outside of peak hours. Rail companies can introduce their own discounted tickets to encourage advance booking or to encourage demand for less heavily used services. Time restrictions on the use of cheaper ‘saver’ or other discount tickets provide incentives for cost-sensitive users to travel off-peak. This is an effective way of tackling demand problems in the peak but is a fairly blunt method of pricing. It generally acts to shift demand from the peaks to time periods directly either side of the peaks, as Figure 3.6 illustrates.

Figure 3.6: Crowding and ticket restrictions on intercity services out of London, Friday pm

The graph below shows the levels of crowding on an intercity route departing from London, together with the ticket types that are valid at particular times throughout the day. Savers tend to be the cheapest available walk-up ticket, followed by business saver, the weekender and the open. It seems that the current pricing incentives are helping to reduce crowding during peak periods, from the period 1700 hours to 1900 hours, but are increasing crowding at the shoulder peaks after 1900 hours.

3.66 Some train operating companies have made greater use than others of discounted advanced booking tickets to fill empty off-peak seats and spread peak demand. Since privatisation, all intercity operators have seen an increase in the proportion of revenue they gain from these tickets, and they now make up between 7 and 21 per cent of train operating companies’ revenue.

3.67 There has been a limited form of peak pricing on the London Underground for a number of years, with cheaper all-day travelcards available after 9.30am. More recently, the introduction of the ‘pay as you go’ Oyster card has enabled more sophisticated peak pricing on buses, with cheaper fares available after 9.30am. For example, the current charge per journey is 80p compared with £1 per journey before 9.30am.

Pricing on public transport

*Government regulates commuter and long-distance saver fares (or ‘protected fares’) through a mechanism called a ‘fares basket’, where a cap is applied to a weighted average of the relevant fares for each train operator. The cap on each operator’s commuter fares and protected fares basket is set at the 2002/3 value of each basket, increased by RPI plus 1 per cent in January 2004 and cumulatively after that. Operators are able to adjust individual fares within each basket by more or less than the average increase, as long as the average increase does not exceed the cap and as long as no individual fare increases more than 6 per cent above RPI in a particular year.*
Pricing on roads 3.68 On the roads, motorists pay duty on fuel use. This is an effective way of pricing for carbon dioxide emissions, that are directly related to the amount of fuel consumed, but does not directly vary to reflect the full costs imposed on society such as congestion, noise and air pollutants that are more closely related to location and time of day. There are a number of ways in which a road pricing scheme could be introduced and the total amount that motorists pay will depend on the design of the scheme and future decisions on the tax system. The illustrative, national road pricing scenario modelled for this study was a system of marginal social cost pricing in which the cost of motoring for some motorists would be less than it currently is today, namely when they are travelling on less busy roads or at quiet times of day. Higher road prices would be faced by those wanting to travel when demands are high for road space because that is when the costs and impacts of congestion are greatest. The variation in prices faced will of course depend on the particular scheme introduced.

Local road pricing can be effective 3.69 In February 2003, Transport for London (TfL) introduced an area-based congestion charging scheme in central London, described in more detail in Figure 3.7. TfL estimates that after four years, the scheme has been successful in reducing overall traffic levels within the charging zone by 15 per cent (including a 30 per cent reduction in car, van and lorry traffic), and in reducing congestion levels by 26 per cent. Average traffic speeds inside the zone are estimated to have increased by 2 km/hour since the introduction of the charge.7

3.70 The scheme has delivered notable benefits in terms of reduced congestion and improved traffic speeds. Although scheme-operating costs have been published, the set up costs have not, so it is difficult to form a view on overall cost-effectiveness; but this scheme has demonstrated the potential for pricing to manage demand effectively in areas of high congestion.

---

The potential benefits of a national road pricing scheme

There are many different ways in which roads could be better priced in the UK, ranging from a full national distance-based scheme covering every road, to relatively simple local schemes. Evidence from a variety of modelling sources has been used in this chapter to assess the potential benefits of both national and local schemes.
3.72 Experience of how road pricing works in practice is limited, and it is largely necessary to depend on estimates and modelling to understand the benefits, costs and risks. However, the size of the potential benefits is so striking that it has to be taken seriously as a policy measure to support economic growth.

3.73 In the UK, the Government is actively engaged in exploring the potential of road pricing to address congestion through the promotion of demonstration projects and local pricing schemes. The idea is that local pricing schemes will be part of a wider package of transport improvements that the Government would support through its Transport Innovation Fund. The pilots and demonstration projects will allow different technologies, systems and scheme designs to be explored to inform longer-term policy.

3.74 In the Road Pricing Feasibility Study (RPFS), the DfT explored the potential benefits of a national road pricing scheme implemented in 2010 using the DfT’s National Transport Model (NTM). This study has explored the impacts of that scheme in the longer term, namely 2025, again relying on the NTM.

3.75 The illustrative national scheme modelled for both the RPFS and therefore this study is a relatively sophisticated, distance-based scheme where prices are based on the marginal social costs of the journeys that takes into account costs of congestion and environmental damage, including a carbon cost of £95 per tonne in 2025. Charges are capped at 80p/km with 75 different levels of charges, varying by time by day, by area and road type.

3.76 Clearly, this is only one of many options, and has been chosen only to make comparisons with the present day more straightforward. The evidence suggests that before considering the costs of setting up and running such a scheme, total benefits have been estimated at around £28 billion a year in 2025, including GDP benefits of £15 billion a year. The costs of such a scheme are not known at this stage in development, and pilots should be used to provide a better assessment. Clearly, costs would have to be extremely high to outweigh the benefits of £28 billion a year, and in that scenario it would not be cost effective to implement a scheme. One available source that is able to offer some indicative cost estimates is the RPFS that suggested a full national, distance-based road pricing scheme could cost between £10 and £62 billion to set up, plus running costs of between £2 and £5 billion a year, with the upper end of these estimates including optimism bias of around 100 per cent. Compliance costs would also need to be factored in. Nonetheless, this implies that there is clearly potential to develop a scheme with very significant net benefits, possibly up to £20 billion a year and the challenge is to ensure a scheme with costs at the low end of the range.

3.77 Such a scheme could reduce the level of congestion on the road network by 50 per cent compared to the baseline without pricing in 2025. Figures 3.8 and 3.9 compare congestion on the road network with and without road pricing. They show the dramatic potential impact better pricing has in reducing congestion and therefore improving reliability.

---

Footnotes:
1 Feasibility Study of Road Pricing in the UK, DfT, 2004
2 Defra guidance in line with GES Working paper 140, GES, 2002.
5 As defined in Volume 2.
Figure 3.8: Congestion patterns on the Great Britain road network in 2025 with no road pricing

Key
2025 baseline – total lost hours per year
- 139,350 or more (1,750)
- 28,000 to 139,350 (3,881)
- 6,520 to 28,000 (5,557)
- 0 to 6,520 (6,465)

Source: DfT.
Figure 3.9: Congestion patterns on the Great Britain road network in 2025 with national road pricing

Key
2025 baseline with national road pricing – total lost hours per year
- 139,350 or more (186)
- 28,000 to 139,350 (2,582)
- 6,520 to 28,000 (8,366)
- 0 to 6,520 (6,519)

Source: DfT
3.78 The main benefits of the scheme come from: the value of reduced delay and improved reliability for road users; revenues; wider economic benefits such as agglomeration, competition and labour market efficiencies; and other benefits for society such as reduced accidents, lower carbon emissions and noise, and improved air quality.

3.79 Motorists currently pay fuel duty which implies a cost of some 4 pence to travel a kilometre, depending on the fuel efficiency of their vehicle. Under the road pricing scenario modelled where prices reflect impacts on society, around 33 per cent of distance travelled would cost the same or less than the current cost of fuel duty. The rest would, overall, cost more than today, with less than 10 per cent costing in total more than 20p/km. Balanced against this and outweighing it, of course, are the benefits of reduced travel delays and more reliable journey times.

3.80 For those who place a high value on being able to make trips by road on particular routes or at particular times of day, the benefits could be substantial. For example, in aggregate, business travellers might see benefits in the region of £4.6 billion and freight around £1 billion a year respectively. The indirect economic benefits to the wider economy from impacts to these users might net to some £2.2 billion a year in total.13

3.81 Although the aggregate picture is one of significant overall benefits from road pricing, not all groups would benefit. Those who place a lower value on the ability to make a particular trip at a certain time of day may not find it worthwhile to pay the relevant price because, overall, the benefit to them of improved travel conditions would not be worth it. They would instead seek alternative routes or means of travel. For example, the analysis suggests this would be the case for the majority of individuals making their commuting trips by road because, when faced with the price of travel, the value they place on making that particular trip at their preferred time of day by car is less than the price being charged, so they change their behaviour. This effect implies an aggregate direct welfare cost of some £1.2 billion plus estimated costs to the labour market of around £370 million per year. The actual magnitude of these types of effects would of course depend on the availability and quality of alternative ways to make a trip and accompanying policies, plus how the revenues from such pricing are used. These same travellers would however expect to benefit when travelling for other reasons, e.g. non-work/leisure.

3.82 Despite this, within the benefits is a GDP benefit of around £15 billion a year, driven by the efficiency savings to business and freight. Again, this is before the costs of implementation, operation and enforcement have been taken into account.

3.83 The impacts of road pricing are subject to the availability of travel alternatives such as the ability to work flexible hours, and the availability and cost of public transport. If, for example, public transport improvements meant this were an attractive alternative for the commuter then the adverse impacts would be expected to be much lower.

3.84 There is also the potential for significant environmental and safety benefits from a well-targeted national road pricing scheme. Such a scheme might generate safety benefits of around £1.2 billion a year owing to the impacts on traffic, and reductions in greenhouse gas emissions, air quality problems and noise pollution might be worth over £500 million a year in total. The extent to which road pricing offers benefits in terms of reduced carbon or greenhouse gas emissions will be heavily dependent on the design of the scheme, the level of the charges, and the extent to which fuel duty changes.

13 These include impacts such as agglomeration, labour market effects etc.
Environmental impacts depend on the design of the scheme and the level of charges

3.85 This particular example of a relatively sophisticated scheme offers reduced carbon emissions but this depends on the fuel duty and pricing design chosen. The reason for this is two-fold: firstly, variation in pricing affects the impact on traffic and congestion. Secondly, carbon emissions are directly related to the amount of fuel consumed. Fuel duties therefore impact on behaviour to the extent that they make explicit the link between fuel use and distance travelled and so provide an incentive for people to purchase more fuel-efficient cars.

3.86 However, at a practical level, the introduction of pricing based on congestion impacts would facilitate the introduction of pricing to reflect all externalities. This includes the opportunity to price environmental externalities, one of the main recommendations of the Stern Review.

3.87 Other forms of national-level road pricing have not been explored in this work, but it is possible that simpler forms of pricing would also provide substantial benefits if they are well-targeted. The national scheme modelled and described here is relatively complex as prices closely reflect costs of road use on society. Other pricing regimes could be introduced ranging from reducing the number of charge levels, charging at only certain times of day or on certain links. These could be cheaper and easier to introduce, and potentially offer lower but significant benefits from reduced congestion. Evidence from the RPFS for 2010 demonstrated that if pricing were introduced in urban areas only, where congestion is greatest, the benefits in terms of congestion reduction would only be slightly lower than for the national scheme: an overall reduction of 43 per cent as opposed to 48 per cent but with much lower reductions in congestion on inter-urban roads than with a national scheme.14

3.88 Any scheme with less than full national coverage would, of course, need to be carefully designed to minimise negative impacts of diverting traffic onto non-priced routes because this could be significant and there is a need to understand the land use impacts. A more widespread scheme may be necessary to guard against such impacts.

Potential benefits of local road pricing schemes

3.89 Over 80 per cent of congestion on the UK road network is in urban areas. Significant benefits from well-designed local pricing schemes might therefore be expected. Evidence from local modelling suggests that well designed schemes can offer substantial welfare and GDP benefits. This Study commissioned a case study to explore illustrative interventions in the South and West Yorkshire area to build an understanding of their potential welfare and GDP impacts.15 Among the interventions tested was an illustrative distance-based, congestion-targeted road pricing scheme. This suggested gross present value benefits16 of over £40 billion over a 60-year period could be delivered, including GDP benefits of around £6-8 billion over the same period. The costs of implementing such a scheme are, of course, as yet unknown and could be substantial, given the reliance on technology to deliver a relatively sophisticated pricing regime.

3.90 As with other pricing schemes, it would be worthwhile only if the costs of implementation and enforcement could be managed such that significant welfare gains were achievable.

---

14 Feasibility study of road pricing in the UK, Chapter 4, DfT, 2004.
15 For more detail see separate paper on the South and West Yorkshire Case Study Wider economic impacts of transport interventions, MVA in association with David Simmonds Consultancy 2006.
16 Defined to be the overall benefits accounting for revenues excluding environmental effects.
3.91 The environmental implications of this form of road pricing, could, to the extent that they are related to impacts on traffic congestion, deliver beneficial impacts on noise, air pollutants and carbon emissions. For example, reductions in traffic-related carbon emissions could be in the order of 10-20 per cent in the peak periods, with much smaller reductions or marginal increases in off-peak periods.

3.92 Local area road pricing is likely to be less cost-effective in towns and cities that are not characterised with high congestion, simply because the magnitude of the challenge to be tackled is lower, so the potential benefits are also likely to be lower.

3.93 The same arguments that apply to a national scheme also apply to any sub-regional or local scheme. That is, pricing must be transparent, practical and well targeted. There are strong arguments on both practical and efficiency grounds for ensuring consistency and comparability between local charging schemes. For example, where neighbouring areas have pricing in place, a traveller going from one to the other could make better travel decisions if the nature and scope of the pricing schemes were well understood. It would also minimise transaction costs, for example for logistics firms who typically travel in many different areas.

Factors influencing the effectiveness of road pricing

3.94 The practicalities of designing a workable, intelligible scheme will have a very considerable bearing on the most desirable road pricing scheme; so the analysis of a national scheme presented here should be seen as purely an illustration of the ‘top end’ of GDP and welfare benefits that might be achieved, before consideration of set-up and operating costs.

3.95 The costs of such a scheme are not known at this stage in development, and pilots should be used to provide a better assessment. Clearly, costs would have to be extremely high to outweigh the benefits of £28 billion a year and, in that scenario, it would not be cost effective to implement a scheme.

3.96 As noted earlier, one estimate of the possible costs was provided in the Road Pricing Feasibility Study (RPFS) where it was estimated that a full national, distance-based road pricing scheme could cost around £10-£62 billion to set up, with the upper end reflecting optimism bias, plus running costs. In reality, costs would vary based on the extent of implementation; the technological solution chosen; and how quickly the costs of technology fall through time. Further work is needed to develop technologies that allow road pricing to be delivered at the lower end of costs. Enforcement costs must also be considered and accounted for because these could also be significant.

3.97 Given the potential expense of setting up and running a national scheme, before taking any decision to implement a national road pricing regime, government would want to be confident that a scheme could be delivered to ensure the potential benefits are realised, at a cost, and with a manageable level of associated risk, that would not significantly erode and outweigh the benefits. Any decision on choice of technology and design of scheme would need to incorporate an assessment of the cost risk associated with commissioning what might be new and untested at a national level.
3.98 In terms of the design of the better pricing system implemented, analysis from the modelling shows that well-designed and carefully targeted schemes can generate very high GDP and welfare benefits. But the same models also show that poorly designed schemes could result in large numbers of losers and very low benefits, or even net costs.\(^{17}\)

3.99 The modelling evidence highlights several factors, in addition to cost, that influence the effectiveness of pricing schemes, and should be fully recognised in working up schemes:

- the scope and quality of the transport system in the area targeted: it is important to understand the congestion challenge faced, availability and performance of public transport options in the area, and the nature of travel patterns;
- the prices implemented: prices should vary sufficiently to reflect congestion and other costs of road use and provide the incentive for a behavioural response, but still be understandable and practical for the road user;
- the geographical coverage of the scheme: diversion of traffic and economic activity to areas not charged could increase problems in those areas that should be netted off the estimated benefits;
- the level of the charges should be carefully assessed so as not to have counter-productive effects; and
- impacts on land use patterns such as business and household location should be considered.

3.100 The London Congestion Charging scheme is designed to be relatively simple, transparent and practical. A more sophisticated, distance-based scheme that charged differentiated prices by time of day and by area type may have had greater benefits in terms of reduced congestion, but could not realistically have been delivered at that time. The London scheme may theoretically not be the best possible design, but it provides evidence that road pricing can deliver benefits in terms of reduced congestion and improved traffic speeds and reliability.

3.101 The introduction of a national road pricing scheme would be a significant policy that would have a big impact on most people's everyday lives. A road pricing scheme on this level has not been tested in the UK or abroad, so it is not possible to build a detailed understanding of how people and firms would respond to changes in price signals. Responses of road users in the modelling are based on evidence of how different users respond to changes in cost, often referred to by economists as 'elasticities'. Of course, this is not an exact science because it is possible that people in the real world could respond more or less strongly than models anticipate. For example, the London Congestion Charge resulted in a greater reduction in traffic than TfL's initial modelling had anticipated. However, given that the models used are based on evidence of behavioural patterns and real travel information, in general there is a fairly good understanding of these issues and the models are effective for this purpose.

3.102 The response of freight operators is particularly difficult to model, as it will depend on a number of factors, including the size of the logistics company. There are likely to be implications for freight deliveries, as the cost of transporting goods to be delivered at a particular time are likely to be different, which may feed through into consumer prices and logistics efficiencies. Conversely, freight would benefit strongly from road pricing due to the improvements in congestion, and in particular, reliability. However, larger operators are more

---

\(^{17}\) For more detail see Wider economic impacts of transport interventions, MVA in association with David Simmonds Consultancy, 2006.
likely to have the IT capability to better assess the costs and benefits of different options, while smaller companies may not.

3.103 Similarly, the response of private individuals may be influenced by personal factors, as much as by a highly rational economic assessment of the costs and benefits of different options.

3.104 Recognising that there is a need to understand the behavioural responses to road pricing better, and to manage the risks of technologies that would be needed to implement road pricing, pilot schemes would help build an understanding of likely impacts and the most effective designs and technologies. Indeed, some pilot schemes are already being worked up in some areas. In addition, learning from the evidence from other countries where road pricing has been introduced or is planned would be valuable.

**Distributional impacts**

3.105 As discussed earlier, although road pricing would be expected to have net benefits, there would be winners and losers from the point of view of those using the roads, and these distributional impacts could have implications for the level of economic benefits achieved and for social inclusion objectives and public acceptability. The design of the pricing scheme is of course very important in this regard, with particular implications for the distribution of impacts owing to the nature and location of travel being undertaken.

3.106 On the basis of the evidence of the national distance-based scheme, the extent to which different road users are better or worse off when making particular trips would depend on the impacts and accompanying policies on the transport system as a whole. In the absence of complementary policies on other parts of the transport system, in general, business, freight and most non-work/leisure travellers benefit from road pricing, given the balance between the value they place on making the journey and the price they have to pay, although within these groups there would be some variation. Those making commuter journeys could be made worse off as a group, especially if alternative journey options, such as a different time of travel or public transport capacity, are not available. Policies on other modes and use of revenues are therefore important to consider when assessing overall impacts. However, it is important to remember that commuters, as individuals, would benefit from improvements to their journeys as non-work/leisure travellers or while on business.

3.107 There may be economic costs associated with these distributional impacts if pricing results in the suppression of economically important journeys, particularly where there are wider benefits to that journey that the user may not cost into their decision making, such as labour market and agglomeration benefits. If there were evidence of significant wider benefits from these journeys, there would be a case for reflecting these in the prices set. However, the extent of these external economic benefits is likely to be location-specific, so should be considered at the more detailed level where possible.

3.108 There would also be complicated, but often positive social inclusion impacts from road pricing at the local, regional or national level. A scheme that involved differentiated pricing by area would tend to benefit motorists in rural areas as the cost of using these roads falls. Levels of car ownership are higher in rural areas than in urban areas, including for lower income households. Many socially excluded groups in rural areas have access to a car and would be expected to benefit. However, those without a car might be adversely affected, as the cost-effectiveness of providing rural public transport would be reduced as car travel is made relatively cheaper which reduces public transport demand.
The converse would be true in the most congested urban areas, where car owners would be paying more than they would do otherwise. Those who were dependent on car use would incur higher costs. However, car ownership tends to be lower in urban areas, particularly amongst lower income households, so the social impacts would be mixed. Those without access to a car would benefit from improved reliability, and speeds on public transport, and a better local environment in terms of congestion and air quality.

**Delivering road pricing**

National road pricing has the potential to deliver substantial benefits for road users, for the environment, for the economy and for taxpayers. However, pricing of this scale is not to be found anywhere else in the world. There are many technological, geographical and design options for implementing road pricing, and there is currently insufficient evidence to be able to identify what the ‘right’ option should be. Before taking decisions on the precise design of a national scheme, better information is needed on how users will respond to road pricing, what the most cost-effective technologies are, and what the indirect implications might be for the environment, land-use, the economy, and for particular sections of society.

This uncertainty is not an excuse for doing nothing. Indeed, one of the most serious risks is that government and the private sector scale down their plans for investment on the basis that pricing will reduce the need for additional capacity, but for road pricing not to be delivered. This could result in a severe shortage of transport capacity, resulting in worsening congestion for road users and billions of pounds of cost to the economy.

So, although the economic case is clear, as the potential welfare benefits are substantial, there are a several issues that would need to be addressed for road pricing to become a reality. These are described in Figure 3.10.
In addition, with the move to widespread road pricing, decisions will need to be taken on tax policy in order to ensure that it contributes to the overall aims of road pricing and does not impede its introduction. A future framework of taxes and charges will need to take into account the impact on the motorist, the requirement for a sound revenue base to fund essential public services and the need to protect the environment.

**PRICE SIGNALS ON OTHER MODES**

The arguments for making greater use of price signals on the road network apply equally to other modes too, particularly on the priority links characterised by high demand and congestion during peak hours and spare capacity off-peak.

Although the evidence base is weaker on targeted pricing on other modes, the principles and potential benefits of better pricing still apply. That is to say that, if prices were to better reflect the true costs of making journeys, the incentive would be provided to make improved travel decisions and to make better use of transport infrastructure.
As described above, train operators already make use of differential pricing to some degree, to encourage peak spreading and to fill empty off-peak seats. Preliminary modelling suggests there could be benefits from making better use of price signals on the rail network, both to manage peak demand, and to encourage better utilisation of off-peak services. Indeed, where overcrowding is extreme, such as on particular commuter corridors into some major urban areas, the potential for pricing to redistribute some peak demand into the shoulder peak could make a useful contribution.

Although there is no evidence available to this study on the most efficient prices for rail use, strategic modelling evidence suggests that, for illustration, if rail fares increased by RPI plus 2.5 per cent across the board out to 2026, growth in demand over the period would be at least 12 per cent lower than under RPI plus 1 percent. If applied as a blanket change in fares, however, this would be a very blunt and untargeted way of using price signals. The purpose is not, in any case, to price people off the railway, but rather to encourage greater use of the shoulder and off-peak services. There would be far greater potential in using price signals to redistribute demand by charging more for journeys with the highest cost, such as at peak times, and less for those off-peak journeys with a low marginal cost. This would have the effect of spreading demand for peak and shoulder-peak rail services and encourage better utilisation of off-peak services. There would be distributional and economic considerations from such an approach, given the variation across travellers in the extent to which they are flexible in their time of travel and their ability to pay.

However, as identified in the road pricing analysis above, it would be important to consider the economic and welfare implications of changing travel behaviour in this way. A greater understanding of the use of pricing mechanisms on specific routes would be needed to determine the costs and benefits of different options.

While airlines have been making increasingly sophisticated use of pricing mechanisms in determining the prices they charge consumers for flights, slots at the busiest and most congested UK airports are still allocated by administrative means determined by the European Slots Regulation. Although a ‘grey market’ exists for slot trading between airlines, a revision of the Regulation is required for the market to become formalised and transparent. A European Commission study indicates that such changes could increase passenger throughput at Heathrow and Gatwick by up to 5 per cent.\(^\text{18}\) Although the introduction of formal slot trading would be a useful tool for making better use of existing capacity, it would not eliminate the need for additional capacity.

There may be further gains from using market mechanisms, for example auctions, to allocate significant numbers of new slots and provide more reliable signals about the need for additional capacity in particular locations. Such mechanisms could also generate additional revenue for reinvestment in new capacity or in surface access improvements, although complex issues of slot ownership would need to be addressed first.

Within the European Union, a common aviation area is well developed, allowing EU airlines freedom to fly wherever they wish. However, outside the EU, air services remain largely governed by bilateral agreements, many of which are highly restrictive. While some progress has been made in negotiating more liberal agreements with third countries, the EU experience suggests there would be strong competition and consumer benefits from extending this approach.

\(^\text{18}\) Study to Assess the Effects of Different Slot Allocation Schemes, NERA for the European Commission, 2004.
3.123 Given the serious implications that aviation emissions could have for climate change, there is an urgent need to identify and implement an effective mechanism for ensuring that air travellers pay the full cost of their climate change impacts. The implications that some sort of carbon pricing mechanism for aviation might have for the case for additional airport capacity are explored in Chapter 3.4.

**FROM PRICING TO INCREASING CAPACITY**

3.124 As would be expected, road pricing has an impact on the economic case for additional transport capacity and fixed infrastructure. Indeed, the impact on the case for additional road infrastructure is one of its selling points, as discussed in more detail in Chapter 3.4. Having explored the many options for pricing transport, the next chapter considers the case for additional infrastructure to contribute to welfare and GDP.
3.4 Enhancing Current Networks

Headlines

• Even after accounting for environmental impacts, well-targeted infrastructure options are able to offer very high welfare and GDP returns per £1 of government expenditure with big gains for businesses, freight and commuters.

Congested and growing urban areas

• A step-change in understanding of the best interventions in urban areas is needed.
• Walking and cycling options have the potential for very high welfare returns relative to their cost but may not be enough alone to tackle the true scale of the further challenges facing the UK.
• Improved bus services are sometimes able to offer a higher-return solution to transport problems than more costly fixed infrastructure options, such as light rail.
• Roads can, in some circumstances, offer a very high-return solution to transport problems in major urban areas; they should not be ignored as an option to consider but environmental impacts must, of course, be accounted for.
• Targeted additional capacity on key commuter corridors into major urban areas can offer very high returns owing to the competing demands for capacity of large volumes of travellers. This offers substantial benefits not just to commuters but also to freight, business and leisure travellers.

Key international gateways

• Private sector investment in additional capacity at ports and airports, where capacity constraints threaten rising costs to the UK economy and environmental effects are accounted for, would make a significant contribution to GDP and welfare.
• Additional capacity on targeted surface access links offers among the highest returns, even after accounting for environmental impacts.

Key inter-urban corridors

• Targeted inter-urban road capacity offers very high GDP and welfare returns, even after accounting for the environmental impacts; looking beyond 2015, in the absence of road pricing and better use measures, there is an economic case for a rate of road build enhancements that exceeds current rates.
• With national road pricing, there would be an economic case for additional strategic road capacity beyond 2015, particularly on the approaches to, and corridors around, major urban areas but it would be significantly lower than the current rate of road build.
• Additional infrastructure intended to transform the economy and relying on untested technologies is unlikely to be a priority given the UK’s extensive network and connectivity and the speculative demand benefits. Those step-change measures proposed as a solution to existing and likely future problems are more likely to perform well, but must be assessed alongside other options for a given transport challenge.
INTRODUCTION

4.1 The previous chapter demonstrated that better use options have the potential to contribute significantly to GDP and can have good environmental impacts. Therefore these should always be the first option considered. In some circumstances however, making better use can only go so far, prompting the need to consider the costs and benefits of additional infrastructure.

4.2 The case for additional infrastructure is dependent on the nature and scale of the challenge faced; the economic, demographic and environmental implications of taking action in a particular location; and the costs of alternative solutions. In this chapter, the context of infrastructure options will be set out followed by a description of the range of infrastructure options and their relative returns. Given the available evidence, returns will first be discussed in the absence of road pricing, then each section explores the key issues around the impacts on returns if roads were better priced.

4.3 Instead of taking a modal approach, this chapter adopts a structure based on the strategic priorities identified in Volume 2, namely:

- growing and congested urban areas and their catchments – infrastructure requirements in the UK’s often complex urban networks;
- key international gateways – the infrastructure interventions needed to support the UK’s internationally competitive position in the increasingly globalised world; and
- key inter-urban corridors – the infrastructure needed to support connections between the UK’s major urban areas, and international gateways.

4.4 Before examining these groupings, some overview messages are identified.

INVESTING IN INFRASTRUCTURE: OVERVIEW

4.5 Infrastructure provision can take a range of forms, and may involve a combination of more than a single type. This chapter broadly distinguishes between variable capacity provision, and fixed infrastructure:

- variable capacity: investment in assets that increase the effective capacity of the existing transport system without the need for significant additional fixed infrastructure. For example, longer trains and platforms, additional buses; and
- fixed infrastructure: investment in long-life transport capital assets that often create a larger ‘footprint’ in terms of land take, such as new and improved roads, rail lines or ports capacity.

4.6 Most of the evidence available to this study on the GDP and welfare returns is from these two types of infrastructure options. As further described in Chapter 3.5, the evidence reflects real schemes implemented or proposed in the UK, plus modelling of some illustrative interventions. The availability of evidence has meant that the extent to which different interventions or areas are covered is sometimes limited with only a small sample size. For some interventions, there is no robust evidence on which this study has been able to draw, for example on rail freight interventions. In addition, the study relies on evidence which is a function of the existing options generation process. Such interventions have not been generated with growth as the key objective. If they were, different options may have come forward.
4.7 For the purpose of illustration, all sample schemes have been assigned to one of the strategic priorities. This does not necessarily mean that all of these should be a priority, rather it is to allow an understanding, within each grouping, of the types of interventions and their characteristics that are able to contribute to economic welfare. Given the very small sample size of schemes in growing and congested urban areas, other urban interventions have been grouped together along with these to form a group of ‘urban networks’ interventions.

4.8 Considering GDP returns alone as a sub-set of welfare, as in Figure 4.1, shows that all the priority links have the potential to offer high returns if the interventions are well targeted. There are wide variations within each strategic priority, as shown by the length of the vertical lines that plot the range of return between the very best and lowest-performing schemes of the evidence available. The ‘boxes’ on each vertical line demonstrate the range of returns from the middle 50 per cent of schemes. For example, for urban networks, 50 per cent of schemes have a GDP per pound in the range £0.70 to £3.20, with a median average £1.65.

4.9 Some schemes show extraordinarily high returns. Around 15 per cent of schemes show GDP returns of greater than £5 for every £1 spent, including a large number of road schemes, partly because of the large number of road schemes that are included in the database.

4.10 A more surprising result in Figure 4.1 is the lower relative GDP returns of urban networks with an average (median) return of £1.65 per £1 of government spend. Given the potential agglomeration and labour market impacts as discussed in Volume 1, higher returns would be expected in these areas. The findings from this evidence are due to the higher proportion of public transport schemes that typically offer low business benefits or that have been developed for social objectives, so GDP returns are lower. The size of the database is also not considered representative of the numbers of schemes that could be expected across the different strategic priorities because the majority of evidence is on strategic road capacity enhancements.

---

For the wider BCR, the threshold above which the intervention is said to have a good return is 1.3. This reflects the fact that benefits to society should at least outweigh the costs of the intervention, plus the efficiency costs of raising the money through taxation to fund it (assumed to be 30 per cent). GDP is a partial measure of welfare. The cost of the intervention – whilst diverting resources from other parts of the economy – does not reduce total GDP. As such, the benefits need only outweigh the efficiency costs of raising taxation. This is reflected in a threshold of 0.3, which is required for an intervention to have a net contribution to GDP.
4.11 Even so, it is worth noting that even though the schemes considered are not designed explicitly to target growth, the top 25 per cent of urban schemes offer returns at least as high as the average (median) of the better-performing interventions of around £3 of GDP per £1 of government spend (given the smaller sample size of interventions for which evidence is available).

4.12 Perhaps the most significant element of GDP that is missing from the current approach to appraisal is the agglomeration effect. But the options in major urban areas were not generated with an understanding of these effects. If option generation were to take account of these new effects, higher GDP returns would be achievable.

4.13 When the broader perspective of welfare – the wider BCR – is considered, as demonstrated in Figure 4.2, the disparity in returns between urban networks and the other strategic priorities reduces owing to the fact that direct benefits to commuters and non-work/leisure travellers are now included. They are important beneficiaries of urban interventions.

4.14 As with Figure 4.1, Figure 4.2 has the vertical line plotting the range of returns between the best and lowest-performing interventions of the evidence available for each strategic priority. The wider BCRs are higher than GDP per pound achieved owing to the inclusion of a broader range of benefits. The median average return of urban areas is around 4, and that of inter-urban corridors and international gateways is 4.5.

---

Figure 4.2: Distribution of economic returns from government expenditure by strategic priority: wider benefit: cost ratio

Source: DfT.

---

1 The available evidence has, for the purposes of illustration, been allocated to one of each of the strategic priorities.
Another feature of the underlying data is that across each of the priority link groupings, the range of returns is significant. The highest welfare returns on roads appear to be where congestion problems are caused by the shared network nature of UK roads. For example, where a road enhancement is able to improve accessibility to a major airport, it is likely that a range of other non-airport travellers will use and benefit from the improved link.\(^3\)

On the basis of the evidence available, fixed capacity enhancements other than roads often show relatively low returns. This in part reflects several low-returns public transport schemes such as some light rail options, but also reflects the very high-cost of rail infrastructure projects. Rail schemes can potentially generate significant absolute benefits but the high costs involved mean that the return per pound invested is often constrained, when compared with other interventions.

It is of course important to remember that the environmental implications of additional infrastructure can, in some cases, be substantial. Figure 4.3 attempts to demonstrate the illustrative estimated impact on the wider BCR of the most significant social and environmental effects for which it is possible to estimate a monetary value. These are: carbon emissions, using Defra guidance; air quality, noise and landscape using published government research.\(^4\) Figure 4.3 plots out the illustrative reduction or increase in the wider BCR that would be brought about by taking the environmental implications into account. Only those schemes for which this has been possible using available evidence are shown; this is around one-third of the schemes in the database.

As Figure 4.3 shows, the variation in impacts is, wide as they are, highly dependent on location. Interventions in urban areas can have beneficial impacts, for example public transport interventions can reduce congestion through providing incentives for modal shift from cars. For fixed infrastructure options, as are captured in surface access and inter-urban links, the adverse impacts on the environment can notably reduce the wider BCR. As Figure 4.3 shows, for some interventions, the BCR can be reduced by more than 3 points, with many reducing by more than 1, i.e. falling from, for example, a wider BCR of 6 to 3.

Therefore, although the wider BCRs of new inter-urban links are generally stronger, this must be balanced against the environmental effects that are, on average, adverse.

\(^3\) Transport demand to 2025 and the economic case for road pricing and investment, DfT, 2006, Chapter 6.

\(^4\) For more detail see, Transport demand to 2025 and the economic case for road pricing and investment, DfT, 2006.
The next section takes a more focused look at infrastructure options in major urban areas and their catchments.

**GROWING AND CONGESTED URBAN AREAS AND THEIR CATCHMENTS**

4.21 The majority of congestion and overcrowding is to be found in growing and congested urban areas and their catchments. This stems from the density of economic activity that involves significant transport of goods and people in those areas. In a globalising world, such urban areas are likely to be key to the UK’s economic performance as they provide the conditions for a successful and dynamic services sector, especially through their deep and specialised labour markets. If no action is taken to alleviate the pressures, the costs to the economy are likely to be very large and national economic growth will be constrained.

4.22 Urban areas have very diverse economic, social, land use, and physical characteristics. Therefore it is not possible to conclude a single list of interventions that are likely to make the most cost effective contribution to GDP because one size does not fit all. The appropriate intervention will be determined by specific local circumstances, making option generation and prioritisation crucial.

4.23 The density of economic activity and transport networks in urban areas also means that interactions between interventions are very important. An intervention implemented in one area is likely to affect the effectiveness and outcomes of others, either positively or negatively. While the evidence provides some limited insights, there remains scope to understand better the types of synergistic effects that may be possible. This was explored as part of the case study work in the South and West Yorkshire area as described later in this chapter.

4.24 The scope for additional infrastructure in major urban areas and their catchment areas covers a wide range of potential options but land space and environmental constraints may mean that some are less likely to be pursued than others. Nonetheless the case for urban infrastructure should be considered because as will be shown in this section, the available evidence suggests high returns are possible from targeted capacity if implemented under the right conditions.
4.25 To reiterate, the evidence discussed here can only reflect what has been available to this study. Very little, if any, evidence is available on some urban interventions and it is possible that considering urban interventions in isolation misses some of the urban network effects that might be expected as schemes and policies interact. In short, the case for urban investment can only be pieced together drawing from both the evidence in Volumes 1 and 2 (a top down approach) and Volume 3 (a bottom up approach).

### Small-scale infrastructure options

4.26 Chapter 3.3 on better use showed that the severity of the congestion and overcrowding problems in many urban areas allows measures such as traffic management or urban traffic control to be highly effective. To complement these, relatively small-scale investment in interventions such as walking and cycling capacity can help provide the incentive for mode shift away from the car to reduce the costs of congestion.

4.27 Improving walking and cycling capacity by creating or upgrading routes that make these more attractive modes of travel could provide good welfare and GDP returns, especially if utilising dedicated infrastructure targeted around key services or growing urban areas.

4.28 Evidence on a number of schemes suggests a very wide range of returns is possible and that often they are very high, with wider BCRs ranging from 14.9-32.5. However, GDP per pound returns are often much lower, between £1-2.50, though schemes serving high-economic-growth areas can achieve around £5 per pound invested.

4.29 For most schemes, the majority of benefits, often over 85-90 per cent, accrue from benefits to physical fitness, safety and security effects, which can usefully contribute to government’s objectives of promoting a safer and healthier society. Indeed, there are likely to be direct GDP benefits from these health effects but how this feeds through is not yet possible to quantify. Such interventions are also likely to produce a positive impact on the environment, due to the shift to quieter and non-polluting modes, but this may only be small.

4.30 Although these schemes are able to offer very good returns if well targeted, they tend to be relatively small in scale so, on their own, are likely to have only a relatively small direct impact on the overall performance of UK’s transport network. Especially, as many of these schemes only impact on short-distance journeys and often have a limited scale of achievable benefits. Although this is very beneficial, and such interventions could be valuable complementary measures in many circumstances, to tackle larger challenges, a greater scale of action is needed.

4.31 Where larger scale cycling interventions are implemented, preliminary evidence suggests that the returns may also be relatively high. Given the current use of cycling as a mode of transport in the UK, which is among the lowest of EU countries, this may suggest the potential for larger-scale uptake of cycling under the right conditions. A sharp increase in cycling in London, for example, has recently been seen. The interventions required should of course be assessed on the basis of their relative returns and be well targeted, and would need to be sufficient to achieve a sustained shift in travel behaviour.

4.32 The next section discusses the broader range of infrastructure options in urban areas along with the potential returns.

---

1 Summary Note on the Economic Appraisal of Links to Schools, Sustrans 2006.
Variable capacity options

4.33 The transport challenges facing urban areas are very commonly those of road congestion arising from significant volumes of people travelling into or within a dense area at similar times of day. This is a problem for all road users including business travellers, those trying to get to work, non-work/leisure travellers, freight delivery vehicles and buses.

4.34 Not only is there wasted time from delays and unreliable journey times, but there are environmental problems in major urban areas, particularly from emissions and particulates that affect air quality. Options that reduce congestion and reliance on car travel are, therefore, potentially beneficial for the economy and the environment.

4.35 Bus services are a very flexible form of capacity that can be relatively swiftly deployed in response to high travel demands and transport pressures. A minimum level of demand is, however, required to make this a viable form of transport provision.

4.36 Buses are not only competing against other modes for users, they are also competing with cars and freight for road space. This has a number of implications because general road traffic conditions will impact on the service offered by the bus.

4.37 The extent to which mode switch from cars to bus is encouraged and achieved will influence the extent of road congestion in urban areas. Although it would not be efficient or possible to achieve a full shift of all car users to buses, there is a key role for buses to alleviate road congestion.

4.38 Figure 4.4 sets out the types of bus interventions for urban areas that could be considered, though the returns from each will vary according to the specifics of the local area.

Figure 4.4: Types of bus interventions

- **Pricing/Fares**: fares could be used to increase the attractiveness of the bus as an alternative mode to the car. A limitation here is that typically, fares represent only a third of the total (generalised) cost of bus travel. The perception of bus use means that if fares were the only policy tool, it would be likely to take a very large reduction in fares to create the incentive for a large-scale shift in mode from car to bus.

- **Quality/Attractiveness**: improving the attractiveness of bus relative to the car is likely to require interventions to support quality rather than just price. Factors such as improving reliability from introducing bus-only lanes; simplified and common ticketing; real time information; clear routes; and branding and marketing are likely to be more important in making bus services more attractive.

- **Quantity**: broader and more targeted service provision: (i) frequency and (ii) expansion of routes, are also important:

  - **(i) Frequency**: at very low levels of frequency there is scope to reduce waiting time by providing extra bus capacity: increasing frequency can deliver greater benefits than changing fares. The opposite is true if services are already frequent (e.g. more than 10 buses per hour). Under these circumstances, it may be more cost-effective either to reduce fares or increase road lanes for bus use.

  - **(ii) Network/Route expansion**: Beyond a particular level of frequency, encouraging greater shift from the car is likely to require greater expansion of the bus network including through dedicated bus corridor infrastructure.

\[a\] This refers to the overall cost of travel, including the perceived value travellers place on time and other aspects such as journey ambience and quality of the service.
To try and fill some of the gaps in the evidence base on urban interventions, as a case study, some illustrative interventions were explored in South and West Yorkshire. The purpose was to build an understanding of the possible returns from different policies under different circumstances.

It is important to note that the interventions explored as part of this case study are purely illustrative, using a strategic modelling approach to provide high-level indications of the welfare and GDP impacts of different types of interventions. These results are not to be interpreted as detailed value for money assessments of these particular interventions.

Figure 4.5 demonstrates the wider BCRs of some of those interventions. Shown in the chart are:

- enhancement of the Leeds to Sheffield strategic road link;
- enhanced urban road capacity within Leeds;
- additional bus quality corridors within Leeds;
- changes to fares (down 30 per cent) and frequencies (improved 20 per cent) in Leeds;
- enhancement of the strategic road link between Leeds and Bradford;
- changes to fares (down 30 per cent) and frequencies (improved 20 per cent) in South Yorkshire;
- changes to fares (down 30 per cent) and frequencies (improved 20 per cent) in West Yorkshire; and
- changes to fares (down 60 per cent) and frequencies (improved 20 per cent) in South and West Yorkshire as a whole.

Source: SWYSM.

For more details see the separate paper on the South and West Yorkshire Case Study: Wider economic impacts of transport interventions, MVA in association with David Simmonds Consultancy, 2006.
4.42 This demonstrates that returns are similar across the bus interventions considered, with wider BCRs of around 3. These all represent very large-scale bus interventions covering some very large geographical areas in South and West Yorkshire. Conclusions on the extent to which these returns would hold for smaller-scale interventions, or in other areas that demonstrate different transport systems and travel patterns, cannot be made.

4.43 Looking in more detail, despite similar overall welfare returns, there are different wider economic effects. For example, improving bus fares and frequencies in South Yorkshire offers a lower impact on GDP than in West Yorkshire for the same magnitude of intervention. This is due to the different nature of local demographics, economy and travel patterns. It is also important to consider the existing level of bus service in the given area: where bus services already exist and provide a good service meeting all potential demand cost-effectively, the returns from adding more are likely to be lower. In West Yorkshire, accounting for the wider economic effects added around 14 per cent to overall welfare. In South Yorkshire this was just 5 per cent.

4.44 It also appears from this evidence that providing significant additional bus infrastructure that does not take away road space from cars, provides similar welfare and GDP per pound spent, for the given generic cost assumptions, as improving fares and frequencies. The indicative wider BCR is around 3 for both interventions, but adding fixed infrastructure is much more expensive, and would be subject to environmental impacts owing to land take. In practice, many urban areas will not have the landscape available to make this a realistic option.

4.45 It is important to recognise that these wider BCRs are not value for money assessments. It has not been possible to include the environmental implications in these wider BCRs but additional infrastructure in the form of new bus lanes, for example, would have implications for townscape and landscape, depending on the specific location. The impacts are likely to be significant and adverse at some sites.

4.46 Conversely, the environmental impacts of improving bus services should be beneficial, to the extent that there is some mode shift away from cars towards public transport and road congestion is reduced, thus lowering levels of harmful emissions such as carbon and particulates that reduce air quality. This work revealed that when fares and frequencies were improved, carbon emissions were marginally reduced.

4.47 The lower costs of variable bus capacity relative to fixed infrastructure implies a strong case for considering this as one of the policy options for tackling urban congestion challenges before jumping to fixed investment in additional infrastructure.

4.48 However, depending on the nature and magnitude of the problem being faced in major urban areas, there may be a case for considering fixed infrastructure for a long-term solution.

**Fixed infrastructure options**

4.49 Trams and heavy rail should only be considered as an appropriate policy intervention once an urban area reaches sufficient density: they are not likely to be the most cost-effective solution where transport corridors are more sparsely populated. The density and certainty of future demand on particular corridors is an important factor in the viability of light and heavy rail. Figure 4.6 outlines the capacities of different public transport systems.
**Figure 4.6: Capacity offered by different public transport modes**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Maximum system capacity (passengers per hour per direction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard bus</td>
<td>2,500 – 4,000</td>
</tr>
<tr>
<td>Busway</td>
<td>4,000 – 6,000</td>
</tr>
<tr>
<td>Guided bus</td>
<td>4,000 – 6,000</td>
</tr>
<tr>
<td>Tram/Light rail</td>
<td>12,000 – 18,000</td>
</tr>
<tr>
<td>Heavy rail</td>
<td>10,000 – 30,000</td>
</tr>
</tbody>
</table>


4.50 This implies that if demand could only ever reach, say, 6,000 passengers per hour, light or heavy rail options are highly unlikely to prove good value for money.

4.51 The small sample size of available evidence from real tram schemes in the UK demonstrates varying returns with wider BCRs between 2.7 and 5.1 but from a GDP per pound perspective, the returns are considerably lower, ranging between £0.60 and £1.20.

4.52 The high costs of fixed and dedicated infrastructure investment constrain the relative returns achievable. For the schemes explored, costs are between £350-650 million. To tackle the same capacity constraint, bus options could deliver a slightly lower level of absolute benefits but at a much reduced cost, around £15-170 million, hence higher relative returns.

4.53 Quality factors are an important consideration in the extent to which trams may be preferred to bus services and prove viable. Higher quality bus schemes with segregated infrastructure can bring the attractiveness and benefits of buses closer to that of trams. Buses can be a much more cost-effective solution than trams.  

**Figure 4.7: Factors influencing appropriate mode choice in urban areas**

The appropriate mode choice – road, bus, light rail, heavy rail – is determined by specific local circumstances. Scheme specific cost-benefit analyses are needed, but some indicative pointers are:

- **density/size of the urban area or agglomeration**: the more densely populated the city (which also implies a greater degree of agglomeration economies), the more justifiable is the consideration of heavy mass transit as one of the options to be assessed to deliver a cost-effective way of transporting large numbers of travellers;

- **density of specific transport corridor**: mass transit systems are likely to be more cost-effective on high-density transport corridors; where trip-making patterns are more dispersed, private car use and/or bus networks are likely to be most appropriate;

- **geography and land space**: parts of the UK are densely populated and land space in urban areas is limited. Some public transport schemes would need to share existing road space, and could take away from road capacity, which tends to explain why sometimes these schemes can fare poorly from a congestion perspective. There are also broader environmental and landscape issues to consider as free space is scarce; and

- **costs**: the environmental and geographic characteristics of urban areas mean that the costs of transport interventions can be extremely high, and could influence mode choice. Whole life costs tend to be higher for rail than for bus assuming basic road infrastructure exists, but at appropriate densities, cost per passenger can be lower.

7 Atkins Study of high quality bus in Leeds, 2005.
4.54 Heavy rail is most likely to be a worthwhile option where significant volumes of people are being moved such as on radial links into major urban areas and demand management measures are not, on their own, sufficient to tackle the scale of the problem. This can be a particular problem where longer-distance, inter-urban travellers need to use the same available infrastructure as commuters, and sometimes freight, on radial links creating high levels of overcrowding. This is particularly true for London.

4.55 Evidence is available from TfL on the welfare returns of additional variable rail capacity on overcrowded radial commuter corridors into London. These interventions are in the form of longer trains, new rolling stock with seating reconfigurations and longer platforms on existing rail lines.

4.56 This evidence suggests that the costs of implementing these measures can differ significantly depending on the routes being examined with capital costs ranging between £50 million and £3.5 billion. Returns also vary with BCRs typically between 1 and 3. Importantly, this analysis does not include the benefits in terms of agglomeration and wider labour market effects, which for some interventions could significantly add to the benefits.

4.57 The environmental implications of these interventions are not known and will largely depend on the degree of additional fixed infrastructure required.

4.58 This range of return demonstrates the high importance of being able to target interventions. Higher returns are most likely where the enhancement is able to provide benefits over a large part of the day to many travellers, and not just for the limited time during the morning commuter peak, and where additional fixed infrastructure requirements are minimal.

4.59 Rail plays a unique role in the central London economy given its density of employment and volumes of commuters. In general, GDP returns from variable rail capacity are more likely to be cost effective where:

- demand levels far exceed available capacity in the morning peaks creating severe overcrowding and the need for passengers to stand for relatively long distances;
- there is scope to shorten the journey time for significant volumes of travellers on a particular corridor;
- minimal supporting infrastructure is required to deliver the variable capacity such as platform lengthening, so as to keep costs down;
- the link serves an area with industries that are able to exploit the benefits of deeper labour markets such as financial services. This would support agglomeration; and
- rail has a high mode share for accessing the employment centre, otherwise other interventions might be a higher priority.

4.60 There may be a case for additional new fixed rail infrastructure in some limited circumstances where demands are very high and pressures on existing links are severe. However, the costs of delivering this are also likely to be very high, which may act to constrain the relative returns from such fixed infrastructure.

---

* TfL modelling analysis, which assumes Crossrail is in the base case.
4.61 That said, it could be that even with additional variable capacity on existing lines, this may not be sufficient in the longer term in the face of high projected demand growth. In such circumstances, options for additional capacity will need to be considered.

4.62 Recent evidence from large urban rail schemes in London aimed at alleviating extreme capacity pressures in the urban centres suggests wider BCRs between 2 and 3, and GDP returns per pound also in the same range, but with costs running into several billions of pounds. The magnitude of such interventions implies that in absolute terms, the level of GDP and welfare could be substantial.

4.63 But it is not just passenger movement that should be the focus. Many rail links are heavily used by both passenger and freight services. The sharing of those links can in some cases create significant pressures, for example, around London. Upgrading these links could therefore potentially be beneficial for welfare and GDP, subject to the costs. There is little available evidence on returns from these types of intervention but they must of course be assessed on their own merits having considered an appropriate set of options.

4.64 Overcrowding is already a common problem at many key rail and tube stations. Evidence suggests that additional capacity at stations that are subject to overcrowding could contribute to welfare by relieving station congestion, speeding up journey times and improving reliability of interchange facilities. Station congestion relief projects at two proposed London Underground stations suggest BCRs (not including the impacts on the wider economy) between 4.5 and 8.0. Such complementary capacity enhancements play a key role in ensuring the full potential benefits of increased effective capacity on rail and Tube lines can be realised from the whole journey perspective.

4.65 This highlights the importance of recognising the requirements of the whole journey. For example, if heavy rail is used to reach the urban centre but then an onward journey is required to reach the final destination, such as the place of work, enhancing capacity on one leg of the journey may increase pressures on another leg. This should be accounted for in assessing options to enhance corridors into major urban areas.

4.66 Therefore, the complexity of urban transport systems means the need to improve transport connections into and within urban areas is likely to imply considering a mix of measures and interventions, some of which may need to be implemented as a package. Additional capacity may be needed where better use options are either not sufficient, or are not cost-effective.

4.67 Public transport options have been shown to offer good welfare returns under certain conditions, in others, urban road capacity should be considered.

**Urban road capacity as a policy option**

4.68 Road congestion is a huge problem in urban areas and conurbations. A key benefit of the car is the flexibility it offers in terms of route choice and time of travel, that cannot always be matched by public transport. In addition, the nature of urban areas with the mismatch between employment and household location implies significantly dispersed journey patterns, both for passengers and drivers, and freight vehicles to get goods to outlets.

---

1 TfL analysis. These BCRs include the value travellers place on a pleasant station ambience.
Although often not considered or explored, in some cases, additional road capacity is likely to be the most cost-effective option in congested and growing urban areas, especially where origins and destinations of journeys are very diffuse. Urban roads are identified as those found within or in very close proximity to dense urban areas where speed limits are generally less than 50 miles per hour.

As shown in Figure 4.5, illustrative urban road capacity options explored in South and West Yorkshire suggested relatively strong returns with wider BCRs over 4 with GDP per pound of over £3. These results are for the given illustrative cost assumptions but are suggestive of the potential for a higher return to be delivered than for public transport options in some cases.

The local environmental implications of urban road capacity will be highly location specific and may in some circumstances be prohibitive. If the road enhancement is able to reduce congestion and allow more economically important journeys to take place, this is likely to come with an environmental cost. If traffic increases, then noise and emissions of carbon and particulates will increase. Mitigation measures could however be implemented to lessen these effects. Perhaps of more significance is the impact on landscape and townscape in densely populated urban areas. As with additional public transport infrastructure, this should be assessed on an individual basis as the range of potential implications is large, so some may only offer low returns.

Where high returns are possible, they are likely to be driven by congestion relief in those areas that are particularly capacity-constrained for a wide range of users for prolonged periods of the day. The gains from alleviating pressures and reducing the costs of accessing the urban centre are likely to be higher where the urban centre is productive and has high traffic flows. The density of retail activity in major urban areas also means that there are important benefits to freight from reducing urban congestion, both in terms of the direct benefits of reduced delays and unreliability, but also through the effect on freight logistics.

Real urban road capacity enhancement in other areas also appears to have delivered strong returns but the range is wide. For example, urban roads on which evidence is available to this study suggests wider BCRs in excess of 3, with one with a BCR even in excess of 11. The environmental implications would of course need to be accounted for to determine a view of overall returns.

From the evidence available, some key strategic roads around major urban areas and agglomerations, where congestion problems are very high and a wide mix of users travel on the road, are able to offer wider BCRs of between 4 and 11 with GDP per pound returns very high, at between £3 and £7. The cost of these interventions ranges between some £60 million and £300 million. Indeed, these interventions offer some of the very highest returns of the data available.

This evidence suggests that although there may be land-space constraints in some very dense urban areas, there are circumstances where enhanced urban road capacity may be the most cost-effective option and delivers relatively high returns. Where there are land space constraints to road build, public transport options may be the only feasible policy solution.
The link with housing

4.76 Over coming years this anticipated growth of the bigger urban areas is likely to be fed by increasing population and migration. Where additional housing is needed to support the continued success of a growing urban area, particularly to maintain and expand its labour market catchment, it is intuitive that in some circumstances, new or improved transport connections will be needed to deliver potential agglomeration benefits. That is not to say that housing policy should simply drive transport needs: the importance of cost-effective policy making applies here as in any other area. The location of new housing, its transport and other infrastructure requirements all need to be planned together in order to maximise the available benefits. Again this is an area which needs a much improved evidence base in order to support robust decision making.

The impact of road pricing on the case for additional urban infrastructure

4.77 Road pricing, if targeted on congestion and environmental problems, is likely to have a significant impact on congestion in urban areas.

4.78 Road pricing is able to have a significant impact on congestion in most urban areas. Analysis carried out in the context of strategic roads implies that with road pricing the case for additional road capacity in these areas is likely to fall but still remain. High prices signal that congestion is a problem and hence additional capacity may be worth exploring. This is further discussed later in this chapter in the context of inter-urban strategic road investment.

4.79 Preliminary evidence on the returns from public transport interventions when implemented in combination with road pricing as described in the South and West Yorkshire modelling case study suggests that greater welfare returns from the package are possible than if considering them separately. This is largely driven by the beneficial impacts on commuters from improving public transport when road pricing raises the cost of road travel. However, this would benefit from further analysis to understand better the nature of the interaction and the investments likely to offer greater returns.

4.80 The impacts that road pricing might have for the case for additional public transport capacity is determined by a number of locally specific factors. These include:

- the availability of other travel options and whether they are able to absorb additional demand;
- the price of public transport use relative to roads: this will depend on subsidies and the prices set by operators; and
- the type of road pricing being introduced and behavioural responses: mode shift is more likely when journeys are time critical and where public transport services allow the journey to be made at a given time; where road users have more time flexibility, they may travel by car at a different time rather than shift mode.

4.81 In terms of its implications for public transport demand, road pricing is likely to improve the relative attractiveness of public transport in areas where road prices are high. TfL estimates that the London congestion charge reduced car travel by 15 per cent within the congestion charging zone, and that some 50-60 per cent of that traffic was displaced to public transport. Conversely, in areas with little or no congestion, such as some rural areas, the prices could be lower than at present, potentially generating a mode shift away from public transport onto road.
Some users who place a lower value than others on making a particular trip by road, such as some commuters and non-work/leisure travellers, are likely to switch from car use to public transport for journeys in areas where road prices are high; many business travellers, will be willing to pay higher prices to use faster and more reliable roads, generating a small amount of mode shift towards road use for business users.

The car remains the dominant mode of travel in urban areas outside Central London, so even a small modal shift away from the car as a result of pricing could represent a substantial increase in demand for public transport owing to the small initial base.

The introduction of road pricing could also affect the case for subsidising public transport. On the one hand, the environmental and congestion case for subsiding other modes will be reduced or removed if road users are paying the full external cost of their journeys and, in urban areas, as the increase in demand may increase the viability of public transport. On the other, where there are external economic benefits from enabling people to make economically important journeys, there may be a case for subsidy to reflect these external benefits.

Evidence from the modelling case study in South and West Yorkshire suggests that when improvements to bus services in the form of lower fares and improved frequencies are implemented in the presence of a distance-based, congestion-targeted road pricing scheme, not only are the benefits of the package higher than the sum of the separate interventions, but road prices can on average be set lower. The maximum charge paid when bus services are improved is some 10 per cent lower. In addition, the adverse impacts on agglomeration of road pricing would be slightly reduced with improved bus services owing to the reduction in adverse impacts on commuters.

In summary, the implications of road pricing for the economic case for additional public transport capacity will depend on a number of locally specific factors, and detailed appraisal work would be needed for specific areas.

Taken together, the evidence suggests that some guiding principles on where there may be a case for additional urban infrastructure capacity, for road and public transport are as follows:

- The prices themselves: if targeted on the true costs of road use, high prices reflect demand pressures and hence a greater case for considering more capacity.
- Where there remains a capacity constraint: congestion maps show that even with pricing, travel demand remains high in large conurbations suggesting evidence of capacity constraints; and
- Where there are external costs from altering particular trips that are not reflected in an individual’s decision making; for example, in the absence of viable alternatives to car use, some commuters may be priced off the roads and may be forced out of the labour market or into less well paid jobs that are cheaper or easier to access.

The case study of South and West Yorkshire has been referred to in several places throughout this volume, so the next section provides a little more detail of the impacts of illustrative interventions in this case study area.
Case study findings: modelling of illustrative interventions in South and West Yorkshire\textsuperscript{10}

4.89 In order to try and fill some of the evidence gaps, a case study area of South and West Yorkshire was chosen to explore a range of interventions and their relative contributions to welfare and GDP. It is important to note that the interventions are purely illustrative and the assessments in this chapter are from strategic modelling to build an understanding of relative returns. It was not, therefore, possible to carry out a detailed value for money assessment of these interventions, but the results are indicative of the relative returns of different policy options. No attempt was made to draw conclusions or recommendations about specific schemes in the area as this was not the objective.

4.90 The illustrative interventions explored suggest that the extent to which wider economic effects are currently missing from appraisals varies significantly according to type and location of intervention. Figure 4.8 demonstrates the percentage added to conventionally assessed welfare benefits when the currently missing GDP elements – such as agglomeration and labour market effects – are accounted for.

![Figure 4.8: The addition to welfare of missing GDP effects for illustrative interventions from South and West Yorkshire modelling](image)

4.91 As Figure 4.8 shows, up to around 45 per cent can be added to welfare by considering the wider economic benefits, as was the case with improvements to the Leeds to Bradford link. This is the top end of the range so the average is of course lower. The highest additions appear to be for those interventions that improve accessibility between or within a productive major city. This should of course be balanced against the likely higher costs of additional infrastructure in those areas. Taken with the evidence in Figure 4.5, this case study allows some overall messages to be drawn out.

\textsuperscript{10} For more detail see separate paper on the South and West Yorkshire Case Study Wider economic impacts of transport interventions, MVA in association with David Simmonds Consultancy.
Some more general conclusions from the work in South and West Yorkshire are as follows.

- The nature and composition of the local economy and existing transport system have a significant effect on the potential for GDP gains. For example, the same bus improvements in South Yorkshire (with low GDP per head) contributed far less to GDP than the same magnitude of intervention in the more agglomerated and productive economy of West Yorkshire. This does of course need to be considered in the context of overall welfare returns for prioritisation purposes.

- High GDP returns are likely from those interventions that increase accessibility within productive areas, or improve links between productive areas. This result will of course be sensitive to the cost assumptions made.

- Agglomeration is generally the most substantial impact of transport interventions currently missing from appraisals. In assessing this effect, a wide geographical area must be considered because a shift in activity may have disagglomeration effects that should be netted off.

- Transport interventions that increase the labour market catchments of productive urban areas (eg Leeds) are likely to provide good GDP benefits, though of course overall returns are subject to costs.

- Both economic GDP and environmental objectives can be met with some interventions. For example, improvements to bus services in West Yorkshire and in Leeds provide good GDP returns for the estimated cost and are also able to provide environmental and social benefits.

This section has shown the following for urban areas:

- Walking and cycling can deliver very high welfare returns, mainly through health and safety benefits rather than GDP effects.

- Bus interventions can in some cases provide a higher value for money solution than costly light rail options but where demand pressures are particularly high, there may be a case for fixed infrastructure options.

- Urban roads can, in the right conditions, be a very high value for money solution to urban congestion problems.

- Road pricing is likely to affect the demand for public transport and therefore the economic case for additional capacity.

- Additional public transport capacity on key commuter corridors is likely to be effective where large volumes are moving into the very densest urban areas.
INTERNATIONAL GATEWAYS

4.94 The growing significance of globalisation means that the international connectivity of the UK has become more important, and is likely to be increasingly so over the next two to three decades.

4.95 Trade in goods and services is set both to increase and to change in nature, leading to rising and changing demands on international gateways. Strong growth is projected for the volume of goods imported through UK ports, particularly from Asia. Given the UK deep-sea ports capacity, this implies capacity constraints are likely to bite with consequent increases in the cost of moving those goods. In addition, as the service economy grows, the need for people to travel internationally implies increasing strain on UK airports with consequently higher costs of travel, unreliable journeys and a potential reduction in trading opportunities.

Additional ports capacity at deep-sea, feeder and ro-ro ports

4.96 UK ports are for the most part privately owned and operated as private businesses. Without adequate capacity there are implications for the wider economy. They are the key gateways for UK trade in goods, so if UK competitiveness is to be maintained and face the challenges of increasing globalisation, ports must be among the priorities for transport policy.

4.97 Although the public sector is therefore not generally responsible for bringing forward additional port capacity in the UK, there is a role to play for government in ensuring there are no unnecessary barriers to development, for example through the planning system.

4.98 By looking at where the demand for ports traffic is likely to exceed available capacity, research commissioned by DfT for the Ports Policy Review was able to assess when capacity constraints may bite over the next two to three decades by considering a range of scenarios. This work suggests constraints will be at:

- deep-sea container terminals in the South East: this is despite the assumed construction of two recently approved major new container terminal developments, plus one development that currently has ‘minded approval’ status, all in the greater South East. Capacity and efficiency improvements at existing ports and changes in shipping-line behaviour could also affect when and where capacity constraints will actually bite;

- feeder berth capacity around the country for container services via hub ports elsewhere; and

- roll-on – roll-off (ro-ro) terminal capacity, particularly in the South East.

---

11 Notable exceptions being Dover and the Port of London (trust ports) and Portsmouth and Sullom Voe (municipal ports)


13 The Secretary of State for Transport gave final consent for development at Felixstowe South in February 2006, for Bathside Bay in March 2006 and reconfirmed minded approval for London Gateway in August 2006.
3.4 Enhancing Current Networks

4.99 If UK container ports are unable to handle forecast demand growth, this could be for two reasons: they are unable to accommodate the absolute increases in volume; and/or with loads being consolidated in ever larger container vessels, they are unable to berth the largest ships. In this case, the UK will still import and export the additional goods, but they would be transhipped at a Continental port onto a smaller feeder vessel headed for the UK. Transhipment increases supply-chain costs by introducing two additional lifts and an additional sea leg though inland distribution costs may be reduced. The DfT’s research found that a scenario that assumes full construction of Felixstowe South, Bathside Bay and London Gateway, which will remove the need for a good deal of transhipment, delivery costs could be reduced by around £260 million a year or up to 10 per cent by 2025 when compared to a scenario where these three new terminals are not built.

4.100 Even if new container terminals are developed in the South East of England, there will still be growth in demand for container feeder berth capacity in the South East and across the country. For example, by 2020, container feeder volumes are expected to triple at North East ports and grow five-fold in volume at ports in the North West of England. Under this scenario, at least 1,800 quay metres of additional feeder berth capacity would be projected to meet demands at ports in Great Britain by 2015.

4.101 With the three new terminals, UK container ports should on central forecasts be capable of accommodating rising demand to at least 2020. However, growth is forecast to continue up to 2030 and probably beyond, so capacity constraints will again begin to bite. In this scenario, the constraints imply delivery costs per TEU\(^1\) will rise again by some 5 per cent between 2020 and 2030 amounting to some £140 million\(^2\) more each year by 2030, or on average about £9 per TEU.\(^3\) This includes some, but not all, elements of generalised cost,\(^4\) and the operating and capital costs of providing feeder quayside capacity, existing or new.\(^5\) These figures do not account for wider effects such as impacts on trade, globally mobile investment and reliability.

4.102 Given current market trends, private sector investment proposals for additional deep-sea container port capacity in the South East could be expected within the next two to three decades and would create net economic benefits for the UK. However the same is unlikely to be true for new deep-sea container capacity outside the greater South East. In a scenario where there is no remaining deep-sea capacity in the South East, deep-sea container vessels are much more likely to tranship additional traffic at a Continental port, provided that capacity is available there.

4.103 Demand growth and increasing vessel size at ro-ro ports is also likely to exceed current ro-ro port capacity over this period especially at the most heavily used ports such as Dover. Greater use of spare capacity at other ports or on Channel Tunnel freight services may delay the point at which the capacity constraint is reached by a few years but capacity constraints are likely to bite by around 2015 at the latest. Therefore, ro-ro capacity is likely to be under greater strain over this study’s timeframe than deep-sea container capacity.

---

\(^{14}\) Twenty-foot Equivalent Unit – a measure of port capacity.

\(^{15}\) This is the undiscounted nine pounds on 16 million TEU in the one-year, 2030.

\(^{16}\) UK Container Transhipment Study, MDST for DfT, 2006.

\(^{17}\) Includes a fixed rate per distance for road and rail surface transport costs (therefore takes into account the shorter haul of the increasing volume of goods arriving at northern ports closer to their destination) but does not take account of changes in road or rail congestion or reliability, differences in delivery time (on average rail boxes leave ports before road boxes), potential impact of road pricing, or inland warehousing or labour costs (transhipment traffic might be able to take advantage of lower input costs outside the South East).

\(^{18}\) If the cost of providing additional feeder quayside capacity increases significantly, perhaps because more berths are built on greenfield sites, then this may be an underestimate – but an estimate of this risk is unavailable.
If additional ports infrastructure is added, there are, however, likely to be adverse environmental impacts. Ports are mainly located in estuaries where they compete for sheltered locations with birds and coastal habitat such as mudflat and saltmarsh. The three key impacts on nature conservation of additional capacity are:

- direct and indirect nature conservation losses, direct loss of land, longer term changes to inter-tidal and sub-tidal habitats resulting from hydrological change, disturbance from recreational activities, pollution from anti-foulants and spillages, erosion from shipwash;
- knock-on effects from port developments in terms of upgrades to road and rail links that have their own impacts; and
- impacts on air and water quality through emissions, including those from ships (SO₂) and accidents.

Even if additional infrastructure is not needed, surface access and increased levels of traffic between ports and inland destinations will also have an adverse effect on the environment. This is more likely to be significant if road is relied on as the main means of inland movement of goods owing to the associated emissions and noise. This is likely to be the case for transhipped short-sea traffic where rail may be less viable owing to the smaller consolidated loads and shorter distances involved. The location of additional port capacity to cope with the forecast rise in demand for imports has implications for the environment because impacts will be worse where the distance to final destination is longer and road conditions are more congested.

The environmental impacts of additional port capacity need to be mitigated against, where possible, as part of the planning consent process, and balanced against the benefits to welfare and the UK economy of providing additional ports capacity. The recent port capacity planning approvals demonstrate that in some cases the case stacks up even after accounting for the environmental effects.

Additional airports capacity

As with ports, high levels of current and projected demands are likely to put strain on UK airport capacity. Where capacity is insufficient to meet the demand, there will be adverse implications for the economy: higher costs, both time and money, of international travel; reduced reliability of both air services and services within the airport; and potentially reduced trading opportunities.

Air services are relied on for international business activity, as well as tourism and non-work/leisure trips. Business and consumers place a high value on the range and frequency of air links offered from different airports.
4.109 This study has not sought to repeat the analysis of the Air Transport White Paper\(^{19}\) (ATWP) which suggests there are significant economic benefits from increasing runway capacity at Heathrow and other airports in the South East. Above a baseline of maximum use of existing runways, direct economic benefits of additional capacity at Stansted (2012) and Heathrow (2020) are estimated at some £24 billion. It is estimated that of this figure, some £6 billion\(^{20}\) accrue direct to business travellers, and these benefits would be higher still if reliability were accounted for. Other benefits not captured within this figure include the trade benefits of international connectivity and the benefits from increasing the attractiveness of the UK for foreign investors. Plus, there can be economies of scope from hub airports, through enabling a greater variety and frequency of onward connections, and from greater efficiencies in the provision of support services and fixed costs.

4.110 However, the gross benefits must be adjusted to reflect the impacts on the environment from additional runway capacity. The main environmental impacts of aviation that can be estimated quantitatively are noise from aircraft and the effects of aircraft emissions. Air Transport White Paper analysis estimated that the cost of increased carbon emissions over and above a baseline of making maximum use of existing runways could be in the region of some £3-5 billion.\(^{21}\) In addition, there are likely to be impacts of increased noise and health impacts from reduced air quality but these are likely to be an order of magnitude lower than these climate change impacts, leaving very substantial net benefits.

4.111 The ATWP also assessed the benefits of additional fixed runway infrastructure at other airports and suggested that an additional runway at two other UK airports could each provide overall benefits that are much lower than for expanding major airport in the South East, with the highest benefits at some £1.6 billion over the period to 2060. The benefits of capacity enhancement at other regional airports are therefore likely to be of a much smaller magnitude than for other major airports, given the lesser magnitude of pressures faced.

4.112 This study identifies international gateways as a key strategic priority for the future, and the vital role of aviation in supporting the international competitiveness of the UK’s high-tech manufacturing and financial services sectors. This is in line with the analysis from the ATWP set out above, which demonstrated that the potential economic benefits from further expansion of aviation capacity are significant, running to tens of billions of pounds. However, any growth in aviation needs to be sustainable, and must take full account of its environmental costs. One of the most effective mechanisms for achieving this is by ensuring that air travellers pay the full environmental costs of their journey, including climate change impacts. The principle of ensuring users pay their full external costs was supported by the Government in the Air Transport White Paper and was strongly supported by the Stern Review of the economics of climate change.

4.113 The ATWP passenger demand forecasts assumed the introduction of some form of pricing mechanism to ensure air travellers faced the full external costs of their climate change impacts. This was based on the Defra central cost of carbon estimate of £70 per tonne of carbon (in 2000 prices). With this pricing mechanism in place, the analysis demonstrated that demand would continue to grow, and that there would be significant economic benefits from some additional runway expansion. It is important to understand the impact of a range of carbon pricing scenarios on the case for aviation expansion, and the forthcoming ATWP Progress Report will test a wider range of carbon price scenarios.

---


\(^{20}\) Present value benefit over the period to 2060.

\(^{21}\) Present value over the period to 2060.
4.114 Provided economic analysis shows that there is a net benefit from increasing airport capacity, even after users pay the full environmental costs of their journeys, there will remain a strong economic case for additional runway capacity.

4.115 As with ports capacity, government has a role to play in forming policy to support the private sector development of airport capacity where there are likely to be significant gains for national welfare after taking account of the environmental implications.

The importance of surface access links

4.116 The realisation of these benefits resulting from the provision of additional fixed infrastructure at ports and airports also depends on the extent to which there is adequate capacity on surface access links.

4.117 Surface access links are often used not only by those accessing the port or airport, they are also shared by travellers for a range of purposes, particularly around large urban areas. For example, links to major airports such as Heathrow or Birmingham are used by travellers undertaking inter-urban journeys for business, non-work/leisure, commuting and freight not linked with the ports or airports. The shared nature of these links means that many are subject to high levels of congestion.

4.118 Available evidence suggests that investment in additional fixed infrastructure in these places can deliver strong returns for the economy and benefit a wide range of users. The available evidence is mainly for road links, but sometimes, additional capacity on rail links will be the most cost-effective solution to the problem. For example, in some situations one option to consider may be enhancements to the gauge of rail links on some surface access links to ports where larger containers are likely to be moved.

4.119 The case for additional surface access infrastructure should take into account the full range of possible options and impacts. Use of rail lines for freight surface access, for example, would need to be balanced against the competing need for use of the line by passenger trains and of course the costs of enhancement. These uncertainties point to the need for a study of surface access needs in the UK.

4.120 The potential returns from road surface access to ports can be strong with wider BCRs often in excess of 3 and some even around 15, in some circumstances, and GDP returns per £1 again often over £3 and up to around £11 in some circumstances. The cost of these interventions is relatively low, ranging from around £10 million up to £170 million.

4.121 The available evidence also demonstrates enhancing capacity on selected surface access links to airports is able to deliver strong GDP returns. The evidence suggests wider BCRs of additional fixed strategic road infrastructure in the range 2-15 with GDP returns per £1 of £1-9. The corresponding range of costs is from less than £10 million to just over £88 million indicating that some very strong returns are possible from relatively low-cost interventions targeted at particular pinch points.

4.122 The environmental implications of additional strategic road capacity are likely to be significant, particularly for carbon emissions, air quality, landscape and possibly biodiversity. Incorporating these effects, in many cases, reduces the wider BCRs presented above, possibly by up to one point off the wider BCR, as shown in Figure 4.3. These effects must of course be accounted for in the assessment of each intervention, as some are likely to be highly location specific. It could be possible to mitigate some of these effects on many links. On balance, even after accounting for these effects, in many instances the case for this additional surface access capacity would still be strong, as is also shown later in this chapter in the discussion of strategic road capacity investment.
Impact of road pricing on the case for surface access

4.123 In a world with road pricing, the case for additional fixed road infrastructure is generally likely to weaken. However even with road pricing, on very congested surface access links where prices are consequently higher, the economic case for additional capacity is still likely to be good. The wider BCRs on some of these links are so high that a strong case is likely to remain in a world of road pricing. This would of course need to be assessed in the light of the particular road pricing regime in place that would determine the impact on behaviour of all travellers. On rail surface access, it is unlikely that the case for additional infrastructure would be significantly affected by road pricing, though a slightly stronger case for passenger rail due to induced mode shift might be expected.

4.124 Where the impacts of road pricing might also be significant is around the long-term implications for logistics. It may be that in response to road pricing and the changing balance of costs for different aspects of goods movement, operators may locate warehouses and distribution centres in more cost-effective locations, or they may change port for example.

Conclusions on international gateways

4.125 A number of conclusions emerge from the evidence on the returns from investing in international gateways infrastructure. Policy should support additional ports capacity where, given the changing scale and nature of international trade, capacity constraints are likely to bite. Environmental considerations should of course be accounted for in the overall assessment.

- Provided economic analysis shows that there is a net benefit from increasing airport capacity, after users pay the full environmental costs of their journeys, there will remain a strong economic case for additional runway capacity.

- The realisation of the benefits of additional port and airport capacity is dependent on the capacity and travel conditions on surface access links.

- Targeted additional capacity on surface access strategic roads can offer some of the highest returns.

INTER-URBAN CORRIDORS

4.126 Certain inter-urban corridors play a key role in the economy where they link major urban areas, and where they allow large volumes of people and goods to move across the country to support economic activity, or support the economy directly or indirectly through reducing costs, distributing goods and facilitating domestic trade.

4.127 Sections of the UK’s inter-urban corridors suffer from very high levels of congestion, overcrowding and unreliable journey times. The value of time wasted owing to travel delays amounts to a multi-million pound cost to the UK economy every year and this is set to rise significantly.

4.128 Particular problems on the inter-urban network exist where a mix of users wish to use the transport system at a similar time of day.

4.129 The next sections discuss the options for enhancing inter-urban capacity and describe where the evidence points in order to deliver strong welfare returns.
Strategic road infrastructure

As the car is the dominant mode of travel in the UK, the most significant problem for inter-urban travel is road congestion.

On some links, small improvements can deliver very strong returns for road users, including freight. Where roads are capacity constrained, relieving pressures through junction improvements, for a relatively low cost, offers some very significant returns with many wider BCRs in excess of 5.

Figure 4.9 below plots out the wider BCRs of a range of junction improvements along with their costs, on which evidence is available to this study.

In some cases, additional junction capacity enhancement may be sufficient alone to tackle particular bottlenecks and therefore deliver high returns. In other cases it may be able to complement larger-scale investment in fixed infrastructure.

In the absence of national road pricing, evidence of real schemes from the Highways Agency and strategic analysis using the National Transport Model (NTM) both indicate a very strong case for targeted additional road infrastructure in the UK.

Targeted strategic road infrastructure has been appraised for inclusion in the Highways Agency’s Targeted Programme of Improvements (TPI) that looks out to 2015. Much of this investment delivers very strong returns with wider BCRs, often above 3 and up to 13. The highest returns are for additional capacity on those links around major urban areas and large agglomerations where there is a high demand for movement from a range of users including business, commuters and freight; and where there are significant capacity constraints.

For more detail, see separate paper Transport demand to 2023 and the economic case for road pricing and investment, DfT, 2006.
There are substantial environmental implications from adding road space. Not only does the footprint of existing roads increase with consequent landscape effects, but the likely higher volumes of road traffic generate higher levels of carbon emissions, lower air quality and increased noise levels. Analysis of the available evidence of such effects, where they have been possible to estimate, suggests that BCRs can in some cases be significantly reduced, potentially reducing BCRs by over 3 points for some strategic road enhancements, as shown in Figure 4.3. These must clearly be balanced against the benefits of additional road capacity.

Even after accounting for environmental effects, there appears to be a good case for adding strategic road infrastructure over and above the schemes in the TPI. Strategic analysis that uses best available evidence to estimate the benefits and costs suggests an economic case for additional capacity of between 2,900 and 3,350 additional lane kilometres on the strategic road network between 2015 and 2025. This analysis includes impacts on the economy, environment (such as the impacts on landscape, carbon emissions, noise and air quality) and construction costs. This would imply a rate of investment over 50 per cent higher than that assumed under the baseline scenario over that period, and would cost some £29-33 billion.

That is not to say that government would want to prioritise all of this capacity because there are diminishing returns as more investment is added. Therefore, the first chunks of investment will offer far higher welfare and GDP returns than latter chunks. Where the latter are concerned, there are likely to be other transport options that offer higher relative returns.

For example, beginning with the assumed strategic road network in 2015, the wider BCR of an additional tranche of some 1,450 lane kilometres is estimated to be around 9; as a further 800 lane kilometres are added, the wider BCR of this additional chunk of investment falls to around 3. The wider BCRs of subsequent additional investment then fall rapidly as more capacity is added. The fact that returns fall as more and more additional capacity is added has implications for the extent to which additional capacity enhancements are prioritised, given constrained resources.

Of course, financial constraints, public acceptability and non-monetised environmental impacts will mean that investment on this scale is not desirable: the key point is that this evidence highlights the strength of the returns of targeted strategic road enhancement.

The values placed on environmental damage have been estimated using the best available sources including Defra and DfT research on the external costs of transport. Impacts that have been estimated as part of this analysis are landscape, noise, carbon emissions and air quality. Past experience from the DfT methodology for assessing the value for money of transport interventions has been used to estimate the illustrative magnitude of these possible environmental effects. Even after accounting for these, the net benefits are substantial. Figure 4.2 set out their impacts on each of the strategic priorities.

The strong economic case for additional targeted strategic road capacity after accounting for the environmental effects is driven by the fact that the majority of the investment involves widening existing roads, rather than building new. The impacts of the additional capacity are therefore lower than they would otherwise be in terms of landscape. Carbon emissions, air quality impacts and noise are likely to be worse as these are driven by the volume and speed of traffic, but these are generally outweighed by the benefits to transport users in terms of reduced overall costs of travel and improved reliability.

---

23 Defined to be where the benefits exceed the total costs, including the inefficiency costs of raising public funds.
24 In addition to investment assumed under the baseline scenario up to 2015.
25 The methodology and detailed analysis are set out in the separate paper Transport demand to 2025 and the economic case for road pricing and investment, DfT, 2006.
4.143 The fact that the benefits to wider society from an intervention exceed the costs in terms of environmental effects like higher carbon emissions, implies that, if desired, those benefits could be used by society to invest in actions to reduce climate change in a cost-effective way. Figure 4.10 demonstrates the relative magnitude of impacts of the strategic road investment discussed above. Clearly, public debate is necessary to consider the implications of these choices.

![Figure 4.10: Composition of overall welfare benefits for strategic road build, 2025](source: DfT)

4.144 Figure 4.10 demonstrates the magnitude of benefits to society from investing in those strategic roads for which there is an economic case in 2025. The benefits vastly outweigh the estimated value of adverse impacts on the environment, such as landscape and carbon emissions. This is of course strategic analysis, so local effects cannot be accounted for but this analysis does make clear the balance of the effects.

4.145 Welfare benefits are estimated to be over £3 billion per year from this scale of investment in infrastructure, after accounting for construction and environmental costs. These benefits are driven by the fact that inter-urban strategic roads are heavily used by a wide mix of road users who are subject to significant levels of congestion and unreliability. Users such as business travellers and freight often place a high value on their time and, therefore, lower congestion. A key point to note about this strategic analysis is that it covers inter-urban links, as well as strategic road surface access links to ports and airports. The multiple role of the UK inter-urban strategic road network bolsters its importance in supporting economic activity.
3.4 Enhancing current networks

4.146 The gains are largely driven by the reduction in congestion. Inter-urban roads would be expected to benefit from 12 per cent lower congestion with an average reduction over all roads of some 5 per cent. These gains are net of the impacts on urban areas that may see congestion rise a little, by less than 0.5 per cent.

4.147 Road pricing would of course strongly impact on the case for additional strategic road capacity.

The impacts of road pricing on the case for additional strategic road capacity

If widespread road pricing were introduced, the nature and location of challenges on the roads would be altered.

Analysis undertaken to understand what this means for the case for additional infrastructure in the UK in the longer-term suggests that road pricing would significantly reduce, but not completely eliminate, the amount of additional road build for which there would be an economic case.

By looking at the returns from additional fixed infrastructure, it is estimated that instead of 2,900 to 3,350 lane kilometres, if national road pricing were introduced, this would fall substantially to just an additional 500 to 850 lane kilometres on the strategic road network between 2015 and 2025. This is a reduction of some 80 per cent.

Such a package might cost around £5-8 billion and would generate annual welfare benefits in 2025 of some £30 billion. The vast majority of the benefits of this package of road build and pricing derive from the pricing element with only around £600 million of benefits generated by the road build.

An important variable here is the form of road pricing that is implemented. This analysis assumes that national, distance-based marginal social cost pricing is in place. This is likely to be at the upper end of the possible benefits achievable, and in reality only a much simpler road pricing scheme could be introduced. The extent to which the need for additional capacity would change is likely to be lower under alternative road pricing regimes.

Another benefit of a combination of road pricing with additional infrastructure investment is that there are likely to be environmental benefits relative to the case where only infrastructure was used to tackle the congestion bottlenecks. This is for two reasons. Firstly, road pricing itself has the objective of making better use of the road space, so the lower congestion reduces the time vehicles spend idling in traffic queues emitting harmful gases and particulates. Secondly, the ability of pricing to significantly reduce the case for additional capacity means less damaging implications for landscape and biodiversity etc.

The vast majority of this ‘with pricing’ road-build package would offer an economic case for investment in a world with or without road pricing. For those links where this is true, these should be the priority for investment to support the economy and welfare and are to be found generally around and on the key corridors approaching the growing and congested urban areas, and other key links where congestion problems are most severe.

This section has highlighted that, owing to the interaction of road pricing with the case for additional road build, robust long-term decisions on strategic road capacity can be better made if the case for capacity enhancement has been tested in an environment where pricing – localised or widespread – is approaching. Given the long lead times of such transport interventions, this will be particularly important when considering interventions to tackle challenges beyond 2015.
Providing additional infrastructure when road pricing is uncertain

4.156 The nature of the congestion problem in urban areas and on the strategic road network, and the consequent need for high road prices, indicates that there is likely to be a case for additional road capacity, even if road pricing is introduced.

4.157 Given the uncertainty around road pricing in the long term, there would be merit in testing the case for long-term investments in an environment where pricing is approaching. Priority should be given to those investments for which the case stands up to this test.

4.158 Even with a firm timeframe for the introduction of road pricing, it is likely to take several years. In the meantime there are costs to the economy from road congestion and other pressures. This may therefore point to considering the case for implementing variable capacity options that are cheaper and faster to deliver than fixed infrastructure, reducing the risk of unnecessary investment.

4.159 A framework for identifying and evaluating the case for complementary investment and pricing on other modes and how it will change through time is therefore needed.

Inter-urban public transport capacity

4.160 Inter-urban rail services are likely to experience significant growth over the next two decades with consequent increases in crowding on some services at peak times. These problems are likely to be concentrated on rail links into major urban areas including London. The major cause of pressure is due to the competing demands for rail services on the same lines from both longer distance inter-urban travellers and shorter distance commuters.26

4.161 To the extent that these high levels of overcrowding are perceived to increase the costs of commuting into the major urban areas, there are likely to be adverse labour market effects from the impacts on employment choices and therefore costs on the economy.

4.162 When compared with the sample size of returns from inter-urban strategic road investment, there is much less evidence on the returns from public transport interventions on key inter-urban corridors. The evidence available suggests that where volumes of travellers are high enough to cause capacity constraints, and the density of employment and activity at the destination are also very high, there can be good returns from additional variable capacity on existing rail lines. In the UK this suggests that the case will be stronger on corridors into major urban areas.

4.163 Improved signalling has played an important role in delivering significant benefits on the London Underground. For example, signalling and new rolling stock plus other enhancements such as track and civil works and improved power, communications and depot facilities delivered strong returns on the Central Line. The reappraisal of the scheme in 1999 suggested the scheme was financially positive, such that the benefits to travellers plus increased revenues from higher patronage were greater than the cost of the scheme.27

4.164 To increase the effective capacity of existing heavy rail lines, rail signalling could be adopted, such as ‘moving block’. This technology allows trains to travel at faster speeds and closer together, potentially improving the effective capacity of existing rail lines by some 10-20 per cent depending on the type of traffic and mix of services. These technologies are already being used successfully on a number of light rail schemes, for example the Docklands Light Railway.

---

26 For more detail see Interurban rail forecasts, Atkins, commissioned for the DfT and Eddington Study, 2006.
Therefore, if and only if the costs, risks and challenges associated with this technology were such that this could feasibly be considered on a larger scale for national rail, it could potentially deliver consequent benefits to the economy. It could also be considered as a complement to new additional variable capacity on existing rail links where capacity constraints bite.

Upgrading rolling stock and lengthening trains on congested rail links, combined with changes to timetables to increase frequency can significantly increase the effective capacity of existing rail lines. Evidence of illustrative interventions to increase variable capacity on inter-urban links into London by investing in new rolling stock, for example, suggests strong returns are possible from well-targeted interventions, with wider BCRs ranging between 1 and 13 and costs between £50 and £500 million but more typically between 1 and 3. The higher returns are largely driven by the ability to add variable capacity with minimal infrastructure requirements.

Both variable capacity on rail and inter-urban strategic road capacity are therefore likely to deliver high returns cost-effectively if targeted on the key pressures on the transport system.

It has been argued that investment in new fixed infrastructure can, in some circumstances, create a step-change in economic performance. For example, measures that provide a step-change in the speed or cost of connection may generate wider economic benefits through increasing the catchment areas for labour markets or through enabling return business journeys in a day. Volume 1 showed that such effects are quite limited in mature economies with well-developed infrastructure.

To explore this further, a review of appraisal and evaluation evidence of step-change investments in the UK and abroad revealed that schemes that tackle existing congestion problems and bottlenecks are likely to offer larger economic benefits per £1 of cost than those that are primarily focused on opportunities or enhancements.

The literature and evidence used in this volume also suggested that the bulk of the economic benefits of transport schemes will come from the value of time saved and reliability benefits captured by conventional appraisal, with a limited uplift from including wider economic benefits.

High-speed rail is often considered as an example of a step-change measure. But, it is first important to note a distinction between possible high-speed rail options:

- those that offer the ability to run trains at high-speed using existing and tested technologies, as is the case on some inter-city lines for example; and
- those that allow trains to run at even higher speeds, relying on new, developing and often untested technologies.

For the latter option, the approach taken to the development of some very high-speed rail line options has been the opposite of the approach advocated in this study. That is, the challenge to be tackled has not been fully understood before a solution has been generated. Alternative options do not, therefore, appear to have been fully explored so it is not clear what the highest return solution to a problem would be; nor indeed is the challenge clear.

---

28 For more detail see Interurban rail forecasts, Atkins, commissioned for the DfT and Eddington Study, 2006.
Interventions to significantly increase rail journey times are sometimes claimed to provide a step-change in economic performance. The literature suggests that in most cases, the returns are likely to be modest relative to other smaller-scale options. For example, the evidence on the costs and benefits of new North-South high speed rail lines available to this study suggests returns at the lower end of the distribution compared to the returns available from other policy options. These relatively modest returns are likely to be driven by several factors including the following:

- the UK’s compact economic geography means that most major urban areas are already close together when compared to many European and international competitors;
- for those economically important connections that are more distant, such as London to Edinburgh and Glasgow, air services already provide fast, frequent connections serving business needs and other markets at relatively low cost. The new rail link, therefore, would not be a step change as the link is already there and there is very little evidence that high-speed rail links help regional performance;
- the benefits accruing to intercity business and non-work/leisure travellers in the UK from this new link are likely to be subject to significant uncertainty and speculation because the demand for the link has not been tested and proven;
- history has shown that for large-scale infrastructure projects that rely on emerging technological solutions, costs tend to increase by an order of magnitude against original estimates; and
- in addition, where new rail lines are added and speeds greatly increase, there are likely to be very significant environmental implications from the need for land take, plus emissions and noise.

Given the distinction made above about the types of high-speed rail interventions, it is important to recognise that not all high-speed rail line options would be subject to the same issues. For those that do not involve relying on untested technologies and are targeted at solving proven congestion and overcrowding problems, higher and more certain returns are likely than for high-risk options on new links where demands are speculative. There are several areas of the network where congestion and overcrowding have already been identified and are projected to worsen over coming decades without appropriate policies or responses, for example on commuter links into London and perhaps other cities. New infrastructure options are one potential solution, but they should be assessed alongside other options designed to meet the same objective.

When considering significant improvements to inter-urban links between agglomerations, on any mode, it is useful to recognise that commuters are generally prepared to do a 40-50 minute commute, and measures to improve the speed of connection between neighbouring agglomerations bring more people within this threshold, therefore widening the labour market. Agglomeration benefits are likely to drop off over longer distances.

Step-change measures to deliver a transformation of the transport system are therefore generally unlikely to be a priority, given fixed funding resources. The scale of wider transformational benefits is uncertain and is extremely unlikely to be enough on its own to justify very large amounts of public spending involved. Those that are able to tackle a particular and already demonstrated problem on the other hand, are generally more likely to be cost-effective, but should of course be assessed on their own merits relative to other options such as pricing, variable infrastructure options and line upgrades.
4.177 The case for investing in step-change projects must always be considered against other options for solving the same problem, and against the returns offered by other transport schemes and policies.

4.178 In addition to their potential economic benefits, it has been argued that high-speed rail could deliver reduced carbon emissions from the transport sector by offering a more energy-efficient and lower-carbon alternative to air travel for long distance inter-urban journeys. As the Government has an objective to reduce carbon emissions, it is also important to consider the strategic environmental case for high-speed rail links in the UK.

4.179 Our guiding principle in considering the most effective policy options in contributing to growth has been that government should prioritise limited public resources on those policy options that offer the greatest returns to public spending, and which make the most effective contribution to meeting government objectives. This argument applies equally to money spent on achieving environmental objectives, and government should prioritise those policies which achieve the greatest reduction in carbon emissions per pound spent, taking into account other costs and benefits.

4.180 It is outside the scope of this study to assess the detailed costs and benefits of specific high-speed rail options. Rather, our approach has been to make a strategic assessment of the factors influencing the likely effectiveness of high-speed rail as a policy option for reducing carbon emissions and achieving other environmental objectives.

4.181 At average load factors, rail has an environmental advantage over air travel as it consumes less energy, and therefore produces lower carbon emissions per passenger per kilometre. In theory this suggests that a modal shift from air to rail would offer reductions in carbon emissions. Figure 4.11 analyses the carbon benefits that could be achieved if all air travellers between London and Scotland transferred to rail over a 60-year period, assuming average load factors and energy consumption for rail. The cost of these carbon savings would be high relative to other carbon reduction policies identified in the Government’s Climate Change Programme Review.
Figure 4.11 Potential carbon savings from a modal shift from air to high-speed rail

A high speed line from London to Scotland could attract modal shift from passengers who currently make this journey by air. To get a sense of the potential for high speed rail to generate carbon saving from modal shift from air, it is useful to estimate the carbon benefits of an extreme scenario in which all of the current air travellers between London to Scotland were attracted onto high speed rail.

In 2005 around 8 million passengers flew between Scotland and London one way. The carbon emissions per person from making this journey by air or train are roughly 25kg and 10kg of carbon respectively, assuming average load factors for both modes. There would be further climate change benefits on top of these carbon savings due to a reduction in other emissions from aviation. If it were possible to power a high speed rail service with entirely carbon-free electricity, the climate change benefit would be even greater. Factoring in all of these potential benefits, a generous estimate of the net benefit for every person who travels by high speed rail rather than air would be about 40kg carbon.

If a zero carbon high speed rail line were able to attract all of the existing air travellers between London and Scotland to rail, the approximate net annual benefit would be 0.33 million tonnes of carbon equivalent (MtCe), including an assumption for the non-carbon impacts of aviation. To get a sense of the size of this reduction, the carbon emissions from the UK domestic transport sector were 35 MtC in 2004, and 152 MtC from the UK in total. 0.33 MtCe would represent a saving of 0.2 per cent of the UK’s annual carbon emissions. Taking account of the predicted growth in aviation demand over the period to 2060, the total carbon savings if all aviation passengers on this route were to switch to high speed rail over a 60 year appraisal period would be 31.4 MtCe, or 0.5 MtCe per year on average. In practice, the carbon savings that would be achievable are likely to be much smaller than this, for a number of reasons set out in paragraph 4.182 below. Even under such favourable and optimistic assumptions, this would not represent a major carbon saving measure compared to, for example, the EU ETS (saving 8 MtC per year from 2010).

The cost of saving carbon in this way is also likely to be relatively high. A standard cost-effectiveness approach working out the cost of saving each tonne of carbon gives a high number (showing poor cost-effectiveness), but this is potentially misleading in that contrary to most climate change policies, the main benefit of the policy is not carbon saving but the time-savings benefits to the users which are not captured in the cost-effectiveness number. A fairer approach might be to compare the benefit of the carbon saved with the total costs and benefits of the scheme. The value of the carbon saved would be around £3.2 billion (31.4MtC over 60 years) on the government’s central cost of carbon of £70/tC (and £2.1 billion to £5.4 billion using the sensitivity range of £35/tC to £140/tC, all 2000 prices). The High Speed Line Study by Atkins for the Strategic Rail Authority estimated the construction cost of a London to Scotland high speed line at £33 billion (excluding maintenance and operating costs). On a project with costs of this size, carbon saving benefits of £2.1-5.4 billion (undiscounted), under the most optimistic assumptions, are never likely to play a major role in the business case.
This analysis represents the maximum carbon savings that could be achieved through modal shift from air to high-speed rail on this route. In practice, there are a number of reasons to be more cautious about the likely cost-effectiveness of a North-South high-speed rail line as a policy for reducing carbon emissions:

- it is highly unlikely that high-speed rail would achieve this level of modal shift from aviation, even with carbon pricing;
- and relatedly, rail’s carbon benefit over aviation will depend upon the load factors achieved, and there is a significant risk that demand for high-speed rail would be low on some parts of the route, and at some times;
- rail’s energy consumption and therefore carbon emissions per kilometre increases with speed meaning that, all other factors being the same, high-speed rail has higher carbon emissions per passenger kilometre than conventional rail, and a smaller carbon advantage over air travel;
- there could be carbon costs from passengers switching from conventional to high-speed rail, both because of the energy consumption of the respective modes and because load factors could be reduced on existing rail services; and
- there would be significant carbon and other environmental costs in the construction of the line.

These issues are discussed in more detail below.

The impact of high speed rail on the air market depends upon how competitive it is compared to flying, in terms of both cost and travel time. The Atkins High Speed Line study anticipated a 9 per cent reduction in air demand for the London to Edinburgh journey in 2016, rising to 24 per cent in 2031.30

Some commentators acknowledge the uncertainties around the demand forecasts, but argue that if air travellers were made to pay the full external environmental costs of their journey, this would increase the comparative price advantage of rail travel, leading to a modal shift from air to rail, increasing the commercial viability and environmental performance of high-speed rail.

This study fully supports the principle of ensuring transport users face their full external costs, including environmental and congestion costs. This volume earlier explained that the introduction of some form of carbon pricing for aviation would result in increased air fares for passengers. Such a pricing mechanism might increase the cost of a one-way air fare from London to Scotland by around £6, including an assumption for climate change costs of other non-carbon emissions from aviation.31 A price increase of this magnitude would not be expected to have a significant impact on the competitive position of rail versus air on this route. Furthermore, it is expected that this increase in costs would be offset by cost savings through increased efficiency and competition in the aviation sector over the medium term, meaning prices would not be expected to rise in real terms.

Rail’s environmental benefit compared to other modes will depend heavily on its load factors. A well-utilised rail service has relatively low carbon emissions per passenger per kilometre. But if services are running at low occupancies, the energy consumption and carbon emissions per person could be high, potentially higher than those of alternative modes for the same journey.

---

31 DfT analysis.
4.188 If a rail service was well utilised throughout the day and on all parts of the route, it would most likely offer environmental benefits over other modes for making the same journey. But as discussed previously, demand for high-speed rail in the UK would be expected to be relatively low on those sections of the route where new capacity would be provided in the hope of stimulating demand rather than relieving existing capacity constraints. The risk of low demand on some sections of the route would therefore have implications for the environmental benefits of the scheme as well as its commercial feasibility.

4.189 Rail’s comparable energy efficiency and carbon advantage over air travel decreases as the speed of the train increases. This is because air resistance, or aerodynamic drag, increases exponentially with speed, meaning more energy, and therefore carbon emissions, are required to overcome air resistance at higher speeds. In simple terms, all other factors being equal, a high-speed train would have higher carbon emissions per passenger than a conventional speed train covering the same distance.

4.190 The availability of low-carbon sources of energy would have implications for the balance of carbon emissions across modes, and it is likely that low-carbon rail will become feasible before low-carbon aviation. If a high-speed rail line could be constructed and powered by entirely carbon-free energy sources, this would increase the potential carbon saving (in the worked example above it would increase the potential carbon savings by around 40 per cent). But the increased carbon savings would need to be viewed against the increased costs, if any, of sourcing low-carbon sources of energy.

4.191 While there may be carbon benefits from passengers moving from air to rail, it is likely that there would be carbon costs from passengers moving from conventional rail to high-speed rail, both because of higher energy consumption and carbon emissions per passenger km from high-speed rail, and because of possibility of load factors being reduced on conventional rail services.

4.192 The calculation in Figure 4.11 does not take account of the carbon costs of building a new line, which could be considerable. Furthermore, wider environmental implications of a new high-speed rail line may not all be positive. There would be significant landscape costs from building new track, including implications for biodiversity, national parks and national heritage. The route of a high-speed train could potentially pass through the Chilterns and/or the Peak District National Park. A feasibility study by Atkins for the Strategic Rail Authority noted that high-speed rail does not perform particularly strongly on wider environmental implications ‘since a scheme requiring such substantial new infrastructure would inevitably have significant negative landscape, biodiversity and heritage impacts, with relatively small benefits to air quality and noise levels’.[32]

4.193 High level analysis of the potential carbon benefits from modal shift from air to high-speed rail suggests that these benefits would be small relative to the very high cost of constructing and operating such a scheme, and that under current assumptions a high speed line connecting London to Scotland is unlikely to be a cost-effective policy for achieving reductions in carbon emissions compared to other policy measures.

4.194 High-speed rail is likely to make the most effective contribution to environmental objectives where the scheme is developed to address existing or projected capacity constraints, increasing the probability of high demand and high load factors, and improving the economic and environmental returns.

The energy consumption, and therefore carbon emissions, of very high speed rail is likely to be higher than that of conventional rail, all other factors being the same. Any consideration of the potential for high speed rail to deliver carbon benefits needs to be based on detailed analysis of the costs and benefits, rather than on broad generalisations about the environmental benefits of different modes.

As argued previously in this chapter, decisions on specific schemes or policies would need to be informed by detailed appraisals of specific high-speed rail proposals, and of appraisals of other policy options for achieving the same objectives.

Conclusions

This section has therefore shown the following:

• there is an economic case for a significant amount of targeted additional inter-urban road capacity, even after environmental effects have been accounted for;

• the introduction of better road pricing would reduce the amount required. Even with road pricing, however, there is an economic case for additional inter-urban road infrastructure, albeit at a much lower order of magnitude and in fewer places;

• the case for targeted additional capacity on key commuter corridors into major urban areas is strong; and

• step-change measures intended to provide a transformation to the transport system and rely on untested technologies are not, in a world of constrained resources, likely to be a priority. Those step-change measures proposed as a solution to existing and likely future problems are more likely to perform well, but must be assessed alongside other options for a given transport challenge.
Headlines

- An evidence-based approach has been adopted to assess and compare transport policy options, drawing on evidence of real past and proposed future interventions across the UK, and modelling work using a range of analytical tools. A very wide range of costs and benefits have been taken into account.
- Understandably, evidence is not available for all interventions on the policy menu; nor does the evidence cover every circumstance in which an intervention could be implemented. This is particularly true in growing and congested urban areas and their catchments; but the evidence is sufficient to draw some useful strategic conclusions.
- No assessment is able to capture all the costs and benefits of a transport policy and present them in monetary terms. Impacts on the environment, journey time reliability and some GDP effects are therefore not captured in the typically used benefit:cost ratios (BCRs) that result from the NATA\(^1\) appraisal process, but are assessed qualitatively.
- For the purposes of this study, the best available evidence has been used to attempt to estimate the value of these previously uncaptured effects, and in some cases, a judgement on the magnitude of environmental effects has been made using evidence on environmental valuation. This has allowed the overall value for money of interventions to be compared.
- Some impacts remain unquantified, such as trade and dynamic effects.

\(^1\)See: www.webtag.org.uk

INTRODUCTION

5.1 The purpose of this chapter is to provide more detail on the significant quantity of evidence that has been drawn on to reach the conclusions and recommendations in this volume. In addition, more detail is provided on the approach taken to the assessment and comparison of interventions explored and how the various metrics can be interpreted. This chapter:

- sets out the process of cost-benefit analysis and the role it plays in decision making and prioritisation;
- outlines the range of evidence that has been drawn on and how the GDP and full welfare impacts of different options in different places have been estimated;
- offers some insight into how the evidence can be interpreted; and
- concludes with what this evidence can tell us, and what it cannot.
**COST-BENEFIT ANALYSIS AS A DECISION MAKING TOOL**

5.2 By relying on evidence of the likely returns of transport spending, it is possible to build an understanding of:

- where and under what conditions different interventions are able to offer benefits that exceed the costs; and

- which policy options are likely to be the best.

5.3 Cost-benefit analysis (CBA) has long been used by government and business as a way of measuring the impact of taking action, relative to ‘doing nothing’, (see Figure 5.1). By assessing the costs and benefits in a consistent and transparent way, options can be compared and government is able to allocate its funds to the projects that offer the best returns.

---

**Figure 5.1: Cost-benefit analysis as a decision-making tool**

In the transport context, cost-benefit analyses are carried out for all major transport projects. The impacts of an intervention are assessed against a ‘do nothing’ reference case to allow an assessment to be made of the benefits and costs of action relative to what would otherwise be likely to happen.

In 1998, the UK Government introduced its formal appraisal process, the New Approach to Appraisal (NATA). This sets out guidance on how a transport project requiring government funding should be appraised against the five government objectives for transport: environment, safety, economy, accessibility and integration. The purpose is to assess the overall value for money of the intervention after all impacts have been accounted for.

Impacts are assessed and presented in monetary terms where a robust valuation evidence base exists, for example the value of time to a range of transport users and vehicle operating costs. Where this is not possible, as for some environmental effects, impacts are assessed qualitatively by experts in the field. Overall impacts are summarised and presented consistently in an appraisal summary table.

To reflect the evolving nature of transport appraisal, four cost-benefit measures are referred to throughout this study, all of which express estimated benefits of a proposal per pound of government expenditure. If the ratio is, say, 2.5 then £2.50 of benefit is achieved per £1 of public funds invested. An intervention with ratio of 5:1 would offer double this welfare return.

5.4 The metrics used in this volume are set out in Figure 5.2.
The metrics below have been relied upon throughout this volume and they vary according to the impacts that are monetised and reflected. This study takes the view that the conventional BCR as generated from the NATA process is the most certain measure, but that it is incomplete. The value for money assessment is the most complete ‘single measure’ of transport’s impact on the UK, as it incorporates the fullest possible estimate of a proposal’s economic and environmental impacts. However, those estimates are more uncertain than the conventional BCR because the evidence base is relatively new, and some of the effects are inherently hard to monetise. The metrics are:

- **Conventional benefit:cost ratio (NATA BCR):** the benefit:cost ratio set out in DfT’s appraisal guidance (New Approach to Appraisal¹). The main effects that are monetised in this BCR are: changes to the overall costs of travel, the value of changes to travel times, safety benefits, and the financial costs (including optimism bias) of doing the project, including impacts on taxation revenues. This does not yet include a number of GDP impacts, and in this analysis does not put a monetary valuation on environmental benefits.² Instead, the BCR sits within a broader assessment framework that uses qualitative estimates of environmental and social impacts.

- **GDP per pound:** the contribution to GDP that can be achieved per pound of government money spent on the intervention. It is a narrower metric than welfare because it only focuses on the impacts on the economy. It does not therefore include benefits for non-work/leisure travel, for example. In addition to the GDP impacts already captured in appraisals – such as changes in the costs of travel to business and freight – this assessment also includes impacts on the wider economy that are not currently estimated as part of conventional appraisals, such as agglomeration, labour market impacts, competition effects and reliability. Such effects have been indicatively estimated for this study based on the developing ‘state of the art’ guidance on how to assess these impacts from DfT.

- **Wider benefit:cost ratio (BCR):** this adds the ‘missing’ GDP effects into the conventional BCR.

- **Value for money (VfM) BCR:** the most complete metric used in this analysis. For decision making, all impacts on society should be considered, but only some can be presented in money terms. The value for money assessment, is broader than the three previous metrics, incorporating most significant environmental effects into the monetised assessment by relying on recent valuation evidence. Environmental effects estimated in this way are carbon (using Defra guidance), air quality, noise and landscape (using published DfT and Defra research).

For example, a new piece of transport infrastructure may offer say £3 of GDP per pound; have a wider BCR of 5 i.e. offer £5 of welfare for every £1 of cost (higher than GDP per pound because this captures a broader range of benefits than just GDP); but after environmental effects are accounted for, the VfM BCR may be 4 (i.e. overall welfare return is £4 for every £1 cost).

It has not been possible to provide VfM BCRs for all the interventions considered by the study, so in such cases a qualitative assessment has been carried out, highlighting the likely implications for value for money.

---

¹ For more detail see www.webtag.org.uk.
² Though recent developments in appraisal guidance will lead to future appraisals, capturing the value of changes to carbon emissions and noise.
³ Transport, wider economic benefits and impacts on GDP, DfT, 2005.
3.5 EVIDENCE AND METHODOLOGY

5.5 SOURCES OF EVIDENCE FOR THE STUDY

A wide range of evidence from a range of sources has been drawn on, including broader academic literature. Evidence from real existing and proposed schemes in the UK has been used heavily. However, the evidence available does not cover some policy options so additional evidence has been generated from a range of modelling sources. This includes national transport modelling for the year 2025, rail network modelling for the year 2026, aviation and ports modelling for 2030, limited modelling in the West Midlands and a strategic modelling case study of South and West Yorkshire. The full range of sources is listed in Figure 5.3.

Figure 5.3: Sources of cost-benefit analysis

- DfT’s value for money assessments: a sample of projects submitted for ministerial approval over the last two years including public transport interventions and strategic and local roads.
- A case study of South and West Yorkshire using the South and West Yorkshire Strategic Model (SWYSM) exploring a range of illustrative interventions; and an illustrative intervention in the West Midlands using the Policy Responsive Integrated Strategy Model (PRISM).
- Transport for London analysis and business cases.
- National Transport Model strategic modelling of road pricing and strategic road investment in 2025.
- Strategic modelling of inter-urban variable capacity rail enhancements using the PLANET suite of models for 2026.
- Sustrans analysis of walk and cycle interventions.
- A review of the literature on step-change measures in the UK and overseas.

In total, the database of evidence contains relatively detailed information on the returns of over 170 interventions, plus a range of additional evidence from external sources and modelling.


5.6 The strategic modelling work has been discussed and reviewed by a number of expert academics in the field and more detailed reports on this analysis, including a description of the methodology used, are published alongside this report.

5.7 Unlike a detailed CBA, strategic modelling provides an earlier stage of analysis. It assesses the returns from improvements to particular transport corridors without specifying precise routes. This is a tractable way of conducting strategic assessments, but can only ever provide a high-level assessment of some of the environmental and social impacts involved; and it adopts rules of thumb for high-level costings. Nonetheless, it does form a useful source of analysis where detailed appraisals are not available and can help guide policy makers towards areas where more detailed appraisals are likely to be worthwhile.
Relying on detailed appraisals of particular interventions provides important insights; but it is important to bear in mind that it does not allow a comparison of a full range of options for each transport challenge. The case study of South and West Yorkshire goes some way to rectifying this, as described more fully in Chapter 3.4, as it has compared a fuller range of illustrative options in a particular area.

However, there are some types of options on which the evidence is very limited, including:

- rail freight: options for urban, inter-urban and surface access links;
- the impact of different types of road pricing on the case for additional infrastructure. The evidence is emerging for the strategic road network, but there is still much to do in understanding the impact in urban areas and on public transport needs; and
- the full range of interventions in growing and congested urban centres, for example urban traffic management or bus measures.

On balance, the evidence is considered sufficient to provide a guide as to the range of returns from different types of options; and to highlight the gaps that should now be a priority for transport strategists to fill. The evidence available covers a broad range of locations across the UK, as shown in Figure 5.4.
Figure 5.4: Location of interventions in the evidence base

Key
- Red: Trunk A road
- Teal: Trunk motorway
- Black三角形: Local road
- 桃红色: Public transport
- 橙色: Rail
- 蓝色: Tram
- 灰蓝色实线: M25 Road schemes (trunk motorway)
- 灰色: Urban areas with a population > 100k

Source: DfT

Ordnance Survey © Crown copyright. All rights reserved
Department for Transport 100020237 2006 geo06070512Map8
INTERPRETING THE EVIDENCE

5.11 To make maximum use of the wide range of evidence available in comparing policy options and informing the strategic transport priorities, it is important to fully understand its wider context, strengths and limitations.

5.12 As described in Figure 5.1, the purpose of transport appraisal is to assess the full range of costs and benefits of each transport intervention consistently and comprehensively. Four key metrics have been relied on for this study to allow the relative magnitudes of different impacts to be demonstrated. Of greatest importance for the decision-making process is the notion of value for money – as captured by the VfM BCR because this reflects the broadest possible range of impacts, including environmental effects and impacts on the economy that are not currently captured in appraisals.¹

5.13 But even this measure does not capture all of the impacts of transport interventions. Importantly, at present there is no methodology for estimating the benefits of increased trade and attracting more globally mobile investment. These are particularly likely to be prevalent for some inter-urban links and international gateway options. In addition, dynamic impacts are also not captured in current appraisals. Such dynamic effects are likely to be notable where, for example, transport is constraining growth and interventions are able to support urban areas as innovation centres; or where they provide reliability improvements that allow further consolidation of just-in-time supply chains; or open up new trading opportunities that extend the reach of markets to provide increased economies of scale in production. Unlocking even small scale improvements to the growth rate will cumulate to provide significant benefits through time. So, although uncertain, where current ‘missing’ GDP impacts have here been estimated, if anything, they are likely to be underestimates.

5.14 In many ways, the ‘missing’ GDP impacts are less well understood than the assessment of the value of time saved that forms the bedrock of conventional appraisal, so it is only right that they are separately identified. At the same time, care must be taken not to apply a higher standard of proof to new appraisal developments than to more familiar methods. For example, with current data and analytical tools, there remains much uncertainty around the modelling and appraisal of freight benefits that are incorporated in transport assessments. This area is evolving and will improve as more evidence comes to light of freight responses to transport interventions and their value.

5.15 Not only are there uncertainties around the ‘missing’ GDP estimates, there are also uncertainties around the estimated environmental impacts. There are two aspects of this uncertainty. Firstly, the appraisal information available from real interventions contains detailed assessments of the environmental impacts, but it is not monetised at the scheme-specific level. Therefore, best available evidence must be relied on to estimate the magnitude of these effects, for example, Defra guidance on the value of carbon emissions, and landscape values from the then ODPM.² Secondly, given the nature of the strategic modelling of a range of interventions, detailed assessment of environmental impacts is not possible. But, it is possible to draw from the experience of real interventions to estimate the indicative magnitude of such effects. For example, with strategic road widening, estimates have been made of the extent and type of landscape affected and carbon impacts have been estimated based on the changes in road use.³ The assessment is therefore generic rather than scheme-specific.

¹ For more detail, see separate paper Transport demand to 2025 and the economic case for road pricing and investment, DfT, 2006.
³ For more detail see Transport demand to 2025 and the economic case for road pricing and investment, DfT, 2006.
Likewise, where scheme specific costs have not been available, as for the strategic modelling of interventions, assessments have been made on the basis of evidence of the costs from real schemes. For example, for strategic road widening, average costs per lane kilometre have been estimated from real strategic road widening schemes, including land costs and optimism bias.

These estimates significantly improve the evidence for this study but as highlighted throughout this volume, for actual funding decisions, there is no substitute for detailed scheme assessment.

Given the long-life nature of transport investments, appraisals must be carried out on the basis of expected travel patterns and demands. Inevitably, looking to the longer term there are uncertainties over the variables that determine travel demands. These uncertainties are likely to impact on the most appropriate timing and scope of an intervention and the funding decision-making process must be robust to the possibility that the future may look different to that projected.

This study has also made use of the returns possible from some private sector investment but because these are privately funded, the BCR as defined is not available. Information on scheme costs, user benefits and, in the case of airports, carbon impacts is available and is discussed.

The metrics discussed are able to tell us a significant amount about the returns on investment. The reason for relying on metrics is to allow a transparent and consistent comparison to be made across the range of interventions for which evidence is available. The information that can be inferred from the analysis in this volume is a strategic assessment of:

- whether there are transport schemes that justify their costs and so provide net economic benefits;
- the nature of economic welfare and GDP returns that are available on transport projects (though some effects are missing); and
- clues as to the types of projects that offer the highest returns, subject to missing benefits, missing projects and limited analysis of packages.

It does not:

- justify proceeding on any individual project – detailed cost-benefit analysis within a robust prioritisation process would be needed; or
- provide any accurate and scheme-specific estimations of the wider economic benefits.

The BCR has been defined to represent the welfare returns per pound of government funds.
Volume 3 set out an analysis of which type of policies are likely to be most effective at meeting the strategic economic challenges facing the UK’s transport system. Volume 4 considers whether changes to the policymaking and delivery chain for transport policy can be made to ensure that it delivers these policies effectively and in a responsive manner, to maximise the impact of public and private investment on the transport sector.

Inevitably, this study can only focus on a small number of issues and can only make high-level recommendations, given their complexity. The five issues covered in this volume are:

- chapter 4.1: How the UK’s approach to national decision making might adapt to meet the challenges facing the transport sector;
- chapter 4.2: How sub-national oversight of transport policy might also adapt to the changing challenges facing the transport sector;
- chapter 4.3: How to ensure that the conditions are right for the bus sector to play an important role in supporting the success of the UK’s growing and congested urban areas;
- chapter 4.4: As the market for infrastructure projects evolves, how best to continue to engage the private sector in successfully delivering value for money through appropriate risk transfer; and

1 The economic challenges facing the UK’s transport system were identified in volume 2.
chapter 4.5: Whether the planning system for major transport projects enables the public and private sectors to bring forward projects aimed at addressing transport bottlenecks, whilst balancing the environmental, economic and social impacts. In light of responses received from stakeholders, this chapter sets out an in-depth analysis of the system and makes detailed recommendations for significant reforms. Further detail on those recommendations can be found in the annex.