



Department
for Transport

Understanding and Valuing the Impacts of Transport Investment:

Latest DfT Technical Research and Next Steps in Transport Appraisal

October 2013

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1. Introduction

1.1 This document explains the latest technical research to support development of the Department for Transport's appraisal framework and methods¹. It sets out the reasons for undertaking the research, the key findings and our responses to them. This report should be read in conjunction with 'Understanding and Valuing the Impacts of Transport Investment', which explains why and how we appraise transport investments and how we plan to engage with stakeholders and experts to ensure consensus over the next phase of developing our appraisal approach. This document focuses on three themes:

- **Economic Growth:** as the Department aims to enable economic growth by maintaining and improving our networks, tackling congestion, crowding, and delay and investing in longer term, large impact and long distance schemes, there is now an increasing need to understand the economic growth impacts of this diverse portfolio. Alongside, developments in evidence, data and computing power have the potential to provide new possibilities for appraising economic growth impacts. In chapter two, we describe our latest research on alternative methods for modelling these impacts.
- **Valuing Journey Improvements:** the rapid increase in the availability and capability of technology while travelling may have changed the potential productivity of travel time and the benefits business and leisure travellers receive from improved connectivity. In chapter three, we set out our latest research into non-work and business values of time savings which include: the technical case for updating our non-work values and whether or not the values and methods used to derive the in-work values of travel time savings remain appropriate.
- **Demand Growth and Benefits in the Long Term:** the increasing focus on larger, longer term strategies and schemes has highlighted the importance of the potentially greater uncertainty in such analysis. In chapter four we describe our expert review into projecting rail scheme benefits in the longer term.

1.2 Furthermore, each chapter sets out our response to the research findings, actions we have already taken and our plans for further work. Finally, chapter five sets out how these plans will fit within the development of a broader Analytical Strategy for our appraisal framework and methods, including engagement with stakeholders and experts.

¹ <http://www.dft.gov.uk/webtag/>

2. Economic Growth - Understanding Economic Growth Impacts

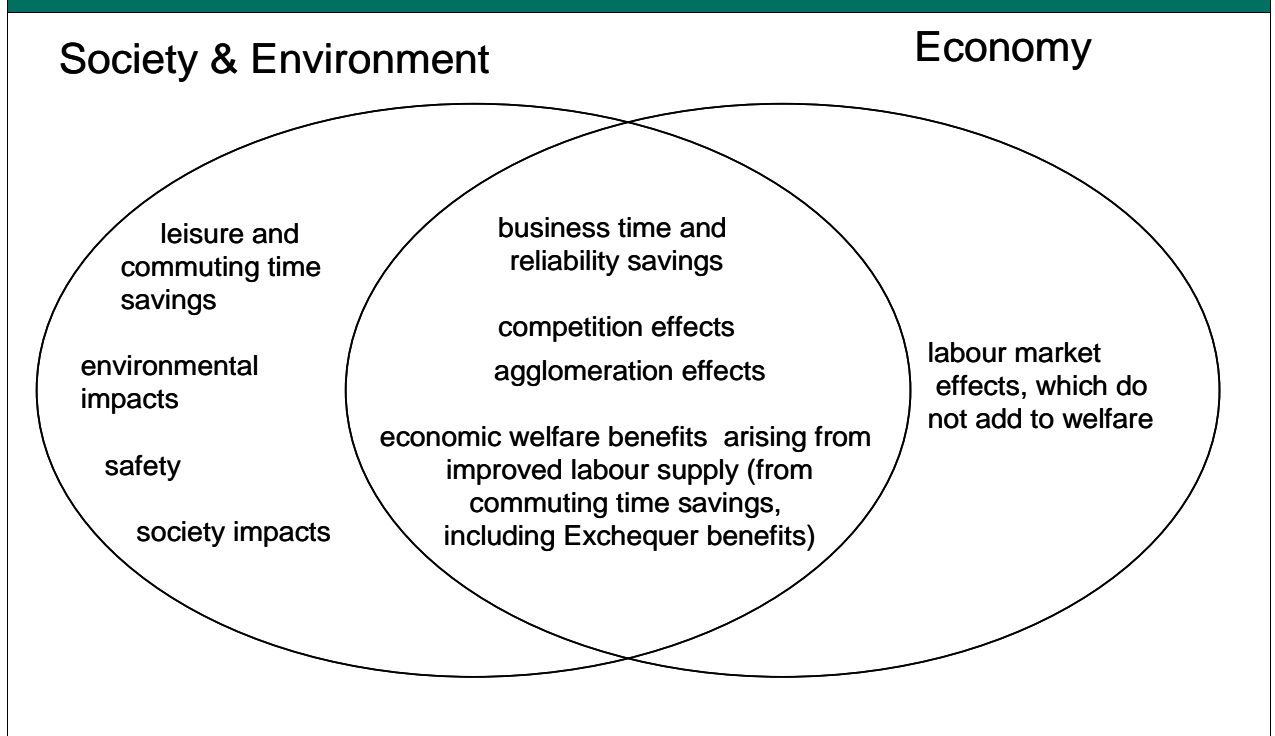
Background

- 2.1** The Department for Transport recognises the important role of transport in enabling economic growth. It is therefore taking investment in transport to record levels, including major upgrades of the road network, modernising the rail network, and improving local transport.
- 2.2** To ensure that transport investment supports economic growth, as part of the wide range of benefits that transport can deliver, there is a need to have modelling and appraisal methods in place that can be used to analyse and appraise the economic growth impacts.
- 2.3** Some of the ways in which transport can support economic growth are clear. Improved connectivity, particularly in urban areas, can increase the effectiveness of business clusters and result in increasing productivity and growth. It can also affect labour markets as reduced commuting costs can encourage more people to enter the labour market and/or to travel further afield to find jobs that better match their skills. This is also a spatial component to the economic impact of transport schemes as improved connectivity can affect where businesses choose to locate, potentially generating significant benefits at a sub-national or regional level.
- 2.4** The Department has led a long term programme of research to improve understanding and estimation of the impacts of transport proposals for economic growth and has a good evidence base to build on for appraisal of economic growth impacts.
- 2.5** There is now an increasing need to estimate the expected economic growth impacts of transport proposals, to ensure the right analysis is in place to support the Department's major programme of investment in transport. Developments in evidence, data and computing power have the potential to provide new possibilities for understanding and valuing the economic growth impacts. Therefore, the Department is continuing to make further progress to enhance and build upon the analytical work and guidance in this area that has been developed and implemented over many years.

Understanding and Valuing Economic Growth Impacts

- 2.6** A key contribution to understanding the linkages between transport and economic growth was made, in 1999, by the SACTRA Committee. SACTRA concluded that conventional transport modelling and appraisal methods should provide the foundation for the economic appraisal of transport schemes but there were circumstances in which market imperfections would mean that transport user benefits would not capture the full effects of transport investment.
- 2.7** Following this, the Department developed, over several years, methods to estimate journey time reliability impacts and "Wider Economic Benefits" (now referred to as "Wider Impacts") which are the economic impacts associated with agglomeration, imperfect competition and the labour market. The 2005 discussion paper, "Transport, Wider Economic Benefits and Impacts on GDP" describes how the different impacts contribute to growth and the methods to capture them. Figure 2.1 illustrates the overlap between social, environmental and economic impacts.

Figure 2.1 - Overlap between social, environmental and economic impacts



- 2.8** During the development of methods for estimating agglomeration impacts, research for the Department attempted to capture the causal impact on productivity of reducing the "effective distance" between businesses. This involved development of econometric methods that used different statistical estimators and production function specifications (Graham et al, 2009). Using this evidence, the Department developed

guidance² on application of these methods to measure wider impacts, and these are now routinely used in appraisal.

2.9 The Wider Impacts, set out in the Department's guidance, are:

- Agglomeration impacts: increases in productivity resulting from higher densities of employment;
- Increased output in imperfectly competitive markets: the increase in production expected to result from transport improvements; and
- Labour market impacts: the effects of more people working and/or moving to more productive jobs (the increase in productivity resulting from jobs relocating into higher productivity areas).

2.10 The Department's response to SACTRA also included work to further develop Land Use Transport Interaction modelling, which can be used to estimate the impact of transport on the pattern of land use. The Department decided, at that time, against the recommendations from SACTRA for developing Spatial Computable General Equilibrium methods (intended to provide a comprehensive model of the economy) identifying the high cost of collecting the data required, and the limitations of the data then available.

2.11 The Department also developed, in response to the SACTRA report, guidance on the regeneration impacts of a transport scheme, so that the impact on jobs created or supported in designated regeneration areas could be estimated. Guidance includes details of how to prepare a Regeneration Report, which estimates numbers of jobs dependent on the transport intervention.

2.12 The Department recognises that the evidence regarding the Wider Impacts of transport, and the methods for estimating these impacts, continues to evolve and will continue to monitor and develop guidance as the evidence base increases.

2.13 In 2006, HM Treasury and the Department commissioned the Eddington Report to review transport's role in productivity and competitiveness. The report supported the Department's appraisal methods, including the development of methods to include Wider Economic Benefits.

2.14 More recently, the Department commissioned the Institute for Transport Studies, University of Leeds (referred to as ITS Leeds), to undertake a review of international transport appraisal practice (ITS Leeds, 2013a). This review found that the methods the Department has developed to capture "wider economic impacts" are now being adopted in other countries around the world.

2.15 The Department recognises that there are alternative methods to estimating economic impacts, such as those described by the SACTRA³

² See WebTAG Guidance link: www.dft.gov.uk/webtag/documents/expert/pdf/U3_5_14-wider-impacts120723.pdf)

³ In paragraph 2.9

report. None of these alternative methods have been developed as part of a comprehensive framework which includes economic, environmental and social impacts, so they can be difficult to fit within the economic case. However, they could potentially provide estimates of economic growth and jobs, which could be useful to consider alongside the broader framework used in WebTAG. In particular they can provide greater insight into how the impacts on the economy can vary between regions and illustrate more vividly how the overall economic impacts are transmitted through the economy.

- 2.16** There is also some evidence from surveys of businesses to suggest that the quality of transport infrastructure can be an important consideration in the decisions they make regarding foreign direct investment. However, there is a need for more development of evidence and methods before this effect could be estimated and included in transport appraisals.
- 2.17** The SACTRA report also identified the possibility of specialisation effects that could result from businesses relocating to where they are more productive (in line with comparative advantage), bringing benefits of higher productivity. Research on this effect has tended to be in the context of trade between countries. It is possible that the same effect could be generated from increased trade, resulting from improved transport links between regions or local area. However, there has been less research into this, and there is less data to empirically test for this effect.

Recent research for the Department for Transport

- 2.18** Although extensive research has been undertaken in this area, by the Department and others, estimates of the spatial economic impacts are less well developed than many other aspects of transport modelling and appraisal. The Department's review of international transport appraisal practice (ITS Leeds, 2013a) identified that this topic has shown the greatest pace of development in recent years, but noted "absence of a widely accepted and codified evidence based method of estimating these effects".
- 2.19** In response to these developments, the Department commissioned a review of methods for modelling of sub-national economic impacts of transport (MVA and ITS Leeds, 2013). The remit of the review was to:
- identify the various methods that could be used to assess the sub-national, regional and economic impacts of transport proposals;
 - develop a set of criteria that could be applied to assess these methods;
 - assess the suitability, strengths and weaknesses of the methods; and
 - provide recommendations for further research to develop these methods

Review of developing methods

- 2.20** The review identified four broad groups of methods and proceeded to develop a set of criteria to assess the different approaches. These are described in Box 2.1 below. The main differences between the methods reviewed lie in the means whereby the method links improvements in accessibility with increases in economic activity and productivity.

Box 2.1 - Methods and criteria for modelling sub-national, regional and economic impacts

The study identified four broad groups of approaches:

Survey-based approaches which rely on estimates of the changes to the local economy using data on local firms; the role of transport in their business; and how the change in transport provision may impact on performance, and the opportunities that brought about by the increase in competition made possible by the reduction in transport costs.

Land Use and Transport Interaction (LUTI) models, which involve modelling the changes in land use that follow from a transport scheme.

Methods based on the link between **connectivity, productivity and employment density**; using evidence of how increased transport connectivity is correlated with increased productivity and employment density.

Comprehensive models of the economy, extending from firms and employees to households as consumers, and as suppliers of labour and, in some versions, as providers of land and capital.

Based on a review of literature and evidence, a set of criteria was developed that could be applied to assess whether specific methods would meet the Department's requirements for estimating the sub-national, regional and local economic impacts of transport interventions.

These criteria included: consistency with economic theory; impacts and assumptions supported by empirical evidence; consideration of the spatial distribution of impacts, including localities that are disadvantaged as well as those that gain; the use and availability of relevant data; dependency of impacts on other factors; implementability; proportionality; and the appropriateness of the metrics produced.

- 2.21** The review concluded that:

- no single method was identified that could be widely used in its current form to estimate local or regional economic impacts;

- all of the existing methods have strengths and weaknesses, and there is currently no single method which could be consistently applied across all scheme types;
- some methods are better suited to addressing specific questions than others, and are capable of providing information that can be useful for informing decision making; and
- the methods could be further adapted and developed to more closely meet requirements for assessing the sub-national, regional and local economic impacts of transport schemes. The choice of the appropriate approach to use, and identification of how the method should be further developed, will depend to a large extent on the specific questions that need to be considered.

2.22 The research described so far in this chapter focuses on the impacts of domestic transport schemes. However, the Department is also working to better understand the potential economic impacts of transport interventions which affect the UK's international connectivity. The Department commissioned research published in 2010 (NERA, 2010), to consider whether wider impacts related to international business are adequately reflected in existing transport appraisal. The research suggested there could be some indirect impacts specifically relevant to the international context. These include:

- agglomeration impacts through significant international relocation of firms;
- increased output in imperfectly competitive markets: relevance to imports, where domestic firms reduce prices in response to increased competition;
- labour market impacts: indirect impacts from cross-border labour; and
- productivity gains associated with newly exporting firms and changes to levels of unemployment from tourism.

Summary of responses, actions and next steps

2.23 The Department agrees with the conclusions from the MVA/ITS review. In light of this, and the increased need to estimate the economic impacts of transport proposals, we are planning a programme of further work and research to ensure our appraisal framework keeps pace with emerging challenges and opportunities, and to better enable the methods needed to estimate economic impacts.

2.24 We will engage with stakeholders and the academic community on the technical and practical challenges to be overcome and the feasibility of so doing.

2.25 This programme will involve the following:

Changes to Department for Transport guidance

- As part of the release of restructured guidance, which will replace existing guidance in early 2014, we are providing clearer guidance on how Wider Impacts and regeneration impacts should be appraised and reported in scheme business cases.
- We will develop guidance on estimating the impacts of transport on the location of economic activity.

Renewing our understanding of economic growth impacts

- We will undertake a comprehensive survey of the latest theoretical and empirical evidence for the potential growth impacts of nationally significant infrastructure and programmes of expenditure.
- We will use the findings from this survey to decide how we should take forward this agenda to develop our appraisal techniques in this cutting edge area.

Longer Term Analysis and Research

- We will implement a programme of research to further develop methods for estimating the impact on productivity and economic geography of changes in transport connectivity. A key issue to address will be evidence on the extent of causality between changes in transport connectivity and measures of economic impacts such as productivity and employment density.
- We will make further progress with the application of Land Use Transport Interaction (LUTI) modelling to estimate economic impacts. This will include examining how estimation of land use changes can be considered in a way that is consistent with the transport models used in transport appraisals.
- We will implement a feasibility study into the development of a Spatial Computable General Equilibrium (SCGE) approach that can be used to estimate economic impacts of transport. In theory, the SCGE approach provides the most comprehensive framework for modelling these impacts. However, such models also have very high technical complexity, and data requirements, that have posed problems in the development and use of this type of modelling approach. Therefore, the feasibility study would inform a decision regarding whether to progress further in development of an SCGE modelling approach.
- We will implement a programme of evaluation of the economic impacts of transport schemes. The Department has recently published a new monitoring and evaluation strategy, which sets out the Department's commitment to evaluation⁴.

2.26 Some aspects of this programme of work are aimed at establishing an approach that can be widely applied in a way that is proportionate to the

⁴ <https://www.gov.uk/government/publications/dft-monitoring-and-evaluation-programme-2013>

cost and scale of the transport scheme proposal that is being considered. Other aspects of the programme of work are aimed at developing methods that will mainly be appropriate for application to larger schemes. While providing a high level of technical challenge, this further work is aimed at significantly developing the evidence base for estimation of these spatial economic impacts.

- 2.27** Our work on international economic impacts will, in the first instance, need to consider any new analysis or research undertaken by the independent Airports Commission⁵, which was established to examine the need for additional capacity in the UK and provide recommendations on how this should be met. As part of this remit, the Airports Commission is considering the economic impacts of potential changes in aviation connectivity, and it has published a discussion paper on this topic (Airports Commission, 2013). Its interim report is due to be published before the end of 2013, with its final report in summer 2015. Following publication, the Department will review any research undertaken as part of the Airports Commission's work, and use it to inform our appraisal evidence base.

Analytical Strategy and Engagement plan - Economic Growth

- 2.28** Developing the appraisal tools to understand the economic growth impacts of transport schemes will form a key component of our analytical strategy. The development of the analytical strategy and engagement plan is set out in chapter 4 of the high level document 'Understanding and Valuing the Impacts of Transport Investment'.

⁵ <https://www.gov.uk/government/organisations/airports-commission>

3. Valuing Journey Improvements - The Value of Travel Time Savings

Background

- 3.1** It is some time since the Department settled on its current approach to deriving values of travel time savings. Over this time period incomes and lifestyles have changed and the increased availability and capability of technology while travelling has increased the potential productivity of travel time, potentially affecting the way business and leisure travellers benefit from improved connectivity. The following sets out our latest research into non-work and business values of time savings, considering the: technical case for updating the non work values; and advice on whether or not the values and methods used to derive the in-work values of travel time savings remain appropriate.

The economic impacts of improved connectivity for non-work travel

- 3.2** The majority of travel takes place during people's own time, not during the course of work. Therefore, it is important that the Department understands the impact that proposed transport schemes would have on individuals travelling in their own time.
- 3.3** Individuals will respond to reduced journey cost in different ways. For example, in response to a quicker commute, some people might choose to use the saved time to get up later and spend more time at home in the evenings, while others could decide that the quicker commute gives them the opportunity to move to a larger house further from where they work. Regardless of the response, the benefit of improved connectivity from reduced journey costs needs to include an estimate of the willingness-to-pay for travel time savings.
- 3.4** The Department's values of individuals' willingness-to-pay for travel time savings in their own time have, for many years, been derived from evidence from 'stated preference' surveys, which present respondents with realistic hypothetical choices. This approach, and the application of the values to calculate the benefits of improved connectivity for non-work travel, were reviewed in the "Transport and the Economy" report (SACTRA, 1999). SACTRA endorsed the approach but noted that evidence behind the then current values, and on how they increase over time with income, was growing old. Both of these issues were addressed

following further research (ITS Leeds, 2003), which forms the basis of the values recommended today in the Department's appraisal guidance.

Recent research for the Department for Transport on non-work travel

- 3.5** The evidence base is, once again, becoming old and several developments (the type of projects to be modelled and appraised, improvements in in-vehicle technology and advances in data and analytical methods), have led the Department to review whether these values are still reasonable and whether they should be updated. This took the form of a series of research projects to:
- consider the technical case for updating the values;
 - understand better the range of uncertainty around the values; and
 - examine whether the expected growth in values assumed in our guidance matches with more recent estimates of non-work values of travel time savings.

The technical case for updating values for non-work journeys

- 3.6** The first of these studies (ITS Leeds, 2010) was commissioned to scope the research activities that would be required to update the values for non-work travel time savings and to make recommendations about which elements should be taken forward. The study concluded there is a strong case for updating the values based on:
- the age of the survey evidence underlying the current values;
 - developments in travel behaviour, policy questions and analytical methods since the last national study; and
 - the potential to investigate factors such as values for reliability consistently with values of travel time savings.
- 3.7** The study then set out a proposed research programme, based around a 'core' element to update the values for car travellers, which form the basis of the current values, with additional modules to investigate 'areas of concern', such as values of reliability and values for freight.
- 3.8** This programme would be a significant undertaking so, before commencing a national study, the Department commissioned the two further pieces of research listed above to better understand the case for updating these values; the uncertainty associated with the current values; and how they compare with recent evidence from other sources.

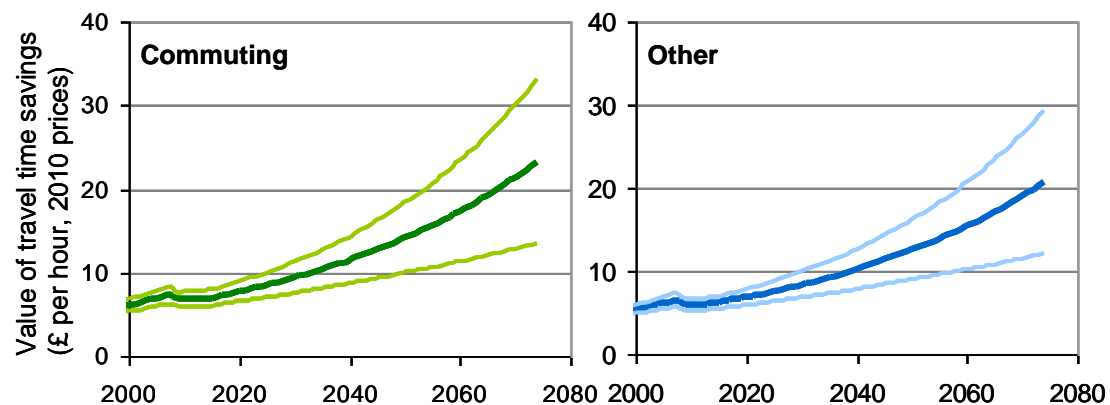
Understanding the range of uncertainty around the values for non-work journeys

- 3.9** This study (ITS Leeds, 2012) estimated a range around the values based on the level of statistical confidence in the values of travel time savings. This looked at the uncertainty around (i) the base year estimate, and (ii) how that uncertainty changes over time, assuming there is no fundamental shift in people's preferences over time. This research has

greatly increased the Department's understanding about the levels of uncertainty around these key values and the factors which affect that level of uncertainty.

- 3.10** Figure 3.1 shows the results from this research, represented as the 95% confidence interval around the central values for commuting and other non-work journey purposes. Transport investments are typically appraised over a 60-year period and the range widens significantly over that period. This is because the uncertainty is primarily driven by the relationship between GDP growth and growth in the values over time. As GDP increases over time, the level of uncertainty widens.

Figure 3.1 - Uncertainty range around values of travel time savings for commuting and other non-work journey purposes



These charts differ from those in the final report as they use 2013 GDP forecasts and updates to the values and how they grow with income over time introduced in WebTAG Unit 3.5.6 in October 2013.

- 3.11** Applying the profile of upper and lower bound values shown in Figure 3.1 to scheme appraisals resulted in an approximately +/-25% impact on the benefits from travel time savings.

Investigating how the growth of values for non-work journeys over time compares with our appraisal guidance

- 3.12** While the research on statistical confidence explored the uncertainty associated with the values of travel time savings, it did not look at whether socio-economic or technological changes since the values were originally estimated had lead to fundamental shifts in individuals' willingness-to-pay for travel time savings. ITS Leeds (ITS Leeds, 2013b) were commissioned to investigate this using evidence from their meta-dataset, which contains more than a thousand values of travel time savings from hundreds of studies spanning almost 50 years.

- 3.13** This work looked at two key questions: (i) is there evidence that the GDP/capita elasticity (the relationship between income growth and growth in the values over time) has changed from the 0.8 recommended in guidance; and (ii) whether the growth in the values implied by this relationship matches with the most recent estimates, or if there has been some fundamental change not picked up by the GDP/capita elasticity.

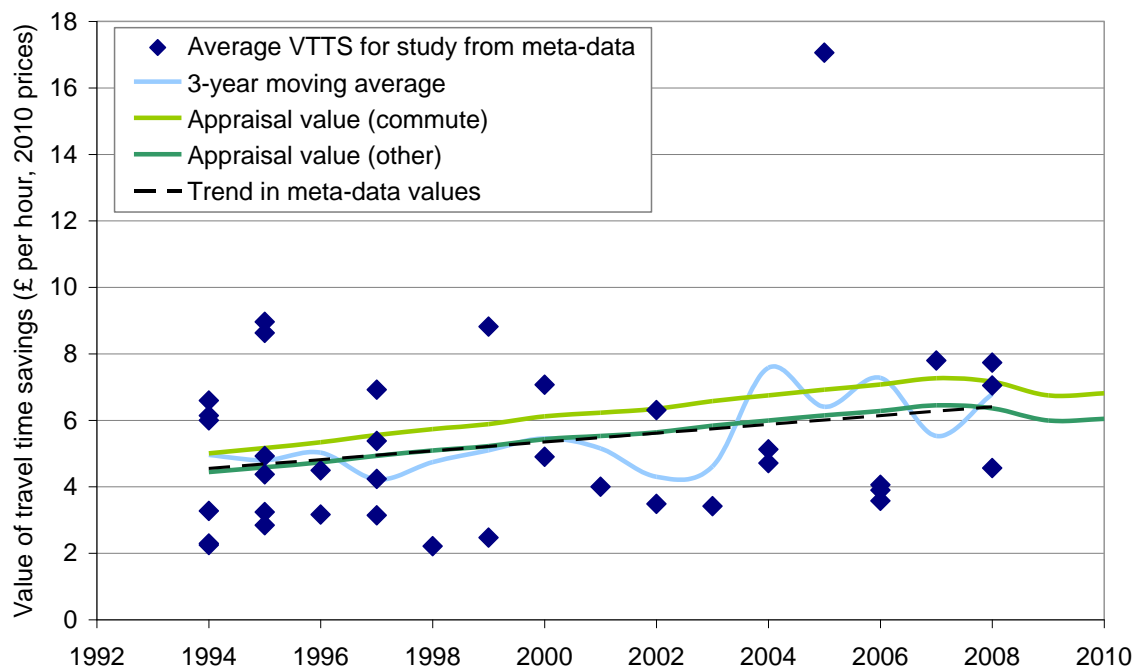
Relationship with GDP growth

- 3.14** Individuals' willingness-to-pay for travel time savings will, all else equal, increase with income and meta-analysis of ITS Leeds' dataset forms the basis of the relationship between GDP growth and growth in the values over time recommended in guidance. A previous version of this analysis (Wardman, 2004) found an elasticity for in-vehicle time of 0.82, which formed the basis of recommendations in guidance.
- 3.15** While this particular study focused on a sub-sample and did not re-estimate the elasticity, the most recent analysis of the whole dataset (Abrantes and Wardman, 2010) found that the values grow more strongly over time than has previously been assumed: the in-vehicle time elasticity increased to 1.0.

Growth in values of travel time savings

- 3.16** Figure 3.2 re-produces one of the key charts from this study, focusing on evidence of values of travel time savings for car, because they form the basis of the values recommended in guidance, and comparing them with the values recommended in WebTAG guidance.

Figure 3.2 - Values of travel time savings for car from ITS Leeds meta-dataset compared with appraisal values from 1994 to 2010



The chart differs from the equivalent chart in the final report as it includes ONS revisions to historic GDP data and updates to the values and how they grow with income over time introduced in WebTAG Unit 3.5.6 in October 2013.

3.17 The chart clearly shows a wide range of values resulting from different studies. However, it also shows that the appraisal values for 1994, when surveys underlying the current values were carried out, correspond closely to other evidence from that time. There is also an upward trend in the average values from other studies over the period analysed, which is closely reflected in the increase in the appraisal values.

Our response to non-work travel research

3.18 To reflect the uncertainty in the values a +/-25% sensitivity test around the non-work value of time has been introduced in guidance, improving how the uncertainty around the benefits of improved connectivity are represented when proposed transport schemes are appraised.

3.19 Further, the in-vehicle time elasticity has been increased from 0.8 to 1.0 in the guidance reflecting the latest meta analysis evidence.

3.20 Taking together all the evidence set out above, the Department concludes that:

- the data underlying the values of non-work travel time savings are old, and there is a degree of uncertainty around the values that needs to be reflected in appraisal results;

- the values for non-work travel time savings are still reasonable to use in appraisal work, especially in conjunction with improved information on the range of uncertainty; but
- there is remaining uncertainty around the values as our research could not include evidence beyond 2008.

3.21 Therefore, we accept the recommendation that the non-work values for travel time savings should be updated and will be taking this forward as part of our ongoing work programme.

The economic impacts of improved connectivity for business travel

3.22 Transport costs form part of the costs of most goods and service. The primary mechanism through which transport investments affects growth is by reducing transport costs, which reduces the costs of production and increases productivity. Businesses will benefit from transport schemes which reduce these transport costs and improve their connectivity. Ultimately, the benefits to businesses of improved connectivity could take the form of improved access to:

- suppliers, increasing productivity by lowering the cost or raising the quality of inputs; or
- customers, by widening the market which a business can serve.

3.23 Depending on market conditions, this will result in some combination of increased output, lower prices for consumers, higher wages for employees or higher profits for the business and will be distributed across the sectors and regions of the economy. Regardless of the response, the benefit of improved connectivity from reduced journey costs needs to include an estimate of businesses' willingness-to-pay for travel time savings because journey time forms part of costs for business travellers.

The current approach for estimating business willingness-to-pay for time savings.

3.24 There are many real world situations where business travellers choose to pay more for a quicker journey when a cheaper, slower alternative is available. For example, surveys found that around one third of M6 toll road users are travelling on employers' business, compared with 5% of car trips on average nationally, and business users stated that saving time compared to alternative routes was their main reason for using the toll road.

3.25 Market prices are often used to represent willingness-to-pay in cost-benefit analysis. However, although examples exist where travellers trade travel time for cost, market prices for travel time are not easily obtainable and, in the absence of market prices, alternative techniques are required to estimate willingness-to-pay. There are a range of approaches available and, while the techniques, assumptions and

resulting values vary, all of the methods aim to estimate values that effectively proxy for willingness-to-pay.

3.26 Revealed preference evidence is the most direct way to estimate willingness-to-pay and is based on actual business traveller behaviour (for example, surveys of users of the M6 toll road and alternative routes). However, it is difficult to collect revealed preference data of sufficient quality and quantity to estimate robust values and provide the detail needed to fully populate a framework of values. In the absence of revealed preference evidence of sufficient quality, it is necessary to use alternative methods and techniques to estimate values.

3.27 The Department uses an economic theory-based approach, primarily based on distance-weighted average hourly incomes of business travellers.

3.28 We have improved our understanding of the assumptions about travellers' use of time this approach requires. It has previously been suggested that this assumes that travellers do not work whilst travelling. That assumption is consistent with this approach but is not necessary for it. The method assumes that while some proportion of a trip may be used for productive work, there is also a proportion of the journey which is not used productively. It is then assumed that quicker journeys reduce this unproductive travel time and allow more time to be put to productive use. This is illustrated by an example given in Box 3.1 below.

3.29 This approach approximates businesses' willingness-to-pay for time savings, which captures the complexity of the motivations for business travel, such as the value of extra time at the destination (i.e. extra meetings, more time to seal the deal), the level of productivity that can be achieved whilst travelling, the impact of crowding on productivity, the type of work that can be undertaken during travelling and the value of not having to plan an over night stay.

Box 3.1 - An example of how a travel time saving is used productively

A person is travelling by train on a business trip from Reading to Plymouth. The total trip length is around 3 hours. They need to complete the presentation that they are going to give in Plymouth on their laptop, which takes them approximately 1.5 hours. They then check and clear their work email, which takes another half an hour. In the remaining hour, they catch up with the news and email their friends on their smart phone. Following a transport improvement, the trip length is reduced to around 2.5 hours. In this case, the person still needs to complete their presentation and deal with their work emails. But this leaves them less time to browse the internet and chat with friends. The half hour time saving reduces the unproductive part of their travel time, allowing that to be put to more productive use at their destination.

Recent research for the Department for Transport on business travel

3.30 Since the introduction of this method there have been significant advancements in the availability and capability of technology while travelling. These have increased the potential productivity of travel time, potentially affecting the way in which businesses benefit from improved connectivity.

Review of the Evidence for Business Values

3.31 To consider the implications of these changes for our approach, the Department commissioned research (ITS Leeds, 2013c) to look at the evidence for valuing in-work travel time. This study included reviews of:

- the feasibility and theoretical accuracy of different methods;
- international practice in valuing travel time savings; and
- evidence from the UK and abroad of values resulting from the different methods.

3.32 Box 3.2 sets out the approaches considered by ITS Leeds' research.

Box 3.2 - Methods for estimating values of in-work travel time savings

Revealed preference methods elicit values from actual behaviour, for example from surveys of individuals' real-world travel choices or data on choices between modes or routes. Revealed preference arguably gives the best estimate of willingness-to-pay as it is most closely based on actual behaviour. However, the reality of dealing with data from such "natural experiments" mean it is often not of sufficient quality, or available in sufficient quantity, to estimate values robustly.

Stated preference methods derive values from responses to surveys which present choices between realistic, plausible hypothetical options. A key advantage of this approach is that surveys can be designed to produce data that lends itself well to estimating values.

The Cost Saving Approach, the Department's current approach, which is discussed above, based on business travellers' labour costs.

The Hensher (or Modified Cost Saving) Approach, as the name suggests, builds on the Cost Saving Approach with explicit assumptions about how saved travel time would be used both with and without the proposed transport scheme.

International practice in valuing in-work travel time savings

3.33 The ITS Leeds study found that the approach used by the Department dominates international practice in valuing in-work travel time savings. Of

the ten European countries that have national guidelines for transport appraisal the Cost Saving Approach is used in the UK, Denmark, Finland, France, Germany, Ireland and Norway. Outside of Europe, the approach is also used in the USA, Australia and New Zealand and recommended by international institutions including the World Bank, European Investment Bank and European Commission.

- 3.34** Of the countries and organisations reviewed, only the Netherlands, Sweden and Switzerland use alternative approaches. The Netherlands and Sweden both use a restricted version of the Hensher approach and Switzerland is unique in deriving values for in-work travel time savings by factoring up the values for non-work travel with evidence from international studies.

Recommendations from the review of evidence for Business Values

- 3.35** ITS Leeds concluded that:

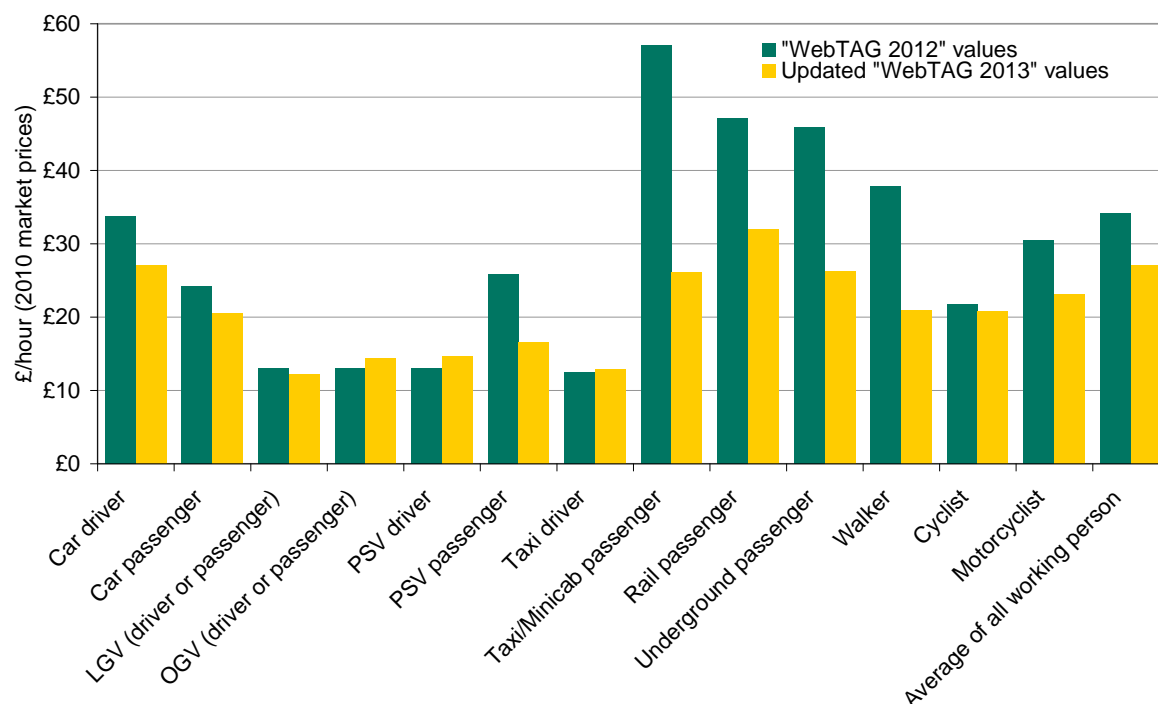
- The current approach does not mean the Department's values are inflated. This is because there are many factors that affect business willingness-to-pay for time savings as discussed above. They also noted that factors such as the relative value of work while travelling, at the normal place of work and at a trip's destination; and the potential for quicker journeys to reduce the costs associated with long working days mean willingness-to-pay for in-work travel time savings could be greater than values from the Department's approach.
- In the short term, the values from the Department's current approach should be updated with the latest available data and suggested some methodological improvements to how the values are calculated. ITS Leeds also put forward a range of longer term research options to look at alternative approaches to valuing business travel time savings.
- The ITS Leeds study also specified a range of sensitivity tests, based on the evidence reviewed, to represent values that might result from the different valuation approaches.

Our response to business travel research

Update of Business Values of Time

- 3.36** The Department accepts the ITS Leeds short term recommendation to update the current approach with the latest data and some methodological improvements and has released updated values for in-work travel time savings in WebTAG guidance. As Figure 3.3 below illustrates, this has reduced business values of time by around 20% for car and 33% for rail.

Figure 3.3 - WebTAG Business Values of Travel Time Savings



Source: WebTAG unit 3.5.6D, October 2013

Ranges around business values

3.37 Based on the sensitivity tests recommended by ITS Leeds, and the range of values from the evidence review described below, the Department has also introduced in WebTAG guidance a sensitivity testing range of +/-25% of the updated values.

Evidence Review and the Validation of updated values

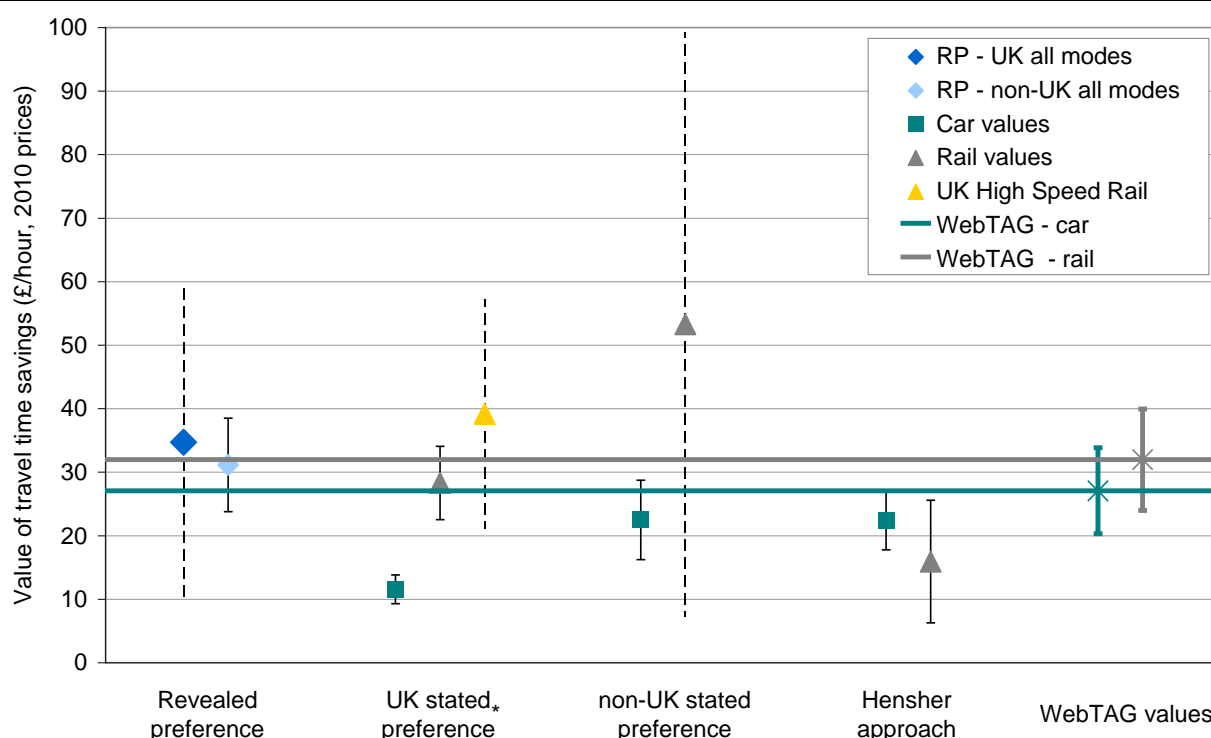
3.38 ITS Leeds also recommended that in the longer term we look at alternative methods for estimating business values such as those set out in Box 3.2. We have taken an important first step towards this using the evidence available now we have looked at alternative methods to develop our ranges and to validate our updated values.

3.39 Figure 3.4 provides the Department's interpretation of the current evidence base, based on ITS Leeds' review of UK and international evidence of values of in-work travel time savings resulting from different valuation approaches. The chart shows the average of values resulting from studies using each approach and distinguishes between values from UK and other European evidence. Ranges are also shown, representing the uncertainty around the average of the values resulting from the studies reviewed.

- 3.40** Revealed preference values are shown for all modes of transport combined, as the limited evidence does not allow a distinction to be made between modes. However, for the other approaches values are shown for car and rail users. ITS Leeds also reviewed evidence specifically relevant to high speed rail and a sample of the studies most relevant to the UK domestic high speed rail market is included in the chart.
- 3.41** The horizontal lines in the chart show the values of in-work travel time savings for car drivers and rail passengers as a result of the recommended update. The range around the Department's values in the chart shows the +/-25% sensitivity test, which is based on based on ITS Leeds' recommendation and an assessment of the evidence base⁶.

⁶ Both the values and sensitivity test range are taken from the "In draft" version of WebTAG Unit 3.5.6 released in October 2013.

Figure 3.4 Values of travel time savings for car and rail business travellers resulting from different valuation approaches



1. The solid line error bars represent robustly calculated confidence intervals. The dotted lines are indicative representations of potential variability as the sample sizes are not sufficient to support calculation of formal confidence intervals.

2. Revealed preference data are taken directly from the ITS report, with the ranges based on the reported standard errors.

3. The Stated preference data for UK car and non-UK rail and car are derived by pooling the urban and inter-urban “valued” data from the ITS report. The mean values have been calculated on a travel time-weighted average basis, with 2008-10 National Travel Survey data, with the ranges calculated as the weighted average standard error. The SP data for UK rail are based on the mean and standard errors reported for inter-urban rail “valued” due to the very small number of UK urban rail studies.

4. The High Speed Rail values are based on the 3 reports covered by ITS Leeds most relevant to the UK domestic HSR market: Bates (2012), Atkins (2009) and SDG (2002). The range is based on the standard error of the mean of 5 values from these studies, meaning the sample is too small to be considered a robust, formal confidence interval.

5. The Hensher approach values are calculated using the parameters included in the ITS report and the values shown in Figure 3.3. The range represents the range of parameter values recommended in sensitivity testing in ITS Leeds’ report.

6. The WebTAG values have been calculated with data from the 2008-2010 National Travel Survey, 2009 Labour Force Survey and 2008 Labour Cost Survey. The range around them represents the +/-25% sensitivity testing recommended in the Department's appraisal guidance.

* ITS Leeds’ report raised concerns over the approach taken in many UK Stated Preference studies to explaining how company travel policy should be considered and who should be assumed to pay for, and benefit from, travel time savings. There is therefore a concern that the values could reflect more personal, than business valuation, likely leading to a downward bias in the values shown in the chart.

Sources: Valuation of travel time savings for business travellers, ITS Leeds, 2013; and DfT analysis

3.42 Figure 3.4 shows that there are a wide range of values and wide ranges around them. However, it is possible to draw some broad conclusions that:

- The values recommended in WebTAG are broadly centred on the revealed preference evidence of business travellers' willingness-to-pay for travel time savings.
- The WebTAG values for rail business passengers are also within the range of stated preference evidence, both from the UK and abroad.
- The WebTAG values for car business travel time savings are within the range of the European stated preference evidence but significantly greater than the UK evidence. ITS Leeds noted that it was often not explicit in UK stated preference surveys what respondents should assume about who would pay for, and benefit from, travel time savings. Therefore, it is possible that these represent personal valuations, rather than what the business would be willing to pay to save travel time, resulting in lower values. This could equally apply to the stated preference values for rail, as well as those for car.
- Stated preference evidence shows that business travellers on rail are generally willing to pay more for travel time savings than those travelling by car. This is at odds with results from the Hensher approach, suggesting that the ability to work while travelling might not be the key factor in how businesses value travel time savings. Rather, the benefit from reduced journey times and improved connectivity is likely to depend on the value of additional activities that travel time savings allow businesses to undertake.
- The evidence reviewed by ITS Leeds also suggests that values of travel time savings for business travel increase with trip distance, similarly to the values for non-work travel. As high speed rail trips will tend to be longer than those by classic rail, this may explain why the high speed rail specific evidence reviewed by ITS Leeds suggests higher values than for classic rail.

Conclusions from the Evidence Review

3.43 Taking into account our updates to values, our introduction of ranges into guidance and the review of evidence which has validated our results against the existing evidence base, the Department considers the updated values to be reasonable for use in informing decision making.

3.44 Nonetheless, the Department also recognises the value of drawing on multiple sources of evidence when developing values for business time savings, as suggested by the range of research options put forward by ITS Leeds. While the existing evidence has been useful to validate our updated values and inform the size of the range, we recognise that there is a high degree of uncertainty around the results of all the various approaches to measuring business values. As our aim is to reduce the level of uncertainty around the values that we use in appraisal the Department plans to collect fresh revealed and stated preference

evidence for business travellers' willingness-to-pay for travel time savings.

Summary of responses, actions and next steps

3.45 We have accepted the recommendation to update the values of non-work and business time savings with the latest data and to introduce sensitivity tests around both the non-work and business values. We have implemented these in our guidance.

3.46 We have updated the data underpinning, and improved our understanding of the assumptions implicit in, our approach to valuing business time savings. We have also validated our results against the existing evidence base. On this basis the Department considers the updated values to be reasonable for use in informing decision making based on the current evidence base.

3.47 Nonetheless, the Department accepts the recommendations to further develop the evidence base for both non-work and business time, namely those recommendations in the non-work review to undertake fresh data collection, and the value of the alternative business time savings approaches put forward by ITS Leeds. The Department therefore plans to collect fresh revealed and stated preference evidence of both non-work and business travellers' willingness-to-pay.

3.48 Before beginning this research, the Department will engage with stakeholders in the academic and transport practitioner communities. This will inform the final specification of the research, helping to ensure that the research is focused on answering the key questions, which might include:

- The relative strengths and weaknesses of the different approaches to estimating willingness-to-pay for business time savings.
- What are the best methods for structuring and carrying out stated preference surveys?
- What alternatives are available to traditional survey methods?
- How do the values vary with trip distance and the size of the time saving?
- Do the values vary by mode of transport?
- Should factors such as values for reliability and crowding, which are linked to values of travel time savings, be included in the study?

Analytical Strategy and Engagement plan - Valuing journey improvements

3.49 The next steps outlined above will form part of our Analytical Strategy which is set out in chapter 4 of the high level document 'Understanding and Valuing the Impacts of Transport Investment'. This includes our engagement plan and proposals to respond to the challenge of better

understanding economic growth impacts by considering the extent to which we use differentiated values of time savings.

4. Demand Growth and Benefits in the Long Term

Background

- 4.1** Transport decisions can have long-lasting effects on our society, economy and environment because much of transport investment is for the long term. Infrastructure can have a very long lifetime when maintained and renewed and it has always been necessary to take a long term perspective on transport investment. However, this requirement is becoming increasingly important with the growing need to understand and value the impacts of larger and longer term transport schemes.
- 4.2** Key analytical issues that arise from taking the long term perspective are:
- how best to forecast transport demand and the impacts of options into the long term; and
 - how to handle the inherent forecast uncertainty.
- 4.3** This chapter describes our current approach to these key analytical issues, recent Department research into demand and benefits forecasts in rail and our plans for development.

Demand Growth

- 4.4** There is, unavoidably, uncertainty in future forecasts. This makes demand and scheme benefits harder to predict the further in the future we go. For example, assumptions about rail capacity improvements in the more distant future and whether demand is expected to grow indefinitely, particularly where there is minimal investment in capacity ('market maturity' or 'market saturation').
- 4.5** Our appraisal guidance recommends that benefits are extrapolated beyond the final modelled year in an evidence-based manner, on a scheme-by-scheme basis. The guidance suggests that further growth in the magnitude of benefits (in their natural units rather than monetary values, e.g. the change in tonnes of carbon emitted) will largely be driven by the growth in usage. A core sensitivity test is recommended where the magnitude of annual benefits after the final modelled year is assumed equal to the magnitude of benefits in the final modelled year. In rail appraisal, this is often termed the 'demand cap' which assumes no further growth in the drivers of benefits (i.e. demand) after a certain time.

- 4.6** The following describes the approach adopted in practice across different modes and schemes. These are generally based on applying no further increase in benefits after the final modelled year (the core sensitivity) due to the difficulties in modelling that far ahead:
- For highway and local public transport schemes, the final modelled year is usually 15-20 years after the scheme opening year.
 - For rail schemes the final modelled year, hence the cap year, is specified at 20 years from when the appraisal is undertaken. However, it recognises that under exceptional circumstances, such as with long-term infrastructure projects or where the modelling approach allows, it may be appropriate to use a different demand cap.
 - For aviation there is no demand cap; however, demand is reduced over time through a representation of market maturity. This is delivered through an assumed reduction in income elasticities over time. This is based on expert advice due to limited empirical evidence.
 - Walking and cycling schemes have no formal cap, since these schemes are relatively modest and are frequently undertaken with shorter appraisal periods.
- 4.7** The Department first introduced the core sensitivity test in the late 1980s in response to a criticism of highway scheme appraisals that rising travel demand would not be sustained and in relation to rail schemes the demand cap was introduced in 2005 and incorporated into the Department's appraisal guidance in 2007.
- 4.8** For reasons of practicality, promoters usually base their business cases on the sensitivity test rather than developing a method to change the profile of annual benefits past the final modelled year. Where comparability is important (e.g. bids to a pool of funding) the Department usually requests that a consistent approach is used.
- 4.9** There is, unavoidably, uncertainty around the evidence that may be drawn upon to support the specification of the rail demand cap, or support the choice to run transport models only 15-20 years after construction. However, implicit within appraisal guidance, which encourages the use of a final modelled year as far into the future as practical, is the idea that the model should be able to identify where capacity is reached and hence scheme benefits no longer increase. Two analytical issues arise from this:
- When comparability is important (e.g. bids to a pool of funding) the Department usually requests that a consistent approach is used. However, it is difficult to define an approach that will apply to all modes and all schemes because of different modelling approaches and different capacities of schemes.
 - In the absence of evidence for market saturation we could be underestimating the benefits of schemes by adopting the core sensitivity test as the default.

Valuing the benefits

- 4.10** As set out in paragraph 4.5, the guidance states that benefits should be extrapolated as far into the future as is practical. If we assume that we can identify where capacity will be reached, or a demand cap imposed, benefits will still change as a result of changing living standards, through the value of time. These benefits are then discounted. This could mean that with a low discount rate, and long appraisal period, real benefits per year could rise over time.

Handling forecast uncertainty

- 4.11** The discussions above arise out of the inherent uncertainty in forecasting into the long term. Within our appraisal framework, we try to describe the size of the uncertainty in both the calculation of the benefits, through the development of high and low demand forecasts, and on the scheme costs side, through the application of optimism bias and quantitative risk assessment.

Recent research for the Department for Transport

- 4.12** To set the direction for progressing these issues, we commissioned expert technical advice on the rationale, theory, evidence, practice and options for representing market saturation within rail demand forecasts (Specifying the Demand Cap for Rail, J. Bates et al. 2013). The review focussed on rail demand but also considered evidence for market saturation for aviation and road schemes. The report considered alternatives to demand capping for rail and also set out options for how benefits could be projected, post the final modelled year, applicable to all modes.
- 4.13** The report also looked at varying practices in relation to the modelling time horizon in other European countries. Across the five European countries who responded to the request for information, they generally assumed that rail traffic could not grow indefinitely at current rates and a slowing down in growth was assumed for appraisal purposes. France did apply some form of cap on demand forecasts. However, in this case the process was not consistent between modes, having been developed separately by the rail and road authorities, and there did not appear to be any clear rationale for its level.

Our response and next steps

- 4.14** The Department recognises the importance of understanding uncertainty in appraisal. We have strengthened our value for money guidance, which underpins the economic case, to require core sensitivity tests, such as those around demand forecasting and value of time, to be presented as part of the economic case. Further, we are releasing improved and more accessible guidance on uncertainty in demand forecasting, through the

delivery of our restructured guidance⁷ which will replace current guidance in early 2014.

- 4.15** We aim to go further on tackling uncertainty and we will look to how we can embed our methods in a more general risk-based approach to understanding uncertainty, and to further consider the issues of market saturation, limiting demand growth and extrapolation of benefits over the appraisal period.

Analytical Strategy and Engagement plan - Demand Growth and Benefits in the Long Term

- 4.16** Developing our understanding of uncertainty within our modelling and appraisal toolkit is a key to being able to present a balanced view of scheme benefits and costs to decisions makers. The next steps outlined above will form part of our analytical strategy, our approach to which is set out in chapter 4 of the high level document 'Understanding and Valuing the Impacts of Transport Investment'.

⁷ Restructured guidance can be found here: <https://www.gov.uk/transport-analysis-guidance-webtag>

5. Conclusions and Plans for Development

- 5.1** The Department firmly believes that its strong evidence base, developed over many years, and bolstered by the research and actions outlined in this report, gives us an appraisal framework and methods that remain world-class. They continue to provide a sound basis for informing decisions about transport investment, as part of the five-part 'Transport Business Case' approach. Nonetheless, maintaining and developing our framework is an ongoing endeavour. We are determined that we will keep pace with emerging challenges and opportunities in appraisal, and do so by engaging with stakeholders and experts to build consensus on the next phase of development.
- 5.2** The plans resulting from our recent research listed in chapters two to four are important steps towards this. But we will go further, and take them forward as part of a wider plan to continuously develop our appraisal framework and methods. The accompanying document 'Understanding and Valuing the Impacts of Transport Investments' explains (chapter 4) that we will develop an Analytical Strategy for our appraisal framework and methods, and outlines our initial views on key areas of likely development. It also explains that we intend to ensure the setting of our Analytical Strategy, and its delivery, involves considerable engagement with stakeholders and experts to help us maintain and further develop robust and credible approaches. As part of this, we intend to create a Transport Modelling and Appraisal Panel, and hold regular engagement events, to ensure all relevant evidence is brought to bear.
- 5.3** We look forward to working closely with stakeholders and experts in pushing ahead with the next phase of developing our appraisal framework and methods. We will open our next phase of engagement with an event, similar to the Transport and Economy and the Openness and Transparency workshops which were held at the Department for Transport earlier this year, to which we will invite stakeholders and experts to begin to shape this strategy. Whilst we will be proactive in involving a wide range of stakeholders, we welcome expressions of interest from all parties⁸.

⁸ Contact email: TASM@dft.gsi.gov.uk

6. References

Department for Transport (2013), Understanding and Valuing the Impacts of Transport Investment.

Standing Advisory Committee on Trunk Road Assessment (1999), Transport and the Economy
http://webarchive.nationalarchives.gov.uk/20050301192906/http://dft.gov.uk/stellent/groups/dft_econappr/documents/pdf/dft_econappr_pdf_022512.pdf

Department for Transport (2005), Transport, Wider Economic Benefits and Impacts on GDP.
<http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/economics/rdg/webia/webmethodology/sportwidereconomicbenefi3137.pdf>

Graham D.J., Gibbons S. and Martin R. (2009), Transport Investment and the Distance Decay of Agglomeration Benefits, Centre for Transport Studies, Imperial College.
<http://personal.lse.ac.uk/gibbons/Papers/Agglomeration%20and%20Distance%20Decay%20Jan%202009.pdf>

Mackie, P. and Worsley, T., Institute for Transport Studies, University of Leeds (2013a), International Comparisons of Transport Appraisal Practice.
<https://www.gov.uk/government/publications/international-comparisons-of-transport-appraisal-practice>

MVA and Institute for Transport Studies, University of Leeds (2013), Assessment of Methods for Modelling and Appraisal of the Sub-National, Regional and Local Economy Impacts of Transport.

NERA (2010), Representing international business impacts in transport appraisal.
http://assets.dft.gov.uk/publications/representing-international-business-impacts-in-transport-appraisal/report_part1of2.pdf

Airports Commission (2013), Discussion Paper 02 aviation connectivity and the economy.
<https://www.gov.uk/government/publications/discussion-paper-on-aviation-connectivity-and-the-economy>

Mackie, P., Wardman, M., Fowkes, A.S., Whelan, G., Nellthorp, J. and Bates, J., Institute for Transport Studies, University of Leeds (2003), Values of Travel Time Savings in the UK.
<http://eprints.whiterose.ac.uk/2079/>

Batley, R., Mackie, P., Bates, J., Fowkes, T., Hess, S., De Jong, G., Wardman, M. and Fosegrau, M., Institute for Transport Studies, University of Leeds (2010), Updating Appraisal Values for Travel Time Savings – Phase 1 Report.

Wheat, P., Wardman, M. and Bates, J., Institute for Transport Studies, University of Leeds (2012), Advice on Statistical Confidence of Appraisal Values of Non-Work Time.

Wardman, M., and Wheat, P., Institute for Transport Studies, University of Leeds (2013b), Meta-analysis of post-1994 values of non-work travel time savings.

Wardman, M., Institute for Transport Studies, University of Leeds (2004), Public Transport Values of Time. Transport Policy 11, pp.363-377.

Abrantes, P. and Wardman, M., Institute for Transport Studies, University of Leeds (2010), Meta-analysis of UK values of time: an update. Transportation Research Part A: Policy and Practice 45, pp.1-17.

Department for Transport (2008), Birmingham M6 toll road study: utilisation surveys.

<https://www.gov.uk/government/publications/utilisation-surveys>

Wardman, M., Batley, R., Laird, J., Mackie, P., Fowkes, T., Lyons, G., Bates, J. and Eliasson, J., Institute for Transport Studies, University of Leeds, (2013c), Valuation of Travel Time Savings for Business Travellers.

Bates, J., Worsley, T., Wardman, M., Nash, C., and Preston, J. (2013), Specifying the Demand Cap for Rail.