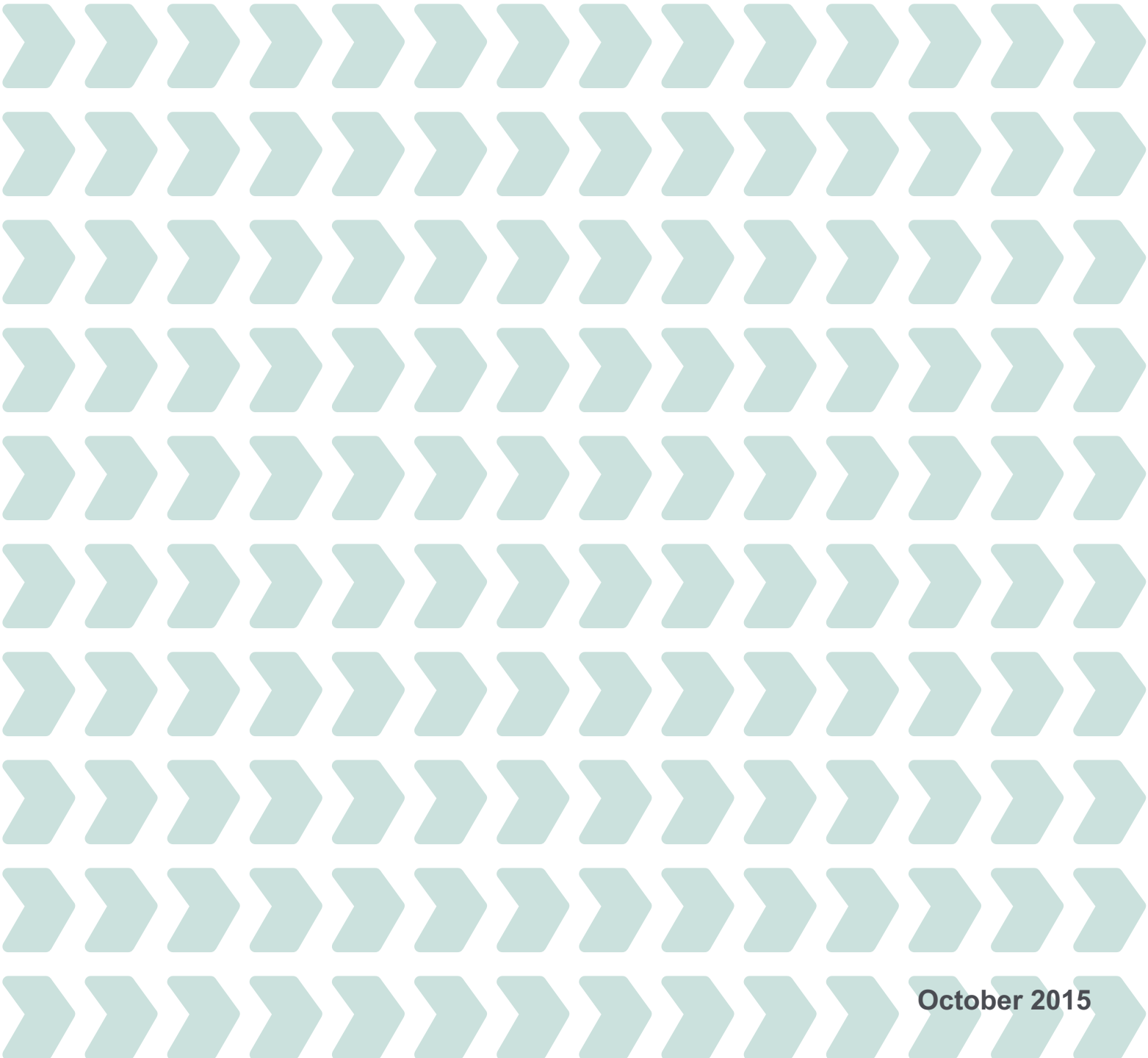
Department for Transport

Understanding and Valuing Impacts of Transport Investment

Values of travel time savings

Moving Britain Ahead



October 2015

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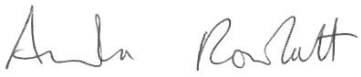
Foreword

In October 2013 we committed to undertake fresh, primary research on business and non-work travellers' willingness-to-pay for journey time improvements. Last year's progress report on the wider programme of work on transport impacts updated you on progress with Phase 1 of the project.

We have now completed our research on the values of time and I am delighted to present this report which sets out our results and our plans for implementing them in our appraisal framework.

The successful completion of this project represents a major milestone in the ongoing process of maintaining and enhancing our methods. In particular, the research has directly addressed how factors like on-train working affect the values of time for business travel by directly surveying businesses and business travellers.

We plan to continue working closely with experts and stakeholders and this progress report highlights several areas where we are specifically seeking input on how we should implement the research results and our priorities for further research in the future. We look forward to continuing to work together collaboratively, to ensure the information used to inform transport investment decisions remains relevant and robust.



Amanda Rowlatt, Chief Analyst and Strategy Director

October 2015

Executive summary

Introduction

1 The Department's evidence base for understanding and valuing the impacts of transport investments is set out in WebTAG[1]. This evidence base has been developed over many years and is internationally respected as best practice. In October 2013 we launched the 'Understanding and Valuing the Impacts of Transport Investment' (UVITI) Analytical Strategy which set out our approach to maintaining and enhancing this evidence base through open, transparent and collaborative working with academics, experts and stakeholders. This document is the latest in the series of publications that describe the progress we have made on delivering this strategy.

2 In 2013 we made a commitment to undertake fresh, primary research on people's and businesses' willingness-to-pay for journey time reductions, and a range of other journey improvements. We have now completed that research which represents a major development to the evidence base on valuing journey improvements in four key areas. It has brought the evidence base fully up-to-date with fresh, primary evidence; extended our surveying to cover a more representative set of modes of transport; applied new methods to estimate values of time for business travel, which avoid the need to rely on theoretical assumptions about how people use their travel time; and has jointly estimated values for other journey characteristics, enhancing the consistency of our framework

3 This document sets out the key results; our plans for implementing those results in WebTAG; and options for future research in this area. We are now seeking input and feedback from our stakeholders on these plans and research options. Specific areas where we are particularly interested in receiving stakeholder feedback are highlighted throughout this document[2].

The scope of the research project

4 The value of time research project had an ambitious scope, covering travellers by car, public transport, walking and cycling, and for a wide range of journey purposes. One of the key innovations of the project was to apply 'willingness-to-pay' methods to the values of time for business travel. By directly surveying businesses and people travelling for business, the resulting values take account of the full range of factors that might affect how businesses benefit from journey improvements, such as whether they are able to work during the journey and how any 'saved' time would be used.

5 Over 11,500 surveys were completed across the project as a whole and, as is good practice when undertaking surveys of this scale, the surveys were informed by an extensive phase of development, testing and piloting. Estimating values of time, and

[1] https://www.gov.uk/guidance/transport-analysis-guidance-webtag
[2] Email TASM@dft.gsi.gov.uk, with the subject 'Values of time research and implementation' by Friday 29 January 2016.

values for other journey improvements, from these surveys requires the use of 'choice modelling' techniques. The research team included leading experts in this field, both UK and international, and they employed state-of-the-art methods to estimate the values, and to explore the variation and uncertainty around them. The results presented below were derived using the Implementation Tool developed as part of the project, which applies the choice modelling results to National Travel Survey data, to ensure the values are nationally representative.

Key results - values of time

6 The table below compares the results from this research with the values of time currently given in WebTAG.

	Current WebTAG values		Research results
Non-work travel			
Commute	£6.81		£10.01
Other non-work	£6.04		£4.57
Business travel		**Distance band**	
Car (driver / passenger)	£27.06 / £20.52	0-50km	£10.08
		50-100km	£16.30
		100km +	£25.12
Rail passenger	£31.96	0-50km	£10.08
		50-100km	£16.30
		100km+	£36.19
Bus passenger	£16.63	0-50km	£10.08
		50-100km	£16.30
Other public transport passenger	£26.28 (London Underground passenger)	0-50km	£10.08
		50-100km	£16.30

Table 1 Comparing current WebTAG values of time with results from the research project (all values are £/hour, in 2010 market prices)

7 Our current business values vary by mode of transport, based on the average incomes of business travellers using those modes as opposed to a 'willingness-to-pay' approach. One of the advantages of applying a 'willingness-to-pay' method is that it allows far greater investigation of what factors cause variation in the values.

8 One of the key factors we investigated was the impact on the values of being able to work while travelling. It has been argued that our current values fail to account for business travellers being able to use laptops and other mobile devices while travelling by rail. However, this new analysis found no significant impact of how travel time was used on the resulting values. This does not necessarily mean that being able to work while travelling has no effect on the values of time, but that these values represent how businesses feel they would benefit from quicker journey times, measured by what they would be willing to pay for them, given current travelling conditions and potential to use travel time productively. This was supported by qualitative research focussing on business travel that observed that "while travel time is not wasted time, quicker journeys are always more desirable."

9 The key factor that did explain variation in the business values, more than mode or income, was trip distance. Longer business trips will only tend to be undertaken for more important purposes, often by more senior staff, and are more likely to involve other costs, like overnight stays. Therefore, it makes sense that the values of time would be higher for longer trips; we are planning to introduce distance-based, rather than mode-based, values of time for business travel; and we are seeking stakeholder feedback on the details of how best to make this change to our guidance.

10 Turning to the non-work values, the similarity between the values for commuting and short-distance business travel reflect the increasingly blurred boundaries between work and personal (travel) time.

11 As well as the more traditional motorised modes of transport, the research also covered how walkers and cyclists value journey time reductions. The specific challenges in this area, namely introducing costs and realistic variations in journey times in the surveys, meant that this element of the research comprised two rounds of piloting, rather than a full survey. However, the results from the second, larger pilot and the results for the other modes, indicate that the values for commuting, other non-work and shorter-distance business travel given in the table above can also be applied for walking and cycling.

Key results - values for other journey improvements

12 As well as how people benefit from, and value, quicker journey times, the research looked at how people value other journey improvements, such as reduced crowding on trains and more reliable journey times. The results were largely in-line with the existing evidence base. For example, the results from this research correspond closely with methods for valuing rail crowding reductions and punctuality improvements given in the Passenger Demand Forecasting Handbook[3] and recommended in our guidance.

13 However, the research also found a reliability ratio for car travel, a key variable in calculating reliability benefits, of 0.4. This is half the value of 0.8 currently given in our guidance and, all else equal, would halve car reliability benefits. This represents a significant change to our valuation of reliability benefits. However, this study also represents a significant improvement in the evidence base, as it drew from a much larger and geographically more diverse sample than the research underlying the current ratio of 0.8.

14 This research project also found that, as with rail, values of time increase with crowding on other modes of public transport. We are seeking stakeholder feedback on how best to implement guidance on calculating crowding impacts for non-rail public transport modes.

Future research programme

15 This research project represents a major milestone in our analytical strategy, especially by demonstrating that businesses benefit from quicker journey times, through their willingness-to-pay for them, despite changes to modern working practices and increasing opportunities for travel time to be used productively.

16 However, we recognise that maintaining and enhancing our methods is a continuous process and we are considering a range of options for future research. These cover

[3] The Passenger Demand Forecasting Handbook (PDFH) is the rail industry's best practice guide on forecasting rail demand, summarising over twenty years of research. Some of the methods are used in the valuation of impacts in investment appraisals, as well as demand forecasting. More information can be found here: http://www.atoc.org/about-atoc/commercial-activities/passenger-demand-forecasting-council/

further analysis of the data collected for this project; potential applications in transport modelling; and scoping a potential ongoing programme to ensure the evidence base remains current.

Seeking your views

17 Collaborative, open and transparent working with our stakeholders is an important element of our analytical strategy. Therefore we are seeking stakeholder feedback, particularly in those areas highlighted above and on where our priorities should lie for future research. You can get in touch by emailing TASM@dft.gsi.gov.uk, with the subject 'Values of time research and implementation' by Friday 29 January 2016.

1. Understanding and Valuing the Impacts of Transport Investment

1.1 The Understanding and Valuing the Impacts of Transport Investment (UVITI) analytical strategy has been designed to ensure that our evidence base, set out in WebTAG[4], remains world class and continues to provide high quality, robust evidence to inform transport investment decisions. It also aims to build confidence in our evidence base through an open and transparent approach, working closely with experts and stakeholders.

1.2 The strategy sets out five key analytical development themes that aim to meet the needs of our stakeholders. Detailed work programmes have been developed for each of the themes and these are summarised at a high level in Figure 1 below. The overall progress on the programme, including the latest research and next steps for development, was set out in December 2014[5] and was shaped further at the UVITI engagement event in April 2015 and subsequent engagement events. This document focuses on the Valuing Journey Improvements theme, with progress on the overall programme reporting in Spring 2016.

1.3 Within the Valuing Journey Improvements theme, a commitment was made to undertake fresh, primary research on people's and businesses' willingness-to-pay for journey time reductions, and a range of other journey improvements. This large scale research programme was designed using advice from UK and international experts in the field, and, now completed, we are seeking wider feedback on our plans to implement the findings in guidance.

[4] https://www.gov.uk/guidance/transport-analysis-guidance-webtag
[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389960/understanding-and-valuing-the-impacts-of-transport-investment-progress-report-2014.pdf

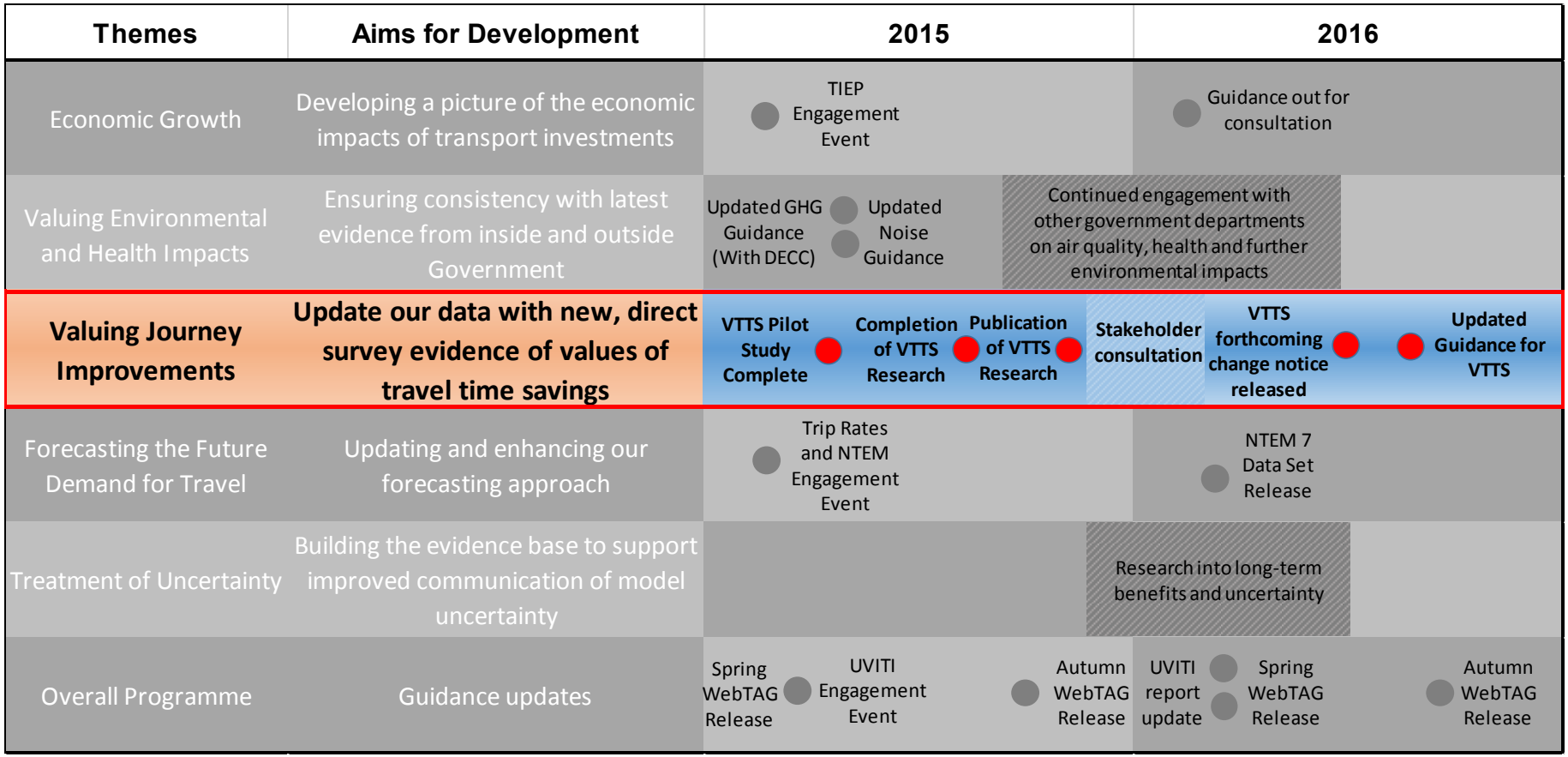


Figure 1 Key milestones of the UVITI Analytical Strategy

2. The purpose of this document

2.1 Values of travel time savings (commonly referred to as 'values of time') play an important role in developing business cases for transport investments. They are used to place a value on changes in journey times arising from an investment and to value changes in travel behaviour, as people and businesses might choose to travel to different to locations to undertake different activities as a result of the investment. They also form the base of the valuation of other journey characteristics, such as the reliability of journey times and crowding on public transport services.

2.2 This document relates to a research project recently undertaken on behalf of the Department by Arup, Accent and the Institute for Transport Studies (ITS), University of Leeds, to provide up-to-date, robust and reliable values of time for use in transport appraisal and business cases. It provides an overview of how the research was carried out; its key results; and how we plan to implement those results in WebTAG guidance[6].

2.3 We recognise that a wide range of stakeholders, from academics undertaking research through to practitioners developing business cases for transport investments, have a keen interest in the values of time. Therefore, rather than introducing new values of time (and values for related factors) straight into WebTAG, we want to share our plans for implementing the research findings and seek feedback from our stakeholders.

2.4 We have identified key questions or issues throughout this document and would welcome stakeholders' views. Responses to these questions, or more general feedback on our plans, should be sent to TASM@dft.gsi.gov.uk, with the subject 'Values of time research and implementation' by Friday 29 January 2016.

2.5 This latest research project should be seen in the context of the programme of research into values of time that we have undertaken and published in the last few years. This research developed our understanding of uncertainty around the values[7] and undertook comprehensive scoping and feasibility work on how a larger piece of primary research, like that discussed in this document, should be undertaken[8]. Similarly, this research project does not signal the end of our work on developing the values of time used in transport appraisal. Development of our appraisal framework is an ongoing process and there is inevitably more research that could be undertaken.

2.6 Therefore, as well as outlining our plans for implementing results from this research project, this document also sets out our plans for future research in this area. Stakeholder views on the priorities in this research programme are also welcome.

[6] More detail can be found in the research reports, available at: https://www.gov.uk/government/collections/transport-appraisal-and-strategic-modelling-tasm-research-reports#valuing-journey-improvements

[7] https://www.gov.uk/government/publications/values-of-travel-time-savings-understanding-the-uncertainty-around-the-non-work-values

[8] Non-work values of time: https://www.gov.uk/government/publications/values-of-travel-time-savings-updating-the-values-for-non-work-travel. Business values of time: https://www.gov.uk/government/publications/values-of-travel-time-savings-for-business-travellers

3. An overview of the research project

The scope of the research

3.1 Compared with previous UK national value of time studies, this research project had a very wide scope:

- **Applying 'willingness-to-pay methods' to business travel** - The current values of time for business travel use a method based on business travellers' incomes and we have previously shown how these values are consistent with evidence from other studies on what businesses would be willing to pay for quicker journey times. In this project we went further and applied direct survey methods, which have previously been used to estimate values for non-work travel, for business travel. Both 'employees' and 'employers' were asked to choose between travel options in carefully constructed hypothetical choices ('stated preferences') and we sought to validate these results with evidence from real-world choices between rail journeys provided by different train operators, where the different operators offer different journey times and fares on essentially the same route ('revealed preferences').
- **Covering a wider range of modes of transport** - The last UK national value of time study focused on car travel but in this project we extended this to cover rail, bus and 'other public transport' modes (including tram and London Underground). The study also covered values of time for walkers and cyclists. Section 3 to 5 focus on the results for the motorised modes, and results from the walking and cycling element of the research are discussed separately, in Section 6.
- **Going beyond the values of time** - Values of time are used in transport appraisals and business cases as the basis for valuing a wide range of journey improvements, such as making journey times more reliable and relieving crowding, not just changes in journey times themselves. Therefore, in this research we did not just explore values of time, but also looked at these other journey characteristics, to ensure that new values of time would be consistent with the methods used to value changes in factors like crowding and reliability.

3.2 While this scope is very wide, it does not cover every possible area in a value of time study. Most notably, the study covered business and personal travel, but did not include freight or values of time for professional drivers, such as taxi or bus drivers.

3.3 This research project represents a major development to the evidence base on valuing journey improvements in four key areas. It has brought the evidence base fully up-to-date with fresh, primary evidence; extended our surveying to cover a more representative set of modes of transport; applied new methods to estimate values of time for business travel, which avoid the need to rely on theoretical assumptions about how people use their travel time; and has jointly estimated values for other journey characteristics, enhancing the consistency of our framework.

How the study was conducted

3.4 As discussed in Chapter 1, this research project should be viewed in the context of the scoping and feasibility studies that were undertaken previously. However, this research project was largely survey-based and, before rolling out any large-scale survey of this sort, it is necessary to first develop, test and pilot the questionnaires that will be used. Therefore the study was split into two 'phases' and the diagram below shows how the project was structured.

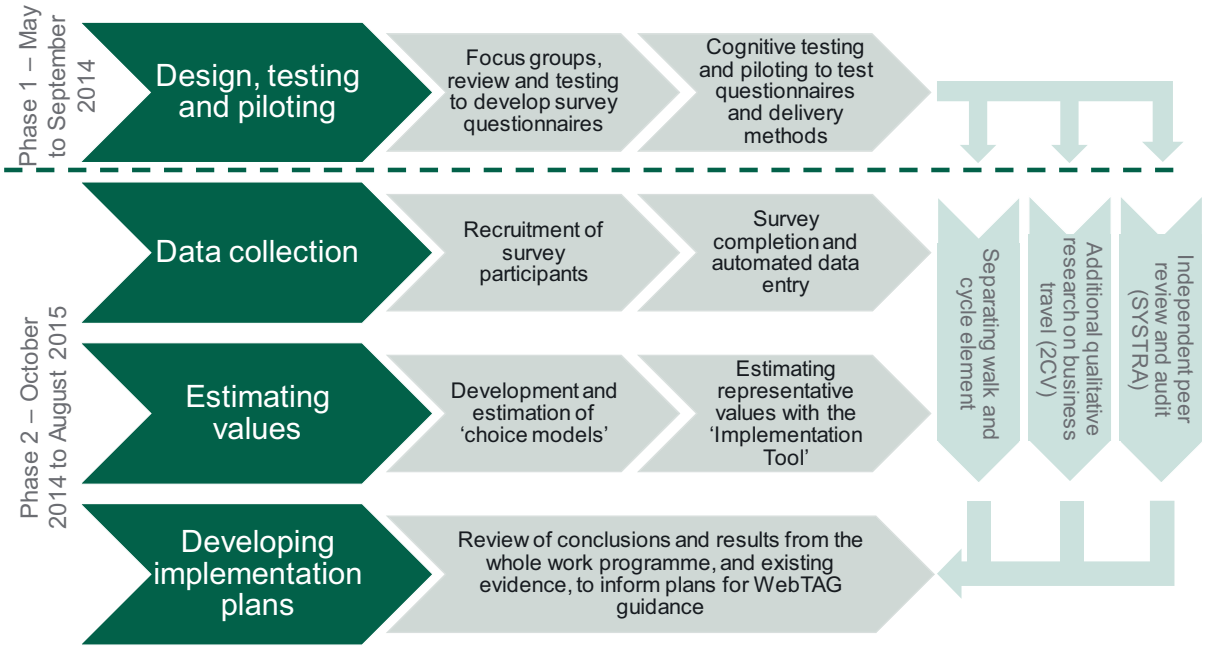


Figure 2 An overview of the project structure

3.5 Phase 1, which ran from May to September 2014, comprised the development of questionnaires, including detailed exploration of some key issues in focus groups; in-depth cognitive testing of those questionnaires, to ensure that respondents understood what was being asked; and two waves of piloting, to ensure that the surveys 'worked' in the field and would produce results from which values could be robustly estimated.

3.6 The study team, led by Arup together with Accent and ITS Leeds, have considerable experience in the field of value of time research. Accent undertook the surveying for the previous UK national value of time study and the team assembled by ITS Leeds included many of the UK's leading academics in the fields of values of time and choice modelling. This considerable experience and expertise was complemented by an Analytical Challenge Team, which reviewed documents at key milestones in the project and provided additional scrutiny and challenge to the core project team.

3.7 Two members of the Analytical Challenge Team, Professors Glenn Lyons and Kay Axhausen, were commissioned to review Phase 1 of the project. At this point of the project, we also commissioned 2CV Ltd to undertake additional qualitative research focusing on businesses and how attitudes to 'buying time savings' might vary between 'employees' and 'employers'.

3.8 The results from Phase 1 of the walk and cycle element of the project highlighted several challenges specific to this area. Therefore, Phase 2 for the walk and cycle element comprised additional testing and piloting of alternative approaches, rather

than a larger-scale survey, which has been reported separately and is discussed in Section 6.

3.9 We also commissioned an independent peer review and audit of the research, led by SYSTRA Ltd, to provide further assurance around the reliability and robustness of the results.

3.10 All of the research reports are available at this link: https://www.gov.uk/government/collections/transport-appraisal-and-strategic-modelling-tasm-research-reports

3.11 In forming our plans for implementing the results from the research we have considered the findings and conclusions from all of these studies, and our plans for implementing the results are given in Sections 4 and 5. The peer review raised a number of issues around the study and resulting values, and these are discussed in more detail in Section 7.

Carrying out the surveys in the field

3.12 Surveying was carried out in November and December 2014. The majority of respondents (around 90%) were intercepted and recruited to take part in the survey during the course of a trip, for example at a petrol or service station, or a public transport station or stop. This method, especially for car, increases the chances of recruiting people making longer trips, so was complemented with phone recruitment (around 10% of respondents) to ensure a wide spread of trip distances. Over 8,600 questionnaires were completed for this main stated preference survey and Figure 3 shows how this was broken down by mode and journey purpose[9]. In addition, 400 employer interviews and over 2,500 revealed preference interviews on rail (covering both work and non-work travel) were undertaken.

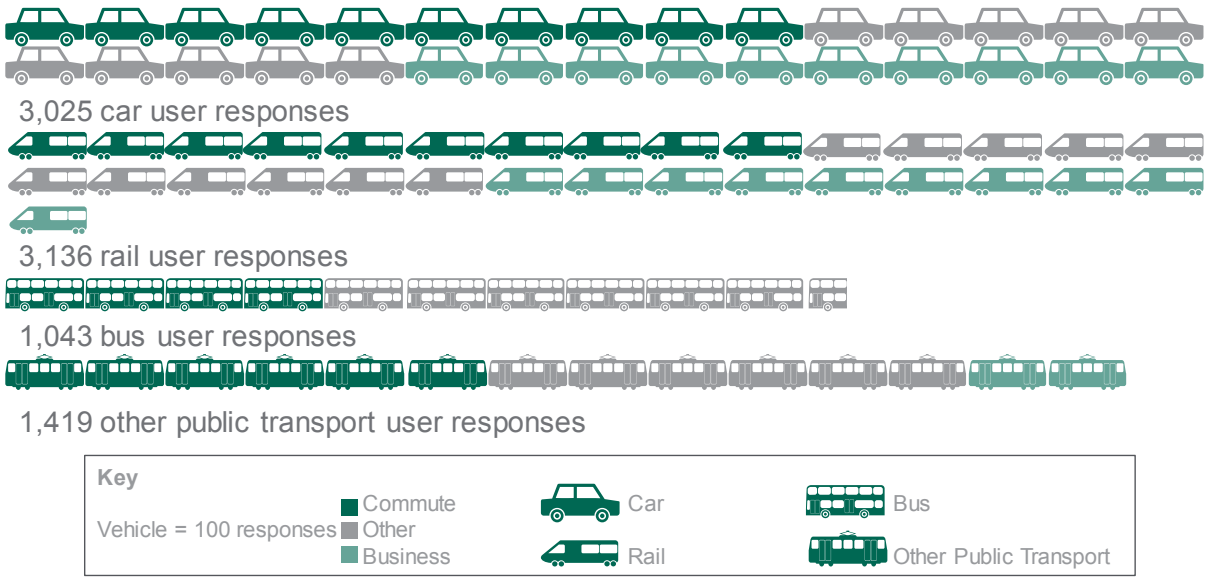


Figure 3 Sample size of the main stated preference survey

3.13 Developments in survey delivery, especially online or computer-aided interviews, mean that surveys can be better tailored to information provided by respondents - for example, by basing stated preference experiments on the time and cost of a trip

[9] The 'other public transport' mode covered London Underground, tram and light rail.

described by the respondent. To ensure that those who could not, or did not want to, complete the survey online were not excluded, respondents were offered the choice of a phone interview and 16% of the responses were collected in this manner. The peer review identified some issues with how some of these phone interviews were administered, and this is discussed in more detail in Section 7.

3.14 The final report for the project provides more detail on the composition of the sample but it is important to note that obtaining a fully representative sample was not the primary objective. Rather, the sample was constructed to be able to estimate values for different segments of interest, and to be able to explore what factors cause variation in the values. Traditionally, values of time have been segmented by mode of transport and/or journey purpose. However, previous studies have repeatedly found that factors such as trip distance and the traveller's income affect the values. Therefore it was important that the survey covered a sufficient range of these different factors to allow investigation of how they affect the values of time.

How values are estimated from the surveys

3.15 Respondents to the questionnaires were presented with two options for a hypothetical journey, one quicker and more expensive, the other cheaper and slower, and asked to choose which they would prefer.

	Option A	Option B
One way fuel cost	£33.30	£35.00
One way travel time by car	4 hours 23 minutes	3 hours 30 minutes
	Option A	Option B

Figure 4 'SP1' - the time vs. cost stated preference experiment

3.16 While this is a relatively simple approach (referred to as 'SP1'), this experiment was included in the surveys to provide comparability with previous studies, both in the UK and in recent European studies, where a similar approach was used. While the choice was essentially hypothetical and the different options were 'unlabelled' (i.e. rather than being labelled as representing different routes), the journey times and costs presented were based on information collected from respondents on their actual travel behaviour.

3.17 Respondents were also asked to make more complex choices, where more characteristics or attributes were described for each option. Each respondent was faced with two different choice experiments in addition to the simple journey time vs cost trade-off described above:

- A second choice experiment introduced the concept of uncertain journey times, by offering five possible journey times, to enable estimation of values of reliability (referred to as 'SP2'); and
- A third choice experiment investigated a range of different 'quality' factors, such as crowding on public transport services and congestion for car travel, by

breaking down the amount of time that was spent in different travel conditions (referred to as 'SP3').

Imagine that on five occasions that you make the car journey **departing at the same time and on the same day of the week**, the actual travel time varies for the reasons suggested above. We want you to think about that car journey and look at the two options below, each of which show five possible travel times that could arise.

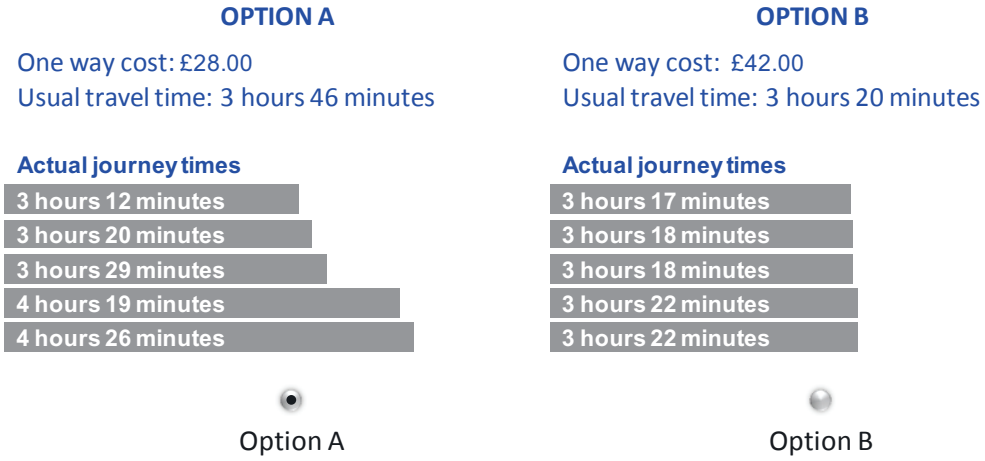
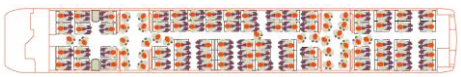
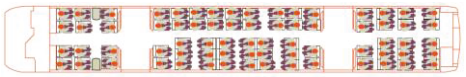


Figure 5 'SP2' - including reliability in the stated preference experiments

	Option A	Option B
One way travel time	3 hours 54 minutes	3 hours 18 minutes
One way fare	£18.00	£24.00
Crowding level when you boarded	 Seated, 100% of seats occupied, eight people stood around each door	 Seated, 100% of seats occupied, nobody is standing

Option A Option B

Figure 6 'SP3' - including 'quality factors', such as rail crowding, in the stated preference experiments

3.18 With some minor exceptions, respondents were offered all three experiments (with SP1 presented first and the ordering of SP2 and SP3 - the reliability and 'quality' experiments - randomised) to ensure the maximum level of comparability in the data. To reduce the risk that this three-experiment format would induce respondent fatigue, care was taken not to overburden respondents in terms of the number of repetitions of any one experiment.

3.19 'Choice models' were then used to estimate values (of time and other factors) that best explain how respondents chose between the options presented to them. It is important to recognise that there is no single value of time that would apply to all people in all contexts - the value of time varies with a whole range of different factors. By including other information from the surveys, such as the cost, distance or purpose of the trip, or the income of the traveller, the choice models are able to explain what factors play the most important role in this variation in the value of time.

Testing whether the surveys 'worked'

3.20 For this approach to successfully estimate the value of time, it is necessary for survey respondents to actively trade between the different options. If everybody always picked the quicker/more expensive or cheaper/slower option, and never switched between them, it would be difficult to robustly estimate a value of time. Therefore, the high levels of trading between options reported in the final report, namely that only around 2% of respondents always chose the quickest option and only around 5% always chose the cheapest option, indicate that the levels of trade-off presented in the survey were well designed and suitable for estimating values of time.

3.21 For the values resulting from a stated preference experiment to be robust and reliable, it is not sufficient for survey respondents simply to have traded between the different options. The experiments also need to be realistic and meaningful, so that the choices made reflect what would be done in real life. In Phase 1 of the project, significant effort was put into the questionnaire design to ensure this would be the case, and the final questionnaires included a set of 'diagnostic questions' around how well respondents understood the experiments and found them realistic.

3.22 Figure 7 presents the responses to these questions. The percentages of respondents 'strongly disagreeing' or 'somewhat disagreeing' with the statements are low for a study of this sort and we can, therefore, be reassured that the stated preference experiments were well understood, realistic and reflected real-life decision-making.

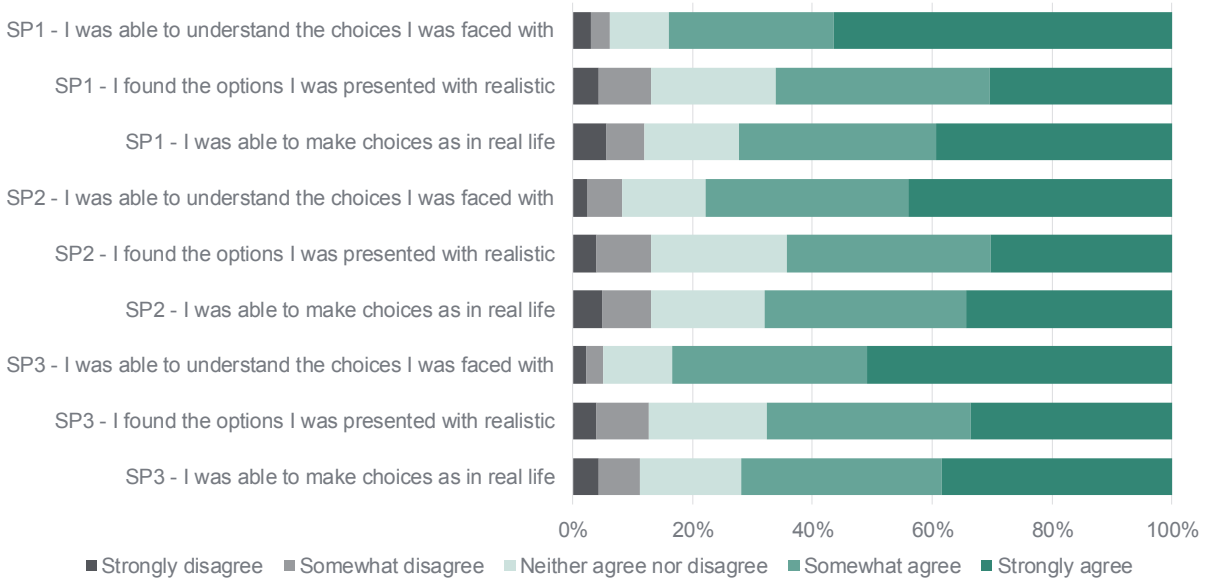


Figure 7 Responses to diagnostic questions about the stated preference experiments

Developing national, representative values

3.23 Results from the choice models allow estimation of a value of time for a given mode, journey purpose, trip distance, traveller income etc. These results could - in principle - be applied to the surveyed sample to estimate an average value of time for use in transport appraisal. However, as noted above, the survey sample was not constructed to be nationally representative, and calculating values for appraisal in

this way would risk introducing a bias if the sample were significantly different to the wider travelling population.

3.24 Therefore, the study team also developed an 'Implementation Tool', which applied results from the choice modelling to trips recorded in the National Travel Survey (NTS). Using NTS data from 2010 to 2012, this essentially estimated a value of time for each NTS trip, which could then be averaged to produce nationally representative values for use in transport appraisal.

3.25 The Implementation Tool offers a high degree of flexibility in how the average values are calculated and the segments they are calculated for, as well as estimating confidence intervals around the average values. We have used the Implementation Tool extensively to inform our planned implementation of the research results and the results are presented in the Sections 4 and 5.

Developing plans for implementation

3.26 In forming a plan for how to implement the results from the research in appraisal guidance we have:

- Reviewed the results and recommendations in the study team's final report;
- In line with those recommendations, used the Implementation Tool to investigate different levels of segmentation and uncertainty ranges around the values;
- Reviewed the evidence underlying our current values, and results from recent similar studies elsewhere in Europe; and
- Considered the conclusions from the peer review and qualitative research on business travel.

3.27 We recognise the important role the values of time play in developing business cases for transport investments and the significance of the changes that we plan to implement in our guidance. Therefore, before introducing new values into WebTAG, we are seeking stakeholders' views on our plans and in this section have set out several key areas (highlighted in blue boxes throughout the document) where feedback would be particularly welcome.

3.28 Responses to these key questions, and more general feedback on the research and our implementation plans, should be sent to TASM@dft.gsi.gov.uk by 29 January 2016 with the title 'Value of time research and implementation'.

3.29 In line with the Orderly Release Process governing updates to our guidance, we will release a set of Forthcoming Changes, detailing the changes to guidance, in spring 2016, in advance of the full implementation of new guidance planned for May 2016.

3.30 In the period between publication of the research and implementation of new guidance, and particularly between release of Forthcoming Changes and implementation of new guidance, scheme promoters and sponsors may wish to undertake sensitivity testing using the results from this research to gain an understanding of how the business case would likely be affected by new guidance and values. In such instances, guidance in WebTAG on the Proportionate Update Process[10], provides some useful principles to help inform the decision about whether an update to the analysis is required.

[10] https://www.gov.uk/government/publications/webtag-tag-proportionate-update-process

3.31 In most instances it is likely to be proportionate to undertake a sensitivity test using the values of time proposed in this document during the period before new values fully enter guidance. Advice on how to apply the values in sensitivity testing is given in Annex A:. In business cases where benefits from time savings form a very small proportion of the total benefits, such sensitivity testing might not be necessary. And in some instances, for example tolled crossings, where the values of time could significantly affect demand and revenue forecasts, it might also be necessary to investigate the impact of the new values on the behavioural transport modelling.

4. Implementing the value of time results

Values of time for business travel

4.1 One of the key areas of this research was the use of direct, survey-based, 'willingness-to-pay' methods to estimate values of time for business travel. Our current values are based on business travellers' incomes and, while we have demonstrated that they effectively proxy for business willingness-to-pay when compared with evidence from other studies[11], the method makes simplifying assumptions around the many complex factors that affect how much a business would benefit from (and therefore be willing to pay for) a quicker journey.

4.2 By directly surveying both business travellers ('employees') and business representatives ('employers'), the methods employed in this study should capture all relevant considerations, such as the extent to which people can work productively while travelling or whether travel takes place outside 'normal' working hours. The methods also allow greater investigation of what factors affect how much a business would benefit from quicker journey times, as represented by what they would be willing to pay for them.

Employees or employers?

4.3 The previous scoping work on business values of time identified several different options for how willingness-to-pay methods could be applied. In this study we chose to undertake surveys with both employees, people recruited to the survey while undertaking a business trip, and employers, people recruited to the survey specifically as 'business representatives'. In addition, information was collected to investigate what drives variation in these values and to allow calculation of income-based values. Business travellers' values of time were also investigated through their 'revealed preferences' - i.e. real-world travel behaviour - primarily to validate results from the more hypothetical 'stated preference' surveys.

4.4 This approach raised the question of which dataset the appraisal values should be drawn from - the employees or the employers? Each has their pros and cons - the employee dataset is much larger, lending itself better to model estimation and investigation of variation in the values. But, from a theoretical perspective, employers might be better placed to judge how a business would benefit from quicker journey times, especially if employees bring elements of their 'personal' valuations of time savings into play. On the other hand, there are inherent difficulties in identifying a single representative who can speak on behalf of a business, and in generalising results from the employer survey to form nationally representative values. The challenges in identifying the correct person in a business to interview was highlighted

[11] See Valuation of travel time savings for business travellers, Wardman et al (2013): https://www.gov.uk/government/publications/values-of-travel-time-savings-for-business-travellers and the 2013 DfT reports on Understanding and valuing the impacts of transport investment: https://www.gov.uk/government/publications/transport-appraisal-in-investment-decisions-understanding-and-valuing-the-impacts-of-transport-investment

by the Analytical Challenge Team, and was the primary motivation behind the additional qualitative research we commissioned 2CV to undertake in this area.

4.5 Ultimately, the study team used the employee values because of the greater sample size and benefits this brought in applying the modelling results across the NTS to produce nationally representative values. This decision was supported by conclusions from the qualitative business research undertaken by 2CV, which concluded that most employees feel accountable for their travel decisions and therefore make responsible choices that reflect the company policy (or 'philosophy').

4.6 In fact, 2CV's qualitative work found that senior staff were often more willing to 'buy time savings' than their employees, who were more cost conscious. However, this was not borne out in the quantitative research. Figure 8, below, compares the employee business values after weighting in the Implementation Tool (and the confidence intervals around them) with values from the employer sample. It shows values of time from all 3 SP experiments (i.e. SP1, SP2 and SP3), with the SP3 values representing the most crowded or congested conditions. There is a reasonable degree of correspondence between the two sets of values but the employee values are generally somewhat higher. The main exception to this is for rail SP3, where employers gave higher values of time in the most crowded conditions.

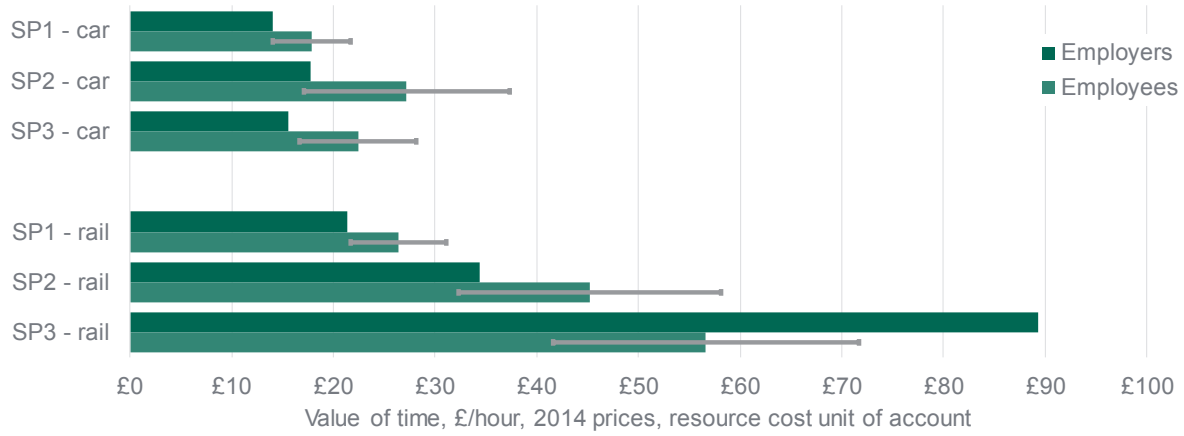


Figure 8 Comparing values of time from the employer and employee surveys

4.7 There are many possible reasons for the difference between the employee and employer values, but we agree with the study team's conclusion that the employee dataset should form the basis of new appraisal values because of the richer analysis allowed by the larger dataset and the supportive conclusions from the qualitative research undertaken by 2CV.

Validating the results with evidence from real-life travel choices

4.8 The study included a 'revealed preference' element, based on people's real-life travel choices, to validate results from the more hypothetical 'stated preference' experiments. The revealed preference (RP) element of the study focussed on carefully chosen rail routes where multiple operators offer a range of different journey times and fares. Stated preference (SP) surveys were also undertaken on the same routes, with the SP3 experiment that looked at crowding for most rail respondents, in this case replaced with an experiment based around choosing between train operators, to mimic the RP and provide the most direct possible validation.

4.9 Neither the RP nor the operator choice-based SP experiment were as successful as we had hoped. Despite extensive efforts to ensure respondents were aware of the time-cost trade-off, many RP respondents did not appear to face, or be aware of, a

trade-off (e.g. their chosen operator was both quicker and cheaper). This and other data quality issues led to a large amount of data being excluded from the final modelling so that viable results could be estimated. Also, both the RP and corresponding SP models produced very high values of time, likely because people's choices were affected by preferences for specific operators, as well as differences in journey times and costs.

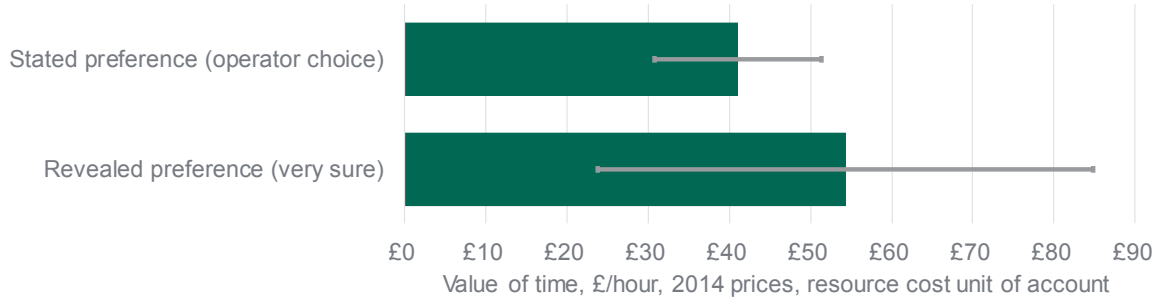


Figure 9 Comparison of business values of time from revealed preference and operator choice stated preference experiments

4.10 Figure 9 shows there was a reasonable level of correspondence between the value of time for the revealed and stated preference experiments, with the SP values within the confidence intervals around those from the RP. Along with diagnostic responses indicating that the SP experiments reflected real-life decisions, this provides some reassurance that the SP results reflect real-life behaviour. However this is limited by the data and modelling difficulties encountered in the RP element of the research, which are demonstrated by the wide confidence intervals that resulted from having to 'clean' so much of the RP data to estimate well-functioning models.

Implementing results from the employee survey

Productive use of time

4.11 A key critique of the Department's current business values of time, and the assumptions underpinning them, is that they fail to account for the productive use of travel time, and the increased opportunities to use travel time more productively offered by developments in mobile technologies. There are two key attributes of willingness-to-pay methods that address this critique: Values of time estimated using these methods should account for how travel time is used, given current technologies and ability to use travel time productively; and facilitate investigation of how the use of travel time affects the value of time.

4.12 Information was collected on how respondents used their travel time, and the effect on the value of time was investigated in the choice modelling. There were two key results in this area:

- While the use of mobile technologies has increased, not all travel time is used productively, even on rail trips where the opportunities to work while travelling have been most affected by technological developments[12]. This finding from the main research project is supported by the conclusions from 2CV's qualitative research on business travel - while travel time is not 'dead time', it is not necessarily used as productively as other 'work time', with the sentiment that "*quicker journeys are always more desirable.*"

[12] For example, see section 3.4.4 of the Final Report, that compares how business travellers reported using their time with similar results from the 2009 study Productive Use of Rail Travel Time and the Valuation of Travel Time Savings for Rail Business Travellers.

- Survey respondents were asked how they used their travel time. For example, how much time was spent on work or non-work activities? How much did they use laptops, tablets or other mobile devices during the journey? How business travellers used their travel time was not found to have a significant impact on the value of time in the choice modelling. The result that the values of time did not vary with time use does not necessarily mean that time use is not important - the values of time estimated in this study are representative of current travelling conditions and uses of travel time. The results could have been different if the opportunities to use travel time productively were significantly different.

Variation in the values by distance and mode

4.13 In line with the recommendations in the final report, we have used the Implementation Tool to investigate different possible segmentations of the business values. Figure 10 presents the results of this testing, comparing the values currently given in WebTAG with business values by mode and distance from this research, and the confidence intervals around them.

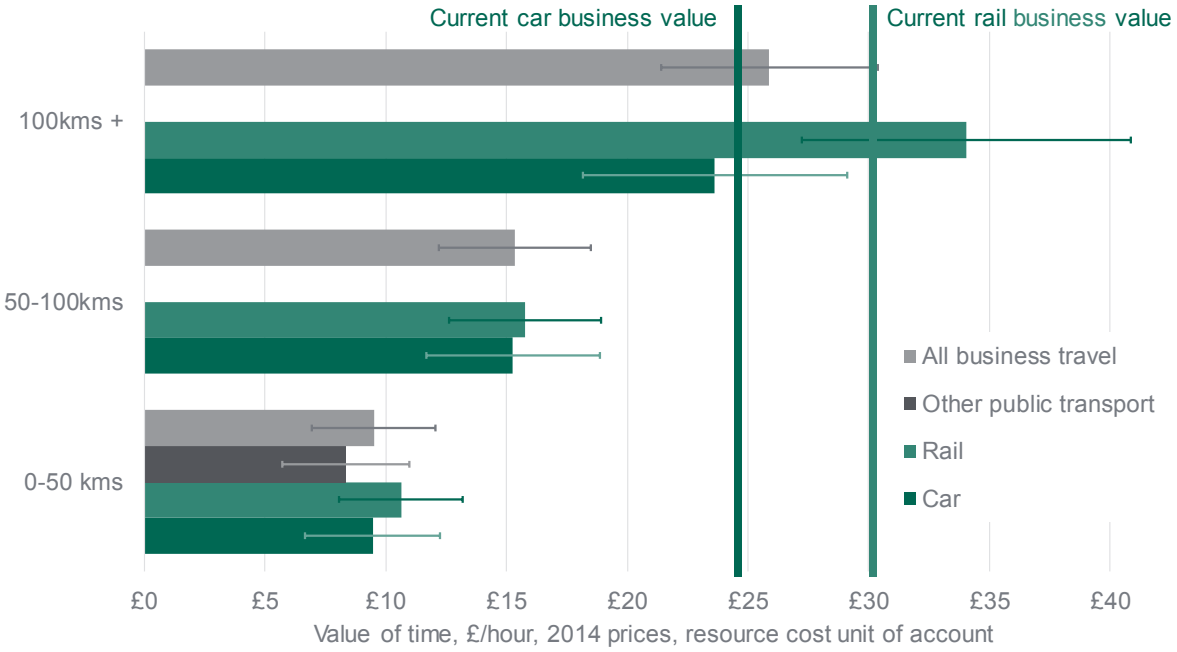


Figure 10 Business values of time by mode and distance[13]

4.14 There are several key results shown in this figure:

- The value of time increases significantly with distance - values for longer trips (over 100km) are similar to those currently given in WebTAG for car and rail business travel, while values for shorter trips (up to 50km) are much lower and are similar to the value of time for commuting presented later in this document.
- Variation in the values with distance is far more important than variation by mode - for a given distance band, the differences in values between different modes are small. This is reflected in the values we are proposing to implement in Table 2, below, where the values are given by distance band, with the only variation by mode between the long-distance (100km+) values for car and rail business travel.

[13] Values for other public transport are only given for the 0-50km distance band as the NTS data do not include sufficient business trips of longer distances to support estimation.

4.15 There are several reasons why we might expect values of time for business travel to increase with distance. Longer trips:

- Tend to be more costly, both in terms of financial costs and time away from the normal workplace, and so will likely only be undertaken for higher value purposes, by more specialised (and potentially more senior) staff with a higher value of time - making more time spent at the destination more valuable;
- Are more likely to involve travel outside of normal working hours, possibly involving overnight stays or overtime payments that could be reduced with quicker journey times; and
- While it is possible to work while travelling, 2CV's qualitative research highlighted the limitations on the sorts of tasks that can be completed during a journey. For longer trips it is more likely that these tasks will be exhausted during the journey so that there is greater potential to put unproductive time to more productive use.
- Also, the similarity between the values for shorter business trips and commuting trips could be seen as reflecting the increasingly blurred boundaries between work and personal (travel) time - where people might increasingly undertake some work activities during their commute and can 'chain' together trips between their home, usual workplace and other business locations.

4.16 Given the strength of the relationship between the values of time and trip distance, we plan to implement distance-based values in WebTAG, as shown in Table 2.

	Car (driver / passenger)	**Rail passenger**	**Bus passenger**	**Other public transport passenger[14]**
Current WebTAG values	£27.06 / £20.52	£31.96	£16.63	£26.28
Research results - 0-50kms	£10.08	£10.08	£10.08	£10.08
Research results - 50-100kms	£16.30	£16.30	£16.30	£16.30
Research results - 100kms+	£25.12	£36.19	n/a	n/a

Table 2 Proposed values of time for business travel, £/hour, 2010 prices, market price unit of account

4.17 The number of distance bands, and the boundaries between them, have been carefully chosen:

- Three distance bands strikes a balance between reflecting the variation with distance and maintaining a practical framework.
- The shortest distance band, 0-50km, encompasses all of the NTS business trips by 'other public transport' modes (London Underground, tram and light rail) and would be transferable to other modes, such as bus, or walking and cycling, that were not covered in the employee survey;

[14] The current WebTAG value for the 'other public transport' modes is for London Underground. The surveys for the other public transport 'mode' in this research, and therefore the values presented in the table, also covered tram and light rail passengers.

- The number of business car and rail trips in the NTS dataset is roughly equal in the 50-100km and 100km+ distance bands, and is sufficient for robust calculation of average values;
- For the longer distance band, over 100km, differences between the values for car and rail business travel are more significant.
- The chosen distance bands coincide with those already used to report outputs in the Department's standard appraisal software, TUBA, increasing the ease with which distance-based values can be introduced.

Specific issues with implementing distance-based business values

4.18 We are aware that moving to distance-based values of time for business travel will introduce some additional complexity to appraisals, and potentially transport modelling and forecasting. For example:

- Should distance be defined on a 'crow-flies' or 'network' basis? For consistency with the estimation of the values, which is based on the distances people reported travelling, the network distance should be used. However, this introduces the possibility of the distance between an origin-destination (O-D) pair changing between the without and with intervention scenarios, especially where new routes or links are introduced. We plan to implement the distance-based business values on a 'network' basis, requiring greater attention to be paid to changes in distance, especially on O-D pairs experiencing significant benefits.
- Similarly, if the distance between an O-D pair is close to the boundary of the distance bands being used, then the benefits will be sensitive to the band that the O-D falls in, even if it doesn't change between scenarios. Again, there will be a greater need to investigate the distances of O-D pairs experiencing significant benefits, potentially calling for additional sensitivity tests where the distances of key O-D pairs are close to the boundaries of the distance bands.
- It should be relatively straightforward to apply distance-based values in TUBA, and for TUBA to carry out additional error checks. However, there will be a greater requirement for analysts to enter accurate distance information, including for: a). Public transport schemes, where currently distances are not always entered as they are not required for the calculation of speeds, journey times and fuel costs in TUBA; and b). For trips between external model zones, where currently longer trips may be classified as <100km because of how the external model zones have been set up.
- WebTAG already permits the use of different values of time in modelling ('behavioural' values) and appraisal ('appraisal' values), and includes increasing values of time with distance as one of several possible 'cost-damping' methods in transport modelling. Therefore there should not be any fundamental problems with introducing the distance-banded values given above in appraisals. However, alternative segmentations might be required for use as behavioural values of time in transport modelling.

4.19 As discussed above, before introducing new values and guidance in WebTAG, we are seeking stakeholder feedback on our plans. The box below highlights some of the key questions we would particularly welcome feedback on, relating to the introduction of distance-based business values of time.

Distance-based business values of time

1. On the basis of the evidence presented here, and in the research reports, do you agree that we should introduce distance-based business values of time?

2. And do you agree with the 3 distance bands being proposed?

3. Should distance be based on 'crow-flies' or 'network' distances?

4. What practical difficulties might there be in applying distance-banded business values of time in TUBA appraisals? And how might these be overcome?

5. Similarly for non-TUBA appraisals, what practical difficulties might there be and how might these be overcome?

6. The 'appraisal' values will likely also be used as 'behavioural' values. For transport modelling, what would be the most desirable form for the business values? Could the distance-banded values be practically implemented? Or would it be preferable to have a continuous function or single, average values for modelling purposes?

Values of time for commuting and other non-work travel

4.20 Current WebTAG guidance provides a single value of time for commuting and a single value for other non-work travel, to be applied for all modes of transport. These values are derived from research undertaken in 2003[15], using survey data collected in 1994[16] that focused on car travel only.

4.21 In the new research we have maintained the distinction between commuting and other non-work travel but, as discussed above, have surveyed a range of public transport modes in addition to car users. Similarly to our analysis of business values, we have used the Implementation Tool to investigate differences in the values by factors such as mode and journey distance - Figure 11 presents the results of this testing, including 95% confidence intervals around the values.

[15] Values of Travel Time Savings in the UK, Mackie et al (2003).
[16] The Value of Travel Time on UK Roads - 1994, AHCG (1996).

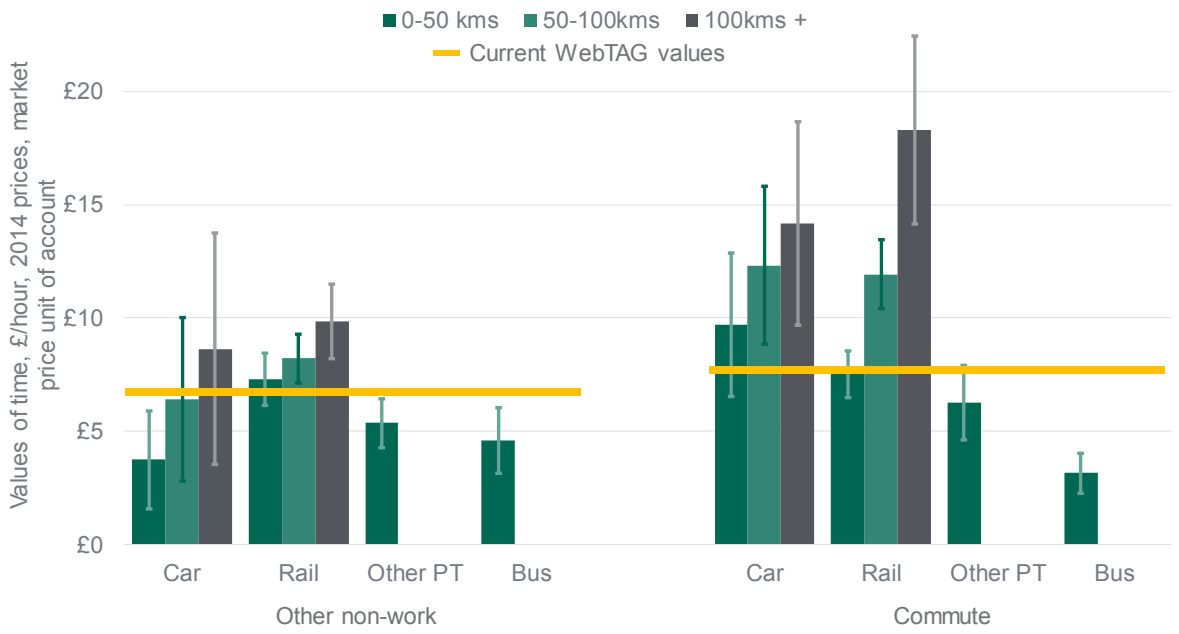


Figure 11 Non-work values of time by mode and distance[17]

4.22 As with the results for business travel, the values for commuting and other non-work travel increase with trip distance. However, compared with the business results, there is far less consistency by mode. For example, in the shortest distance band (0-50km), for commuting the car value is highest and the bus value is significantly lower than all other modes. But for other non-work travel, the values for car, bus and other PT are similar (and not statistically different), while the rail value is the highest.

4.23 There are two possible explanations for these differences by mode: self-selection by those with higher values of time into quicker, more expensive modes of transport; or comfort, where the value of time would be expected to be highest for modes that offer a less comfortable journey. We would expect to see a different ordering of the values of time, depending on the rationale for the differences.

4.24 The values presented in Figure 11 have been calculated for a fixed level of average income, so that income differences between users of different modes (and their effect on the values) should be controlled for. Values of time typically increase with income but, as each mode of transport was modelled separately, the relationship between the value of time and income is different for the different modes. For example, in the bus commuting model no relationship with income was found, possibly because of the limited variation in that relatively small sub-sample.

4.25 The ordering of the non-work values of time by mode suggests the differences between them are predominantly due to self-selection, as it generally matches the ordering of the average incomes of users of the different modes. In turn, this suggests that the analysis undertaken so far might not have fully captured the role of income in variations in values between users of different modes, and this is clearest in the absence of a relationship between income and the value of time in the bus commuting model.

4.26 We consider the results from this study to be a significant development on our current values that should be incorporated in our appraisal guidance and applied in transport appraisals. However, further analysis of the data is required to support

[17] As with the values for business travel in Figure 10, values for the long distance bands are not shown for bus and other public transport modes, as their estimation could not be supported by the NTS data used in the Implementation Tool.

possible further segmentation of the non-work values, for example by distance as with our plans for business travel. Therefore, we plan to update the values for commuting and other non-work travel with results from this study and to maintain the current level of aggregation. Table 3 shows the current WebTAG values and the results from this study that we are planning to implement.

	Commute	Other non-work
Current WebTAG values	£6.81	£6.04
Research results	£10.01	£4.57

Table 3 Proposed values of time for non-work travel, £/hour, 2010 prices, market price unit of account

Values of time for non-work travel

7. On the basis of the evidence presented here, and in the research reports, do you agree with our planned implementation of the non-work values of time?

Uncertainty around the values of time

4.27 Many of the charts above show confidence intervals around the values of time, estimated by the Implementation Tool. Current WebTAG guidance recommends sensitivity tests of +/-25% around time saving benefits, based on research on the statistical uncertainty around the non-work values by Wheat, Wardman and Bates, and the analysis undertaken as part of the scoping and feasibility study on business values of time[18].

4.28 We plan to update this guidance, with sensitivity test ranges based on the 95% confidence intervals estimated in this latest research. Table 4 shows the range that should be tested.

Journey purpose	Current sensitivity test range	Proposed sensitivity test range
Commute	+/- 25%	+/- 25%
Other non-work	+/- 25%	+/- 60%
Business 0-50km	+/- 25%	+/- 25%
Business 50-100km	+/- 25%	+/- 20%
Business 100km+ - car and rail	+/- 25%	+/- 20%

[18] See Advice on statistical confidence of appraisal values of non-work time, Wheat, Wardman and Bates (2012): https://www.gov.uk/government/publications/values-of-travel-time-savings-understanding-the-uncertainty-around-the-non-work-values and the 2013 DfT reports on Understanding and valuing the impacts of transport investment: https://www.gov.uk/government/publications/transport-appraisal-in-investment-decisions-understanding-and-valuing-the-impacts-of-transport-investment

Table 4 Proposed sensitivity testing ranges around the non-work and business values of time

Uncertainty around the values and sensitivity testing

8. Do you agree with the proposed range for high/low testing around the values, based on their 95% confidence intervals?

9. Are there additional data or values (e.g. for different segmentations) that it would be useful for us to make available for sensitivity testing?

Car occupancy

4.29 The values of time for car travel presented above are per person values. However, transport modelling of highway schemes usually produces outputs in terms of vehicles, rather than people. Therefore, assumptions about car occupancy are required to combine numbers of vehicle movements from transport models and per person values of time. WebTAG provides base levels of average car occupancy for 2000, based on National Travel Survey (NTS) data, and projects a decline in car occupancy out to 2036.

4.30 Figure 12 compares the car occupancy projections in WebTAG with analysis we have undertaken with more recent NTS data from 2004-2007 (shown as 2005) and 2009-2012 (shown as 2010). For commuting and other non-work travel, rather than the projection of gradual decline in WebTAG, average occupancy has been stable (or even increased) since 2000. For business car travel, the decline in occupancy from 2000-2005 was similar to that projected in WebTAG, but the decline since 2005 has been much sharper.

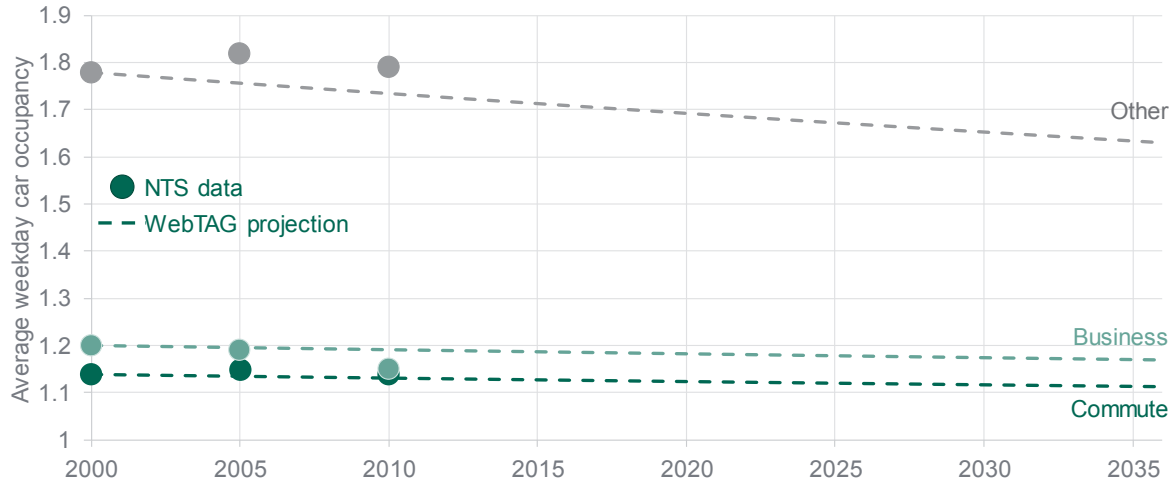


Figure 12 Car occupancy - WebTAG projections and outturn data from the National Travel Survey

4.31 This raises a question about how future changes in occupancy should be projected, especially for business car travel. While non-work occupancy has been fairly stable, and could be projected forward on that basis, the timing of the sharper decline in business car occupancy suggests that it could be linked to the recession. If this were the case, occupancy might be expected to increase with the economic recovery, and

return to its longer-run trend. Therefore, simply projecting forward the trend from 2000-2010 or 2005-2010 would significantly risk underestimating occupancy in this segment.

4.32 Given the stability of car occupancy rates for non-work travel, and the uncertainty around how they will change for business travel, we plan to implement the more up-to-date NTS occupancy data in the TAG data book (shown in Table 5) but to project no change in occupancy in the future. We also plan to revisit this assumption once more post-recession NTS data are available.

Journey purpose	Weekday					Weekend	All week
	AM peak	Inter-peak	PM peak	Off-peak	Average		
Commute	1.13	1.15	1.14	1.15	1.14	1.21	1.15
Other	1.71	1.82	1.79	1.79	1.79	2.12	1.91
Business	1.13	1.16	1.15	1.17	1.15	1.31	1.16
Average	1.35	1.63	1.43	1.45	1.48	2.01	1.61

Table 5 Average car occupancy rates per vehicle km travelled, 2010

Car occupancy

10. Do you agree with the proposal to update the car occupancy assumptions in the TAG data book and to project no future change in occupancy?

5. Implementing results for reliability, crowding and other journey characteristics

Journey time reliability

Calculating reliability ratios and lateness multipliers

5.1 The methods used to estimate reliability benefits vary by mode of transport but, for all modes, the values used are multiples of the value of time. For car travel, the standard deviation of journey times is estimated to represent variation in journey times. A 'reliability ratio' is then applied to the value of time to give a 'value of reliability' that is used to value changes in the standard deviation of journey times.

5.2 For public transport modes, the existence of timetabled services means that reliability is often considered in appraisals as lateness against the timetable. Multipliers are applied to the value of time to give a 'value of lateness' that represents the fact that 1 minute of additional unscheduled journey time is worse than an extra minute of scheduled time. The value of lateness is then applied to forecast changes in average lateness to estimate the benefits of reliability improvements.

5.3 In this study, these conventions for estimating values for reliability differently for different modes of transport were followed - the stated preference experiment that introduced uncertain journey times led to estimates of the value of reliability for car travel and values of lateness for public transport modes. However, to produce the reliability ratios and lateness multipliers used in appraisal, these values of reliability and lateness need to be divided by a value of time. This raises the question of which value of time to use, either:

- The value of time from the stated preference experiment where the values of reliability and lateness were estimated (SP2) - this has the benefit of ensuring internal consistency by calculating reliability multipliers entirely from SP2; or
- The value of time that will be used in appraisal (from SP1) - because of the differences in the values of time from SP1 and SP2, and because the reliability ratios and average lateness multipliers will ultimately be applied to appraisal values from SP1, this approach would generally produce a 'value of reliability' closer to that originally estimated in SP2?

5.4 The study team recommended the former (using the value of time from SP2), on the grounds of internal consistency and also observed that SP2 (the experiment that covered reliability) produced very high values of time. The peer review team hypothesised that the reasons given for the unreliable journey times (especially for car) in the questionnaire might have affected responses. This would potentially explain (again, especially for car) the similarity between the values of time from the

reliability stated preference experiment (SP2) and the value of time spent in highly congested conditions in the experiment that looked at 'quality' factors (SP3).

5.5 On balance we are minded to agree with the recommendations from the study team and the hypothesis put forward by the peer review team. The values of time from the reliability experiment are certainly high and, while the precise reasons for this are not entirely clear, there is a possibility they have been influenced or biased upwards by the instructions given in the questionnaire. Therefore, to ensure that any potential bias is 'contained', the analysis that follows presents reliability ratios and lateness multipliers that have been internally calculated from results from the reliability experiment.

Reliability ratios for car travel

5.6 The current recommended reliability ratio for all journey purposes by car is 0.8. This figure was determined following several rounds of review and expert discussion but is ultimately grounded in a 1993 London road pricing study[19]. That study used a similar format to this latest research, presenting five possible journey times for each alternative in a stated preference experiment, but covered only around 350 respondents in London. Reliability ratios were estimated for a range of different journey purposes, but differences between them were not statistically significant, leading to a reliability ratio of 0.8 for all purposes.

5.7 Despite some of the issues around the reliability experiment raised in the peer review (that are discussed in more detail below), we believe this latest study represents a significant development on our previous evidence, in terms of being more up-to-date and covering a much larger, and geographically more diverse, sample.

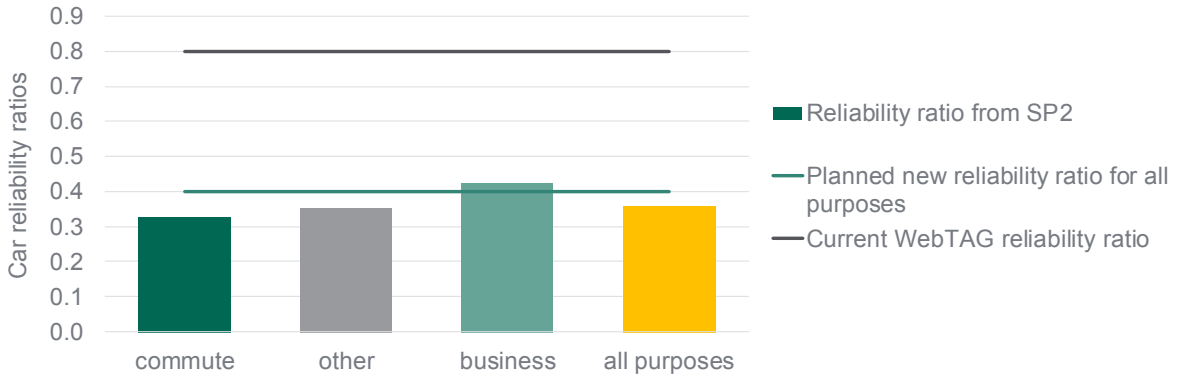


Figure 13 Reliability ratios for car travel

5.8 Figure 13 presents the reliability ratio results from the study. While formal confidence intervals are not presented, given the ranges around the values of time and the similarity between the reliability ratios for the different purposes, it seems appropriate to maintain a single ratio across all purposes. Therefore we plan to change the reliability ratio for car from 0.8 to 0.4 for all journey purposes. For commute and other non-work travel, these results are fairly similar to those found in the recent Dutch value of time study[20]. That study, however, found a larger reliability ratio of 1.1 for business travel.

[19] Demand Effects of Travel Time Reliability, Black and Towriss (1993)
[20] Values of time and reliability in passenger and freight transport in The Netherlands, Significance and John Bates Services (2012)

Reliability ratios for road travel

11. On the basis of the evidence presented here, and in the research reports, do you agree with our planned implementation of a reliability ratio of 0.4 for car travel?

12. The reliability ratio of 0.4 from this research, and the reliability ratio of 0.8 currently given in WebTAG, are both for car travel and no explicit guidance is currently given on reliability benefits for freight traffic. In practice, is the 0.8 ratio also applied for freight? And is there any other evidence we should be aware of when considering how the results from this research might or might not be applied to freight?

Lateness multipliers for rail travel

5.9 The Passenger Demand Forecasting Handbook (PDFH) summarises over twenty years of research on rail demand forecasting and is recognised in the rail industry as the key source of evidence in this area. PDFH includes a set of recommended late time multipliers and WebTAG guidance recommends these are applied in appraisals, as well as demand forecasting.

5.10 Figure 14 shows the lateness multipliers for rail from this new research, compared against those given in PDFH (excluding airport flows, which were not included in this study). The multipliers from this research are all within the range of those given in PDFH for the different rail flow types. Given this high level of similarity in the results, we plan to continue recommending the lateness multipliers given in PDFH for use in appraisal.

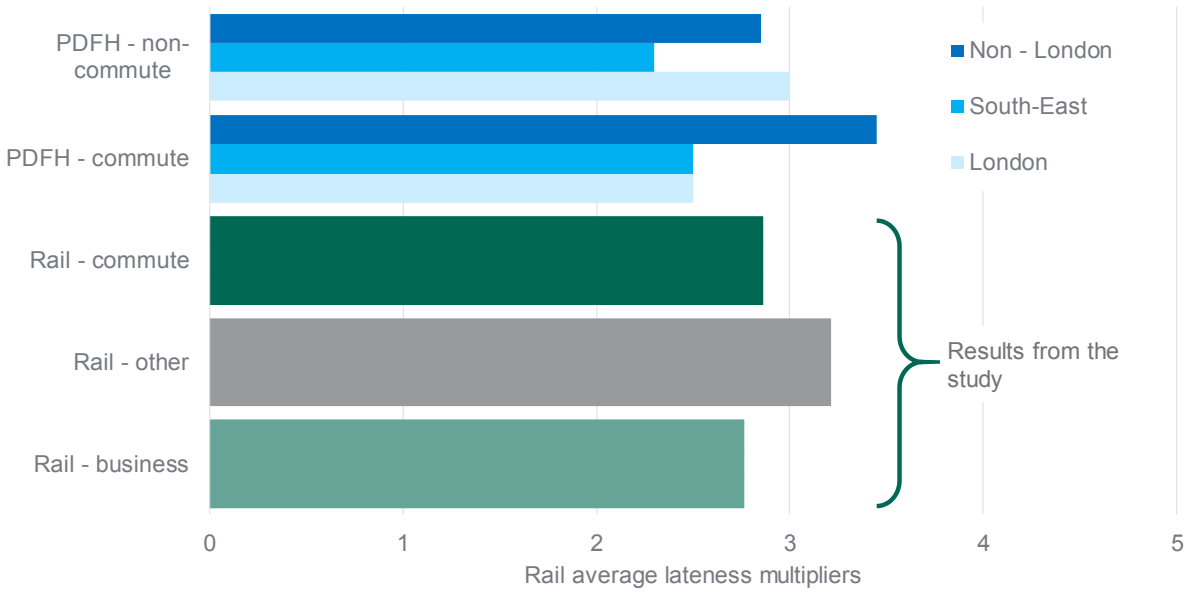


Figure 14 Rail Average Lateness Multipliers from the study and PDFH

Lateness multipliers for other public transport modes

5.11 While multipliers from PDFH are recommended for rail, for other public transport modes, WebTAG currently recommends an average lateness multiplier of 3. Evidence on the value of lateness on public transport, including from PDFH, indicates it is similar to the value of waiting time, for which a multiplier of 2.5 is currently

recommended. A 20% uplift to this multiplier is then applied to represent the uncertainty associated with lateness, resulting in the lateness multiplier of 3.

5.12 The section below on service frequency and waiting time sets out our plan to revise the wait time multiplier from 2.5 to 2.0. Following the method set out above, this would lead to a lateness factor for non-rail public transport modes of 2.4. Figure 15 presents the lateness multipliers from this research, which are consistent with a factor of 2.4. Therefore we plan to revise the lateness multiplier for non-rail public transport modes from 3.0 to 2.4.

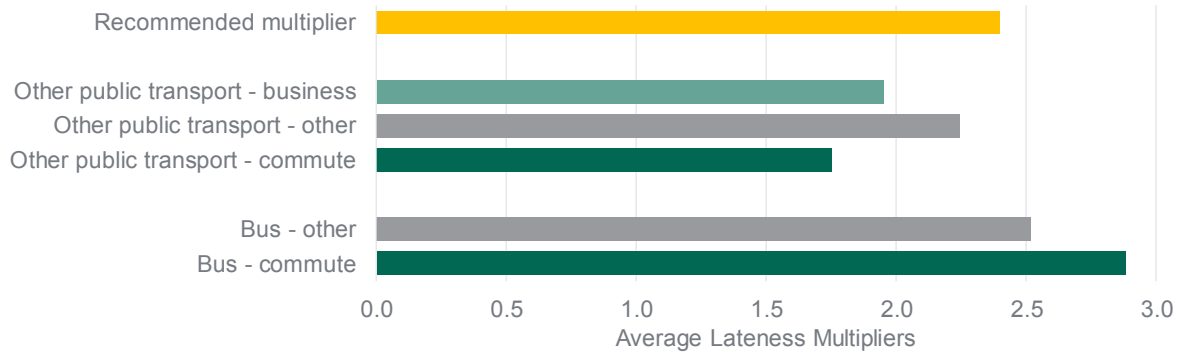


Figure 15 Average Lateness Multipliers for bus and other public transport modes

Average lateness multipliers for public transport modes

13. On the basis of the evidence presented here, do you agree with our planned implementation of changes to the average lateness multipliers for public transport?

Crowding

Rail

5.13 Crowding on rail is considered in forecasting and appraisal through multipliers on the value of time that represent how much less comfortable (and potentially productive) it is to travel in crowded conditions. As with reliability, the recommended crowding multipliers are given in PDFH. In this latest research, crowding was included in SP3 - the experiment covering 'quality' factors - and was presented in a similar way to the study that forms the basis of the current PDFH recommendations.

5.14 Figure 16 presents the results from the rail crowding element of the study for commuting, other non-work and business travel, compared with the multipliers given in PDFH. The light green bars show the 95% confidence intervals around the values of time estimated at different crowding levels from SP3, relative to the appraisal values given in the previous section (from SP1). The three lines show the crowding multipliers from PDFH (which would be applied to the appraisal values from SP1) for London and South East, Regional and Intercity services.

Figure 16 Crowding multiplier results for rail travel, compared with PDFH

5.15 The increasing multipliers show that the value of time increases with crowding for all journey purposes. It is worth noting, in particular, that the value of time increases with crowding for business, as well as for non-work, travel. The chart above is based on 'employee' responses but a similar result was also found from the surveys with employers, confirming that it is appropriate to value changes in crowding through applying willingness-to-pay-based multipliers to the value of time for business travel.

5.16 In most instances the PDFH multipliers lie within the range of results from this study. The main exceptions are for other non-work travel (where the appraisal value to which the PDFH multipliers are applied is from SP1, averaged across all modes, and is influenced by the car value of time, which is lower than that for rail), and for standing on Intercity services for commuting and business travel. Given the broad similarity in the results, and the greater focus on crowding in the research that led to the PDFH multipliers, we believe these results demonstrate consistency between the new values of time and existing crowding guidance. Therefore, we plan to continue recommending use of the PDFH crowding multipliers in appraisal, for all journey purposes.

Other public transport modes

5.17 We do not currently provide any explicit guidance on valuing changes in crowding for non-rail public transport modes, but exactly the same principles - that it is more

uncomfortable to travel in crowded conditions and this could be captured through multipliers on the value of time - apply for travel on buses, trams and light rail systems. Figure 17 presents results from the crowding experiment across all of the public transport modes.

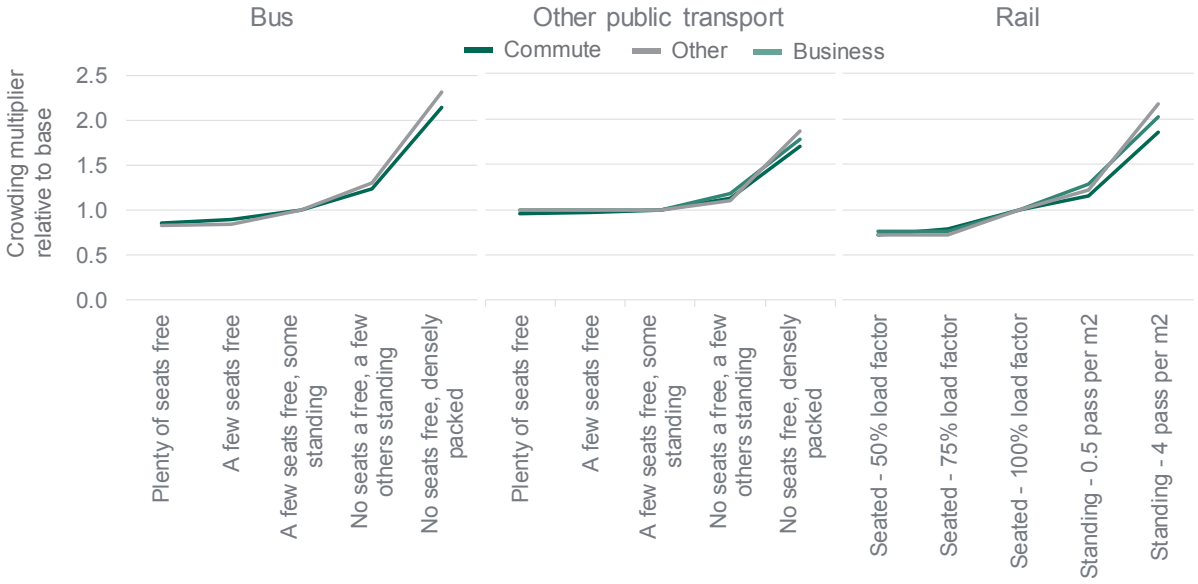


Figure 17 Crowding multipliers for all public transport modes

5.18 As with rail, the results for bus and other public transport (which includes London Underground and tram / light rail) show that the values of time increase with crowding, especially for standing relative to sitting. Furthermore, the multipliers for "no seats free - a few others standing" are similar to rail results for standing at 1/2 a passenger per m^2, and for "no seats free - densely packed" are similar to those for rail standing at 4 passengers per m^2. Therefore, one option in implementing the results from this research would be to extend the use of PDFH crowding multipliers to other public transport modes. The key benefit of this option is that the methods set out in PDFH provide a more detailed framework for valuing changes in crowding than could be taken from this latest research on its own.

5.19 However, the presentation of crowding in this research differed between rail and the other public transport modes; the metrics used in the PDFH methods, load factors for seated passengers and the number of passengers per m^2 for standing, might not be applicable to other modes; and those preparing business cases for investments in these other modes might not have access to PDFH. Therefore, it might be preferable to provide separate guidance on how to assess crowding changes for other public transport modes, or it might be that this research alone does not provide sufficiently detailed evidence for implementation at this stage.

Feedback would be particularly welcome on the options for implementing results on crowding for non-rail public transport modes.

Crowding guidance for public transport modes

14. On the basis of the evidence presented here, do you agree with our plan to continue applying PDFH rail crowding multipliers?

15. Should it be a priority to provide guidance on valuing crowding reduction benefits for bus and other (non-rail) public transport modes in WebTAG?

16. Do the crowding levels described in this study offer a suitable basis for that guidance? If not, what metrics to describe crowding levels should be used? And can these be translated or mapped to the levels used in this study?

17. Are there are other sources of information or research that we should be aware of when preparing guidance in this area?

Congestion levels

5.20 The results presented above (in Figure 9, Figure 10, Table 2 and Table 3) for business, commuting and other non-work values of time are from SP1, the experiment that traded between journey time and cost, only. This is a fairly simple experiment, with the key benefit of being comparable to previous UK studies and more recent studies elsewhere in Europe. However, this simplicity leaves some ambiguity around the type of time or travel conditions that the values relate to. For example, are they for free-flow traffic / uncrowded rail travel, or for more congested or crowded conditions.

5.21 This question was addressed more directly in SP3, the 'quality' experiment. For rail and public transport modes, this experiment predominantly covered crowding (with those results discussed above). For car travel, SP3 broke down journey time into time spent in different traffic conditions, allowing the value of time to be estimated for 'free-flow', 'light traffic' and 'heavy traffic' conditions. The results from this experiment have two potential uses:

- to help interpret the results from SP1 and determine the travel conditions they relate to; and/or
- to introduce 'congestion multipliers' similar to the crowding multipliers used for public transport modes, to reflect changes in the value of time with the level of congestion.

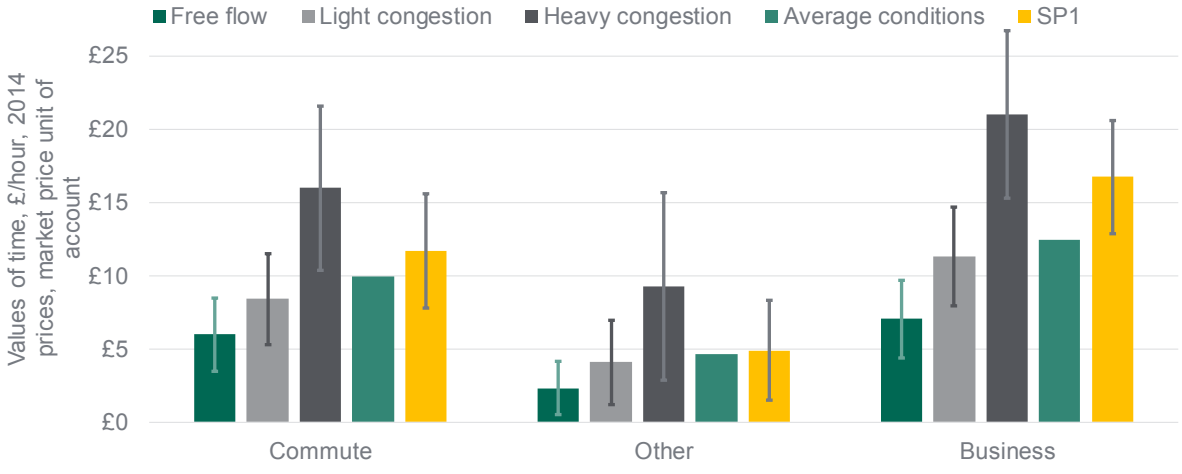


Figure 18 Values of time by congestion level

5.22 The results are presented in Figure 18 and, as with previous research that has looked at this issue, show that the value of time increases with the level of congestion - reflecting the increased stress and effort associated with driving in more congested conditions. The values of time from SP1 presented earlier in this document are similar to the average of the three traffic levels, when calculated with the amount of time in each reported in the surveys. This suggests that the values from SP1 reflect some form of 'average' conditions rather than, for example, values for free-flow traffic.

5.23 While in the short-term we plan to implement results from the SP1 experiment, with further research we could move towards using the greater detail provided by the results from SP3. This is discussed in more detail in Section 8.

Service frequency and waiting time for public transport

5.24 The frequency of timetabled public transport services can be considered as part of a wider definition of the convenience of public transport. Changes in service frequency can be assessed in two ways in transport appraisals:

- through changes in waiting time, which receives a multiplier on the 'base' value of time (similar to crowding) based on extensive evidence that waiting time is valued more highly than 'in-vehicle time'[21]; or
- through 'service frequency penalties' that represent the 'cost' of a given frequency in terms of equivalent additional in-vehicle time.

5.25 Currently, WebTAG recommends a waiting time-based approach, with a multiplier of 2.5. However, especially with lower frequencies and for those familiar with the timetable, the time people actually spend waiting at a station or stop might not fully reflect the inconvenience of the service frequency, which might also affect when people have to (rather than when they would prefer to) leave or arrive. Therefore several areas of the research looked at the valuation of service frequency (referred to as 'headway' in the final report).

5.26 Figure 19, below, presents results from a mode choice stated preference experiment and SP3 of the bus survey, and compares them with results of meta-analysis that reviewed over 300 estimates of service frequency multipliers from across Europe[22]. The service frequency multipliers from the mode choice experiment are broadly in-line with existing evidence from the meta-analysis. However, within this context there are some results that conflict with previous evidence (such as higher multipliers for other non-work than commuting or business travel) and, when the other areas of the research that also looked at service frequency are considered, the results are rather inconclusive.

[21] For example, evidence from *European Wide Meta-Analysis of Values of Travel Time, Wardman et al (2013)*, presented in Figure 20, below.
[22] Value of Time Multipliers: A Review and Meta-Analysis of European-Wide Evidence, Wardman (2013).

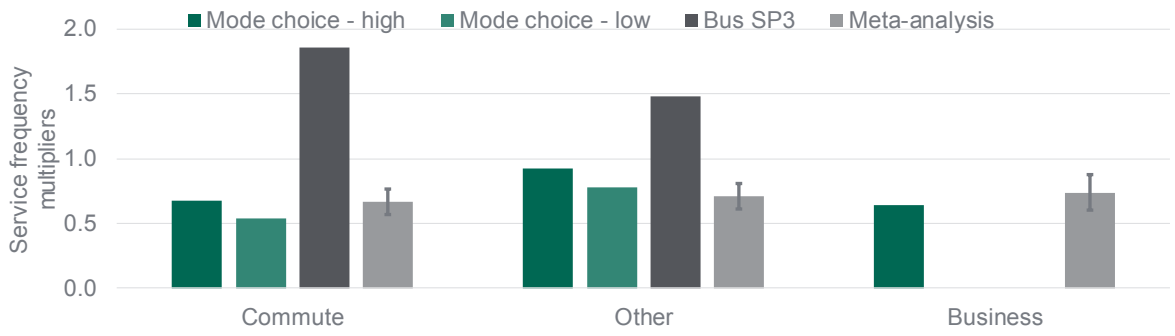


Figure 19 Service frequency multipliers from the research and existing evidence

5.27 Given the inconclusive nature of these results, our plans for changes to guidance in this area are based on pre-existing meta-analysis evidence, rather than results from this research. Figure 20 below compares the current WebTAG multiplier for waiting time of 2.5 with results from meta-analysis covering over 130 estimates of wait time multipliers[23]. The multiplier of 2.5 is clearly above the range of results from the meta-analysis, which draws from a wide evidence base. Therefore, we plan to revise the waiting time multiplier to 2.0, to reflect this evidence from other studies. Also, given our plans to introduce fully willingness-to-pay based values of time for business travel, this multiplier would be applicable to business, as well as non-work, travel.

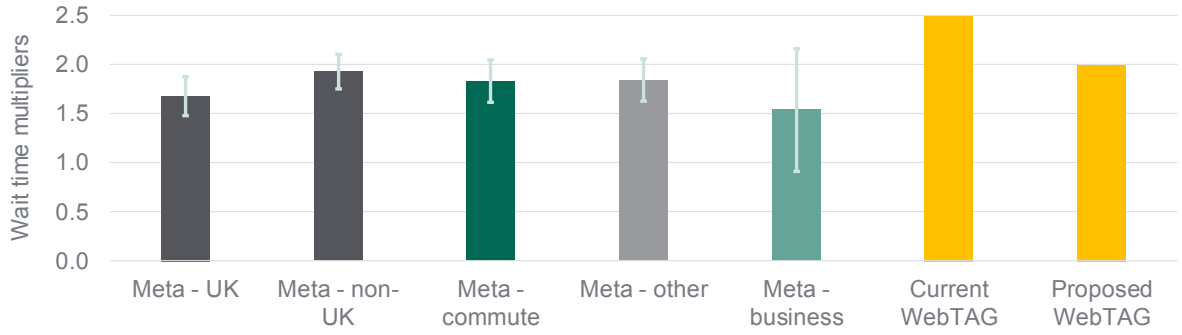


Figure 20 Wait time multipliers - results from international meta-analysis

5.28 As discussed above, in some contexts, especially with longer intervals between services, wait times might not fully reflect the inconvenience of timetabled services. This is reflected in demand forecasting practice in some areas, for example in rail forecasting guidance in PDFH. Therefore, to improve consistency between forecasting and appraisal, and to more fully reflect the impact of changes in service frequencies, we also plan to revise our guidance to explicitly cover the use of service frequency penalties in appraisal, where they have been used in the forecasting.

Service frequency and wait time for public transport

18. On the basis of the evidence presented here, do you agree with our planned changes to guidance on wait time and service frequency multipliers?

[23] Value of Time Multipliers: A Review and Meta-Analysis of European-Wide Evidence, Wardman et al (2013).

6. Walking and cycling

Challenges in estimating values of time for walking and cycling

6.1 While there is an extensive evidence base and literature on values of time for motorised travel, there is relatively less evidence on the benefits of quicker walking or cycling journeys. While the same willingness-to-pay techniques can be used, there are two additional challenges in applying them to walking and cycling:

- Firstly, introducing the concept of payment, required to produce monetary willingness-to-pay values, for modes that are essentially free of charge; and
- Secondly, presenting differences in journey times in a manner that is clearly separated from the amount of effort - i.e. so that shorter walking and cycling journey times aren't simply assumed to be a result of walking or cycling quicker.

6.2 The piloting in Phase 1 indicated that this first issue had not been fully addressed. There were high levels of non-trading - respondents always choosing the 'free' alternative - which led to very low values of time. To some extent this might be expected - walkers and cyclists have chosen a mode of transport that is (often, but not necessarily always) cheaper and slower than other modes, suggesting they have low values of time. However, the high levels of non-trading indicated that there was at least some degree of 'protest' affecting the results - where respondents were choosing the free alternative as a protest against the concept of paying for dedicated walking or cycling infrastructure, rather than expressing their 'true' preferences.

6.3 Therefore, in Phase 2 we undertook a further round of qualitative research and survey design for a second round of piloting, rather than rolling out a larger scale survey. As it was progressing along a different track to the rest of the research, the walking and cycling element of the project has reported separately and full details of what was done, and the results from both sets of pilots, are available with the other research reports[24].

Results from the walking and cycling research

6.4 Results from the second set of pilot surveys are presented in Figure 21. The method for walking, which was based around egress walking trips from car parks or bus stops, worked well. This is likely to be because respondents were familiar with the concept of payment for parking and bus fares, making it easier to introduce a trade-off between the walking time and the cost. However, despite very careful survey design and location selection, the cycling experiment, which was based around payment for dedicated cycling infrastructure, was less successful, with the results still indicating that 'protest' responses were leading to high levels of non-trading.

[24] https://www.gov.uk/government/collections/transport-appraisal-and-strategic-modelling-tasm-research-reports#valuing-journey-improvements

6.5 For both walking and cycling, two stated preference experiments were presented to respondents. The first offered a trade-off between time and cost (SP1) and the second between journeys made up of time spent in different conditions (such as with or without segregation from motor traffic) but without any associated costs for the two journey options (SP2). The intention was to use the monetary valuations from SP1 in conjunction with preferences for the different conditions in SP2 to be able to elicit values for the different conditions that could represent the benefits of improving the 'quality' of the walking and cycling environment. However, despite showing promise in the earliest stages of piloting, the SP2 experiments did not produce reliable results, suggesting there were too many variables being presented to respondents.

6.6 The walk and cycle questionnaires also included an additional form of stated preference experiment. Rather than presenting two different alternatives and asking respondents to choose between them, the 'contingent valuation' experiment simply asked respondents if they would be willing to pay a certain amount for a 5 minute time saving. The initial amount offered was randomised between 40p and £1 and, depending on the first response, was increased or decreased by 10p increments until the respondent's answer changed, giving their willingness-to-pay in a 10p range.

6.7 This contingent valuation (CV) method produced reasonable, realistic results and these are presented below in Figure 21, alongside the results from SP1 for walking and the SP1 values for non-work trips under 10kms from the motorised element of the research. There is a high degree of similarity between the CV and SP1 results for walking, while the CV values for both walking and cycling are within the confidence intervals around the values for motorised trips under 10km.

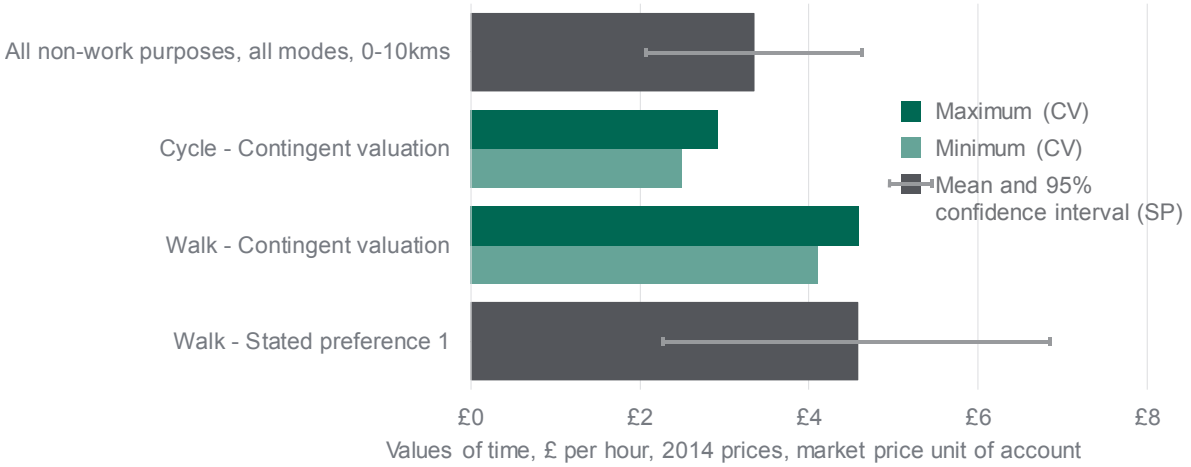


Figure 21 Values of time for walking and cycling

Implementing the walking and cycling results

6.8 Given the high level of comparability shown in Figure 21, we plan to apply the non-work (for commuting and other non-work travel) values from the motorised element of the research to walking and cycling as well.

6.9 For business travel, Figure 10 showed the high degree of comparability between the values for motorised modes for shorter distance trips. Given the similarity in the results, we plan to use those values for shorter distance trips by other motorised modes that were not included in the survey and, therefore, we also plan to apply the short distance business values to walking and cycling business trips.

Implementing values of time for walking and cycling

19. On the basis of the evidence presented here, and in the research reports, do you agree with our proposal to apply values from the motorised modes to walking and cycling?

Further research

6.10 We have outlined above how we plan to implement the results from the research project as a whole, and how this will apply to walking and cycling in a consistent manner. However, there is potential for further research in the area of values of time for walking and cycling. This is discussed in more detail in Section 8.

7. How confident can we be in the results

7.1 The results from value of time research project represent a significant enhancement to our evidence base, providing the latest evidence on how much people and businesses are willing to pay for time savings and reflects modern lifestyles, working practices and technologies. The project has extended the stated preference approach to cover business values; significantly increased the size of the sample upon which the values are based; and extended the surveying to cover multiple modes. The research project was undertaken by a team comprising many of the country's, and the world's, leading experts in the fields of value of time estimation and choice modelling. They employed well-established stated preference survey techniques and deployed existing, state-of-the-art choice modelling methods to meet the scope of the study. The project was subject to review and challenge at key milestones from an Analytical Challenge Team of leading experts, and has also been subject to independent peer review and audit. On this basis, this research represents a significant improvement in the evidence base on valuing journey improvements, and we firmly believe the values presented in this document are sufficiently robust and reliable for use in the appraisal of transport investments. The following sets out how we have reached this position.

7.2 The project was highly complex, involving a large-scale survey that covered multiple modes of transport, journey purposes and valuation of multiple journey characteristics; and state-of-the-art modelling and analytical techniques to estimate robust and reliable values from those survey responses. Throughout the course of the project a large number of decisions were made and implemented about how the study should be carried out, from the wording and delivery of questionnaires through to the formulation of models to estimate values.

7.3 The reliability and robustness of the resulting values was of paramount importance and throughout the project processes were in place to assure the quality of the analysis. The study team comprised many leading experts in the design and delivery of stated preference experiments and the choice modelling techniques used to estimate the values of time. This experience was complemented by an Analytical Challenge Team, who were at arm's length from the day-to-day running of the project and provided a 'critical friend' challenge function for the study team and the Department.

7.4 Both the choice models and the Implementation Tool were subject to rigorous quality assurance processes. The Appendix I to the final report details the validation checks carried out on the Implementation Tool and we have also published a separate document setting out the QA processes relating to the behavioural choice modelling, which included an audit of the model code, undertaken by a highly experienced member of the study team who was not directly involved in producing the code or estimating the models[25].

[25] Details of the modelling QA processes are available here: https://www.gov.uk/government/collections/transport-appraisal-and-strategic-modelling-tasm-research-reports#valuing-journey-improvements

7.5 To provide further assurance around the reliability and robustness of the study's results, we commissioned an independent peer review and audit of the project, led by SYSTRA Ltd., in collaboration with specialists at Imperial College London and the Technical University of Denmark[26].

7.6 The peer review team recognised the highly complex nature of the project and concluded that the study team had successfully tackled many of the challenges involved in collecting and cleaning a large quantity of complex data through systematic and rigorous procedures for:

- Recruiting in-scope survey participants;
- Collecting survey responses; and
- Securely transferring, cleaning and processing the data for subsequent analysis.

7.7 The review team was also generally content with the design of the SP experiments and noted the considerable technical skill exhibited in the choice modelling and estimation of values. They also undertook a detailed audit of the Implementation Tool, concluding that it correctly implemented the approach to calculating national, representative values.

7.8 As might be expected in a research programme of this scale and complexity, the peer review team made a number of observations regarding potential limitations to the design and implementation of the study. We do not believe these observations invalidate or undermine the results presented here. Whilst our investigations have not yet yielded any evidence that these observations materially affect the results, they may merit further investigation as we continue to refine and improve our analytical methods. In the following section we discuss each of the key observations made by the peer review team.

Responding to points raised in the independent peer review and audit

A minority of respondents did not receive visual stimuli relating to the stated preference experiments when completing the interviews by phone

7.9 As discussed above, a 'mixed methods' approach to data collection was employed so that those who did not want to, or could not, complete an online survey would not be excluded from taking part. The questionnaire was designed to use information given in response to earlier questions in the presentation of the stated preference experiments and, given the complexity of the different areas covered by the stated preference experiments, collecting all of this information at the recruitment stage would likely have impacted significantly on recruitment rates. Therefore, for interviews completed by phone, it was necessary to pause the interview part way through to send, by email or post, the visual stimuli relating to each stated preference experiment and tailored to that individual. This introduced the risk of attrition, as some people might drop out and not complete the survey, but this risk was judged to be less severe than the risk to recruitment of collecting all of the information at the recruitment stage.

7.10 The review team interviewed a number of respondents and interviewers and identified that in a number of cases, phone respondents did not receive the visual

[26] The peer review report is available here: https://www.gov.uk/government/collections/transport-appraisal-and-strategic-modelling-tasm-research-reports#valuing-journey-improvements

stimuli but instead had the stated preference experiments read out to them over the phone. Especially given the complex nature of the experiments relating to reliability and 'quality' factors like crowding and congestion, this approach could certainly have affected the quality of responses, and therefore the resulting data, from these respondents.

7.11 The number of respondents who received the stated preference experiments in this way is unknown, but the phone completed interviews as a whole made up 16% of the completed interviews. Therefore it is likely that only a small minority of the dataset was affected by this issue. While not looking specifically at this minority of respondents, the study team undertook two tests to investigate the impact their responses could have had on the final values:

- In their final model, they tested for differences in values between those who completed the interview online and by phone, finding no statistically significant difference (at the 95% confidence level).
- A more stringent set of cleaning criteria were applied that excluded all phone respondents; all those who completed the online questionnaire in under 10 minutes; and all those who "somewhat disagreed" or "strongly disagreed" with diagnostic questions around the realism and ease of understanding the stated preference experiments, which the peer review team had also identified as potentially indicating poor quality responses. The remaining sample was tested in the same model as reported in table 4.4 of the final report, with no significant impact on the resulting values.

7.12 Therefore, while the peer review team's findings will influence how we conduct future surveys in this area (which is discussed in more detail in the next section), the results from the tests undertaken indicate that 'poor quality' data from a minority of respondents had no material impact on the final results from the study.

The format of the stated preference experiments might have introduced external influences that affect the resulting values

7.13 This observation related primarily to the stated preference experiment for car travel that traded just journey time and cost (SP1), where differences in journey times were described as "*The one way travel time may be different because of changes in congestion*", and differences in costs were described as "*The one way travel cost may be different because of a change in the cost of fuel*".

7.14 There are potentially two issues here, which are linked. The first potential issue is that introducing these explanations of differences in journey times and costs introduces external influences that affect how people responded to the choices they were offered, and the resulting values. There is a trade-off here with the realism of the stated preference experiment - for them to be fully meaningful to respondents, some context is needed around why there would be differences in journey times and costs. Alternative explanations would be possible, such as different routes leading to different journey times or tolls or parking charges causing differences in cost, but these would carry similar, or in some instance greater, risks of affecting how people responded. The approach used was similar to that employed in the last UK national value of time study and similar explanations for differences in journey times and costs have been given in more recent studies elsewhere in Europe. Therefore, while we accept that this is an area that could be explored in future research, we do not believe that the context given around differences in journey times and costs in any way undermines the values resulting from the study.

7.15 The second potential issue is linked to the first in that the typical real-world relationship between speed and fuel consumption could often lead to quicker trips being cheaper than slower ones, rather than more expensive (as is required in the stated preference experiment to introduce a trade-off between time and cost). The peer review report contains several quotes from focus groups undertaken during Phase 1 that highlight this issue. However, these quotes relate to a format of the experiment that was tested that explicitly labelled the different alternatives as using different routes. However, these issues were not identified for the 'abstract' presentation that was actually used in the surveys, and the Phase 1 report also included a number of quotes demonstrating that participants in the focus groups fully understood what was being asked:

"Well my understanding is whether we want to pay more from saving the time for the travel, how much are you willing to pay, are you going to, are you prepared to pay the extra or not, that's how I see it."

"Because you save 30 minutes for just an extra fiver."

"I thought they were two different options but it didn't matter what the option was, what matters was the cost, I thought was the point, as a business are you prepared to pay the extra £30 to save half an hour or not."

7.16 The responses to the diagnostic questions presented earlier in this document also show that the vast majority of respondents considered the experiments to be realistic and reflect how they make real-life decisions.

7.17 The peer review team also raised concerns about the context given in the reliability experiment (SP2) for car respondents, that giving breakdowns or roadworks as the reason for unreliable journey times might have affected results. As discussed above, the context that was given might have contributed to the higher values coming from this experiment, but the values from this experiment were also high for the other modes, where the peer review team did not identify the explanations given in the introduction to the experiment as an issue. Therefore it is unclear what has caused the higher values resulting from the reliability experiment, but, in our planned implementation of the result described above, we have contained any bias by estimating reliability ratios and lateness multipliers entirely from the results of this experiment.

7.18 The final models in the study were estimated on data from all three stated preference experiments. The study team tested whether this approach affected the values from SP1 - which form the basis of our planned implementation - by running the final models only on the data from that simpler time vs cost trade-off. This test resulted in only a 3% difference in the value of time, demonstrating that higher values from SP2 or SP3 have not materially affected our planned appraisal values, which are based on SP1.

The reliability stated preference experiments did not give explicit probabilities associated with each possible journey time

7.19 Estimating values of reliability from stated preference experiments is challenging given the difficulty and complexity of presenting uncertainty effectively in these experiments. Throughout Phase 1 of the project, the presentation of the reliability experiment was a specific focus of the qualitative research - it was developed through focus groups, cognitive testing and piloting before the final presentation was determined.

7.20 This final presentation included an introduction that said:

*"Imagine that on five occasions that you make the journey **departing at the same time and on the same day of the week**, the actual travel time varies for the reasons suggested above. We want you to think about that journey and look at the two options below, each of which show five possible travel times that could arise."*

which clearly implies, but does not explicitly state, that the five possible journey times were equally likely. There is an extensive literature from behavioural economics and psychology that, when faced with more complex choices, survey respondents will often employ heuristics, or mental shortcuts, to make the problem easier. Such heuristics could have been applied regardless of whether the additional words "*equally likely*" were included in the introduction.

7.21 Therefore we do not believe that this issue substantially affects the reliability or robustness of the results but agree that this is an issue that could be further explored in future research.

The modelling approach relies heavily on assumptions about reference dependence, without investigating whether it is a 'real' or 'stated preference' effect

7.22 'Reference dependence' refers to the well-established tendency for preferences, especially when expressed in surveys, to depend on a reference point - i.e. whether there are 'gains' or 'losses' and whether changes are 'large' or 'small'. These effects were notably put forward in Kahnemann and Tversky's Prospect Theory[27] and have subsequently been found in a number of contexts, including value of time studies.

7.23 In transport appraisal, what we need are 'reference free' values of time. Transport appraisals are not really concerned with changes from the status quo, or some reference point, but with comparing two alternative versions of the future, one with and one without the intervention being appraised. Given the long asset life of transport infrastructure, transport investments are appraised over a long period so that the journey times, costs, and even the people travelling on the route, will change. Therefore the concept of a reference point, and defining changes in journey times as gains or losses relative to some reference point, becomes less relevant, especially as one of the two versions of the future being considered will never be experienced[28].

7.24 As reference free values are what is needed, it is important to identify reference dependent effects in the values of time so that they can be removed. Otherwise there is a risk that the values will be biased. The study team undertook an extensive review of available modelling methods to do this and considered the approach used in several recent Scandinavian value of time studies to be the best available[29]. They extended this method to cover the three experiments required in this study and found strong, statistically significant evidence of reference dependence (relative to the reference trip given by respondents) in the survey responses.

7.25 This fully justifies the study team's approach as, if they had not investigated reference dependence effects in this way, they would likely have biased the values.

[27] Prospect Theory: An Analysis of Decisions Under Risk, Kahnemann and Tversky (1979).
[28] For further discussion of this issue, see Experiences from the Swedish Value of Time study, Borjesson and Eliasson (2013)
[29] See, The Trade-off between money and travel time: A test of the theory of reference-dependent effects, De Borger and Fosgerau (2008)

The balance of effort in the study was skewed towards developing advanced choice models, at the cost of more detailed investigation of data quality issues and requiring ad hoc assumptions to be made in implementation

7.26 We do not believe that the peer review team's general impression, that effort exerted on developing the choice modelling framework adversely impacted on other areas of the study, reflects the reality of how the study was conducted. The majority of the theoretical development of the modelling framework was undertaken in parallel (or subsequent) to the data collection, and it built on methods that had already been successfully employed in other studies. During the estimation stage, the majority of effort was spent investigating which variables significantly impacted on the values of time and should be included in the final model, not in developing the framework itself. Therefore the allocation of any additional study time to investigating data quality issues would have come at the expense of developing final models that best estimated the final values of time. Furthermore, the tests undertaken to explore the impact of potential data quality issues showed that there was no material impact on these values.

7.27 The peer review team also felt a number of assumptions made in the implementation of modelling results to produce the values of time were ad hoc in nature:

- *'ignoring' gamma and eta* - the variables gamma and eta formed part of the approach to identifying, and controlling for, reference dependence effects. In the modelling approach used, they drop out of the calculation of a value of time free of gain/loss effects but are not ignored - their estimation ensures that the estimated values are free of these effects so that the value of an x minute time gain is of equal and opposite value to an x minute time loss.
- *choice of 'delta t' is arbitrary* - while the gamma and eta variables drop out of the calculation of a reference free value of time, the values depend on 'delta t', the difference between the journey time in the stated preference experiment and the 'reference' journey time (i.e. from the trip the respondent had made). Therefore values have to be calculated for a chosen level of 'delta t'. The study team recommended 10 minutes, which is consistent with application in other studies that had used the same approach, and the Implementation Tool allows values of time to be calculated easily for different levels of delta t. We have used the Tool to investigate how the values vary with the level of delta t chosen and Figure 22 shows that the confidence intervals around values calculated for a delta t of 10 minutes encompass values calculated for a wide range of delta ts, from about 3 to 20 minutes

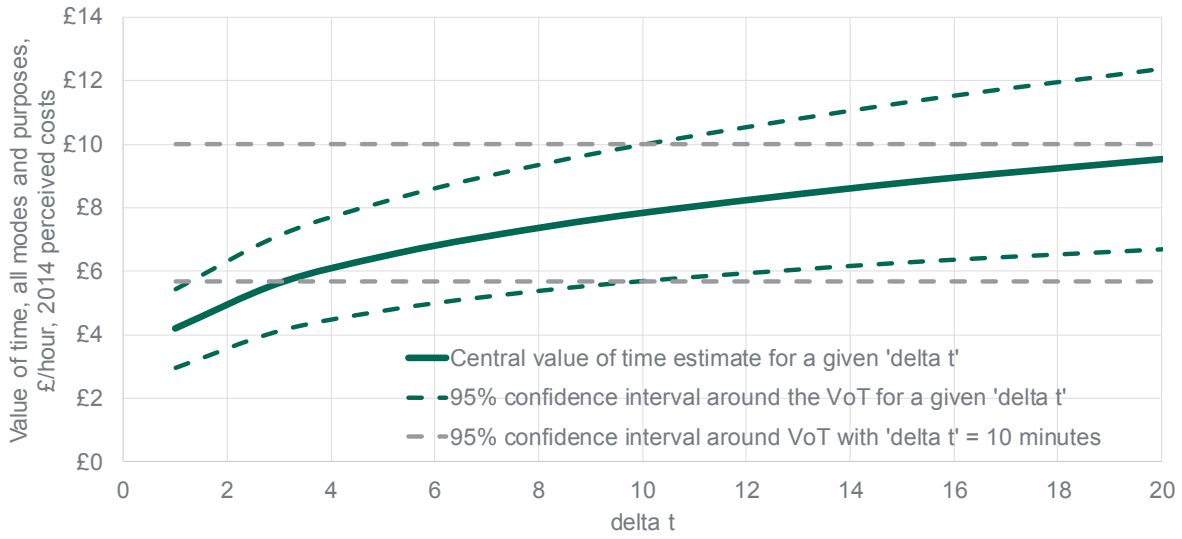


Figure 22 Variation in the value of time with the level of 'delta t' used in the estimation

- *the Implementation Tool employs simple averaging and imputation methods in some areas when calculating national average values of time* - the Implementation Tool represents a significant development in the level of sophistication in calculating national average values of time, and the statistical uncertainty around them. Whilst there are several areas where relatively simple assumptions (such as using 'average' responses from the surveys for some variables) and methods (such as imputation of costs to give point estimates of car costs) have been used, we believe that these were appropriate and proportionate and, given the overall improvement in the approach encapsulated by the Implementation Tool, lead to an improvement in the robustness and reliability of the values of time.

8. Plans for further research

8.1 This project is the culmination of a programme of research over the last 5 years and represents a significant development in the quality of our evidence base for valuing the impact of transport investments and providing high quality, evidence-based advice to decision makers. The results provide us with a fully up-to-date set of values of time, not only in terms of the age of the data but also in how they address developments in modern working practices, lifestyles and mobile technologies.

8.2 The developments around the business values of time are particularly significant. By directly surveying business travellers and representatives and applying willingness-to-pay techniques, these new business values of time take account of a wide range of factors such as the increasing ability for people to use travel time productively and what alternative use any 'saved' time will be put to.

8.3 Also, by covering a wider range of transport modes than in our previous studies, and employing more advanced, state-of-the-art analytical approaches, we have significantly increased our understanding of the key factors that cause variation in the values of time, and the level of uncertainty around the values.

Making the data available

8.4 However, as we have set out before, the development of our analytical framework is a continuous process. We need an ongoing programme of research to ensure that the evidence base continues to keep pace with evolving challenges and opportunities. In the short-term we are undertaking some additional, internal analysis of the data and, following completion of that work, plan to make the data available for further secondary analysis.

8.5 In the longer-term, we plan to scope and undertake a programme of further research. This section sets out several potential areas of research and we would welcome stakeholder feedback on where our priorities in this area should lie over the coming years.

Scoping an ongoing programme of value of time research

8.6 While we have undertaken a significant amount of research in the intervening period, these surveys came 20 years after we last undertook surveys for a national value of time study. Therefore an important element of our future research is likely to take the form of an ongoing programme to ensure the values remain up-to-date and provide more evidence on how the values change over time.

8.7 Before setting up this programme, we would likely undertake a feasibility exercise, to scope the form it should take. This would tackle questions such as:

- Are there alternatives to survey based methods that could be used to 'monitor' changes in the values of time?
- If surveys are the best approach, with what frequency and on what scale should they be undertaken? What sample sizes are required? Is it necessary to cover all of the modes included in this project in every wave of surveys?

- If smaller surveys are undertaken, what criteria or thresholds should there be for triggering changes to the values in our guidance, or larger scale surveys?
- What is the best position in the trade-off between faithfully repeating what was done in this project vs. making incremental improvements or developments to the approach? For example, within an ongoing programme, what potential is there to test issues such as the impact of introductions to the SP experiments on responses and the resulting values; how costs are described for car travellers; or to explore alternative choice modelling approaches?

Exploring the use of distance-based values of time

8.8 The evidence that the values of time increase with trip distance is very strong, especially for business travel, and we are confident that distance-based values can be applied in an appraisal context. However, we aware that the 'appraisal' values in WebTAG are also often used as 'behavioural' values in transport models. Therefore this area of research would focus on application of distance-based values in modelling, covering issues such as:

- Whether there is a need for consistency between 'appraisal' and 'behavioural' values;
- The consistency between the relationship with distance found in this research and cost damping methods described in TAG Unit M2; and
- In what conditions and / or circumstances, and in what way, distance-based values could or should be applied in modelling. For example, are continuous functions preferable to banded values? And would it be more important in demand or assignment models?

Further analysis of the non-work values of time, and differences between them by mode

8.9 The research results, and the analysis using the Implementation Tool we have presented here, show a very clear relationship between the value of time and trip distance. This is especially the case for business travel, where values for users of different modes are similar for trips of the same distance. However, for non-work travel, while the values show a strong relationship with distance, the differences between modes are more mixed.

8.10 This might be due to 'self-selection' by users of modes of transport that best meet their preferences - i.e. people with lower values of time would be expected to choose cheaper and slower modes of transport - which could in turn be influenced by differences in incomes between users of different modes.

8.11 We can control for differences due to income by estimating income elasticities and calculating the values of time at a constant, average level of income. However, the analysis undertaken in this project was on a modal basis, which gave different income elasticities for different modes. The illustrative example in Figure 23 shows how estimating relationships between the value of time and income for each mode separately could mask the 'global' relationship across the population as a whole.

8.12 Therefore, a first part of this research would be to combine together the analysis of the different modes, likely focusing on SP1 which is essentially the same across all the modes. This would enable estimation of a single income relationship across the entire sample and of residual modal effects on the values of time.

8.13 These results could potentially lead to greater segmentation of the non-work values, e.g. along similar distance and modal lines to the business values. Therefore the

research will also cover the equity implications of potential further segmentation of these values. For example, how should income differences be treated in the calculation of the values? And are there any other mechanisms in the appraisal and Value for Money framework as a whole where equity considerations could be reflected?

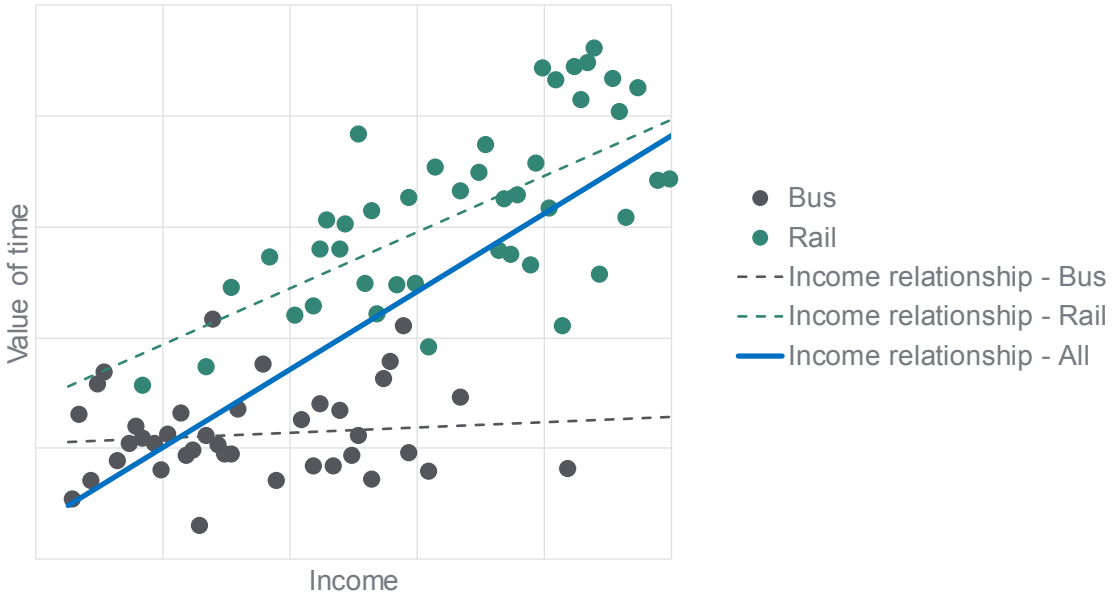


Figure 23 Illustrative example of income relationships estimated jointly and separately for different modes

Using values from SP3 - congestion-based values for road travel

8.14 In-line with the recommendations in the final report, the values of time we plan to implement are taken from SP1, the simple time vs. cost trade-off experiment. This has a benefit in terms of consistency, both with our current values, which are derived from a similar experiment, and across modes, as SP1 was essentially the same across all the modes covered in the study.

8.15 However, there is a degree of ambiguity around precisely what conditions these values relate to, and it can be argued that more complex stated preference experiments, such as SP3, which produced values of time for different travelling conditions, elicit more reliable results by providing greater context. Including SP3 in the study and ensuring it was completed by all respondents has reduced the ambiguity by allowing comparison of the values resulting from the different SP experiments. We could go further and, with more research and development of appraisal methods, base the values of time used in appraisal more firmly on the results from SP3.

8.16 For rail, such methods already essentially exist in the form of multipliers on the values of time that are used to estimate the benefits of reduced crowding. One element of this area of research would be to explore whether similar 'congestion multipliers' could be used in a roads context.

8.17 An alternative would be to estimate 'average' values from the values of time for the three congestion / traffic conditions in the study. Important considerations would include what data are available / would be needed to represent the 'average' conditions faced by beneficiaries of transport investments; and how to relate the three traffic levels covered in the study to other measures of traffic or congestion?

8.18 Finally, but possibly most importantly, research in this area could also cover the use of congestion-based values of time in demand and/or assignment modelling.

8.19 There are links between these areas. For example, if congestion-based values of time were implemented in transport models, it would affect how they could be applied in appraisals. However, the final question, whether congestion-based values could be applied in modelling, and whether they would produce models that reflect actual travel behaviour, is critical. The differences between the values for the different traffic conditions are very large and, as noted in the final report, imply people would be willing to travel significantly longer distances to avoid heavy traffic. If it were not possible to apply these differences in models in a way that reflects actual travel behaviour, then it would cast doubt on whether the differences in the values should be applied in appraisals.

Walking and cycling

8.20 Walking and cycling initiatives and investments are typically aimed at increasing the uptake of travel by 'active modes' and, consequently, the benefits of these interventions are typically dominated by health benefits from increased physical activity; improvements to the 'quality' of walking and cycling journeys; and decongestion (including environmental) benefits from mode shift, rather than time savings for walking or cycling trips.

8.21 Therefore, in forming our programme of research, we will have to consider:

- The specific challenges relating to estimating values of time for walking and cycling, described earlier in this document;
- The greater impact on appraising walking and cycling schemes that would come from developing how we capture health and 'quality' impacts (rather than undertaking more value of time research); and
- The greater impact that further value of time research would have in other areas (rather than concentrating on values of time for walking and cycling).

Walking

8.22 The research team concluded that a 'full survey' could be rolled-out with fairly limited refinement to the survey design, likely involving simplifying the different walking conditions shown in SP2. A further challenge here would be the extent to which values derived from 'egress walks', which introduce the concept of payment in an uncontroversial manner, can be applied to 'pure walking trips'.

Cycling

8.23 Despite the multiple rounds of qualitative research and extensive efforts that went into designing the survey questionnaire and selecting appropriate survey locations, neither SP experiment was very successful for cycling. Also, the qualitative research and responses to the non-SP parts of the pilot surveys indicated that other factors, especially safety, are far more important to cyclists than quicker journey times.

8.24 Therefore any further research would likely require more qualitative research and piloting before a full survey could be rolled out. This would have to consider again how monetary payments could be introduced without eliciting a 'protest' response.

Priorities for future research

20. Of the options outlined here, where should our priorities lie for further value of time research?

21. Are there other areas not covered here that we should also be considering?

9. Seeking your views

9.1 Collaborative, open and transparent working with our stakeholders has been an important element of our analytical strategy in recent years. We have identified key questions or issues throughout this document and would welcome stakeholders' feedback in these areas. Responses to these questions, or more general feedback on our plans, should be sent to TASM@dft.gsi.gov.uk, with the subject 'Values of time research and implementation' by Friday 29 January 2016.

9.2 For convenience, the questions asked throughout the document are collated together below.

Distance-based business values of time

1 On the basis of the evidence presented here, and in the research reports, do you agree that we should introduce distance-based business values of time?

2 And do you agree with the 3 distance bands being proposed?

3 Should distance be based on 'crow-flies' or 'network' distances?

4 What practical difficulties might there be in applying distance-banded business values of time in TUBA appraisals? And how might these be overcome?

5 Similarly for non-TUBA appraisals, what practical difficulties might there be and how might these be overcome?

6 The 'appraisal' values will likely also be used as 'behavioural' values. For transport modelling, what would be the most desirable form for the business values? Could the distance-banded values be practically implemented? Or would it be preferable to have a continuous function or single, average values for modelling purposes?

Values of time for non-work travel

7 On the basis of the evidence presented here, and in the research reports, do you agree with our planned implementation of the non-work values of time?

Uncertainty around the values and sensitivity testing

8 Do you agree with the proposed range for high/low testing around the values, based on their 95% confidence intervals?

9 Are there additional data or values (e.g. for different segmentations) that it would be useful for us to make available for sensitivity testing?

Car occupancy

10 Do you agree with the proposal to update the car occupancy assumptions in the TAG data book and to project no future change in occupancy?

Reliability ratios for road travel

11 On the basis of the evidence presented here, and in the research reports, do you agree with our planned implementation of a reliability ratio of 0.4 for car travel?

12 The reliability ratio of 0.4 from this research, and the reliability ratio of 0.8 currently given in WebTAG, are both for car travel and no explicit guidance is currently given on reliability benefits for freight traffic. In practice, is the 0.8 ratio also applied for freight? And is there any other evidence we should be aware of when considering how the results from this research might or might not be applied to freight?

Average lateness multipliers for public transport modes

13 On the basis of the evidence presented here, do you agree with our planned implementation of changes to the average lateness multipliers for public transport?

Crowding guidance for public transport modes

14 On the basis of the evidence presented here, do you agree with our plan to continue applying PDFH rail crowding multipliers?

15 Should it be a priority to provide guidance on valuing crowding reduction benefits for bus and other (non-rail) public transport modes in WebTAG?

16 Do the crowding levels described in this study offer a suitable basis for that guidance? If not, what metrics to describe crowding levels should be used? And can these be translated or mapped to the levels used in this study?

17 Are there are other sources of information or research that we should be aware of when preparing guidance in this area?

Service frequency and wait time for public transport

18 On the basis of the evidence presented here, do you agree with our planned changes to guidance on wait time and service frequency multipliers?

Implementing values of time for walking and cycling

19 On the basis of the evidence presented here, and in the research reports, do you agree with our proposal to apply values from the motorised modes to walking and cycling?

Priorities for future research

20 Of the options outlined here, where should our priorities lie for further value of time research?

21 Are there other areas not covered here that we should also be considering?

Freedom of Information

9.3 Information provided in response to this call for evidence, including personal information, may be subject to publication or disclosure in accordance with the Freedom of Information Act 2000 (FOIA) or the Environmental Information Regulations 2004. If you want information that you provide to be treated as confidential, please be aware that, under the FOIA, there is a statutory Code of Practice with which public authorities must comply and which deals, amongst other things, with obligations of confidence.

9.4 In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

9.5 The Department will process your personal data in accordance with the Data Protection Act and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties

Annex A: Sensitivity testing with the proposed values

A.1 This Annex describes two methods for carrying out sensitivity tests using the values of time from the research project as proposed in this document. The first method involves making 'off-model' adjustments to appraisal results; while the second involves inputting the proposed values of time in TUBA, or similar appraisal spreadsheets or software.

A.2 Within both methods there are variants depending on whether the level of information required to apply distance-based values of time for business travel is available.

Adjusting appraisal outputs

A.3 The simplest method to sensitivity test the impact of the recommendations in this document is to adjust existing appraisal results, based on the changes to the values. This requires appraisal results to be available split by the different elements in the appraisal (e.g. time savings separated from operating cost savings), journey purpose and mode.

Non-work time saving and reliability benefits

A.4 Table 6 sets out the adjustments to commute and other non-work time saving benefits, based on the difference between the proposed values and those currently given in WebTAG. Different factors are given for car and public transport modes, as the car adjustments also take account of the typical impact of the proposed revisions to car occupancy assumptions.

Journey purpose	Car	Public transport
Commute	+50%	+47%
Other non-work	-18%	-24%

Table 6 Adjustments to time saving benefits for non-work purposes

A.5 And Table 7 shows the adjustments that should be made to reliability benefits, which combines together changes to the values of time and the reliability ratios or average lateness multipliers.

Journey purpose	Car	Rail	Bus and other public transport modes
Commute	-25%	+47%	+18%
Other non-work	-59%	-24%	-39%

Table 7 Adjustments to reliability benefits for non-work purposes

A.6 These adjustment factors should be applied to the present value of the relevant benefits, for the specific mode and journey purpose.

Business time saving and reliability benefits

A.7 Where information on trip benefits by distance is available (for example in the table of monetised time savings by distance band in standard TUBA output files), the following adjustments should be made to the present value of time saving benefits (by mode and distance band):

Distance-band	Car	Rail	Bus and other public transport[30]
0-50km	-62%	-68%	-39%
50-100km	-39%	-49%	-2%
100km+	-5%	+13%	
Average	-33%	-8%	-39%

Table 8 Adjustments to time saving benefits for business travel

A.8 Table 8 also provides a set of 'average' adjustment factors that can be used when information on the distance-profile of business time saving benefits is unavailable.

A.9 Table 9 provides the adjustment factors for business reliability benefits, again combining together changes to the values of time, reliability ratios and average lateness multipliers.

Distance-band	Car	Rail	Bus and other public transport
0-50km	-81%	-68%	-52%
50-100km	-70%	-49%	-22%
100km+	-53%	+13%	
Average	-67%	-8%	-52%

Table 9 Adjustments to reliability benefits for business travel

A.10 As they were outside the scope of this study, no adjustments should be made to freight benefits.

Decongestion benefits calculated with Marginal External Costs

A.11 We plan to update the full set of Marginal External Costs, taking account of a wider range of developments to the evidence base, for release alongside new guidance in May 2016. In the meantime, for sensitivity testing purposes, the decongestion benefits estimated using the MECs should be adjusted by -10%, based on the change in the value of time of the 'average vehicle' across all journey purposes and road-based modes (as the benefits accrue to remaining road users, not those switching modes).

[30] Based on the current value of time for bus business passengers. If business values of time for other public transport modes form a significant proportion of benefits, a separate adjustment factor should be calculated, based on the short-distance value of time of £10.08, in 2010 resource costs.

Using the value of time research results as appraisal inputs

A.12 The alternative method is to re-run appraisals (e.g. using TUBA or similar appraisal spreadsheets), using the research results as inputs. This approach is more resource intensive but is also more accurate. For example, in capturing the impact of revisions to car occupancy assumptions, which will vary with project opening year.

A.13 Table 10 presents the values that should be input, in resource costs, perceived costs and market prices for each journey purpose; Table 11 presents the car occupancy assumptions that should be input (for a 2010 base year, although, given the 0%p.a. projected change in occupancy, the base year is fairly unimportant and the same occupancy rates should be used in every year of the analysis); and Table 12 provides adjusted Marginal External Congestion Costs.

Journey purpose / mode / distance-band	Resource cost	Perceived cost	Market price
Commute	£8.41	£10.01	£10.01
Other non-work	£3.84	£4.57	£4.57
Business by mode			
Car (driver and passenger)	£14.95	£14.95	£17.79
Rail	£24.66	£24.66	£29.35
Bus and other public transport	£8.33	£8.33	£9.91
Business by distance			
0-50km (all modes)	£8.47	£8.47	£10.08
50-100km (all modes)	£13.70	£13.70	£16.30
100km+ (car)	£21.11	£21.11	£25.12
100km+ (rail)	£30.41	£30.41	£36.19

Table 10 Values of time for use in sensitivity testing, 2010 prices

Journey purpose	Weekday					Weekend	All week
	AM peak	Inter-peak	PM peak	Off-peak	Average		
Commute	1.13	1.15	1.14	1.15	1.14	1.21	1.15
Other	1.71	1.82	1.79	1.79	1.79	2.12	1.91
Business	1.13	1.16	1.15	1.17	1.15	1.31	1.16
Average	1.35	1.63	1.43	1.45	1.48	2.01	1.61
Change in car occupancy per annum							
Non-work	0%	0%	0%	0%	0%	0%	0%
Business	0%	0%	0%	0%	0%	0%	0%

Table 11 Car occupancy assumptions for use in sensitivity testing

Congestion band	London			Inner and outer conurbations			Other urban		Rural			Weighted average
2010	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**M'way**	**A roads**	**Other**	
1	0.0	1.2	10.8	0.0	0.8	2.0	0.5	2.0	0.0	0.4	0.2	1.0
2	0.0	3.9	22.4	0.0	2.6	8.0	1.6	7.6	0.0	1.1	1.2	2.5
3	0.0	17.3	46.3	0.5	21.7	17.9	9.4	16.4	0.9	2.9	6.6	8.7
4	12.3	115.5	127.6	22.4	115.8	130.2	39.9	113.8	16.3	43.4	34.4	76.8
5	0.0	226.1	174.4	51.4	148.6	198.1	62.2	188.3	69.0	103.1	114.0	135.9
Average	0.1	58.8	40.6	2.5	29.9	20.8	11.6	9.5	1.0	2.0	2.4	10.0
2015	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**M'way**	**A roads**	**Other**	
1	0.0	1.2	11.6	0.0	0.8	2.1	0.5	2.1	0.0	0.4	0.2	1.1
2	0.0	4.1	24.8	0.0	2.7	8.4	1.7	7.9	0.0	1.1	1.2	2.6
3	0.1	20.2	47.8	0.5	21.9	18.7	9.6	16.9	0.6	3.1	6.4	8.7
4	13.5	98.4	121.0	16.0	111.1	113.9	37.6	114.3	15.7	42.6	29.1	69.3
5	0.0	209.9	187.1	55.6	181.3	220.1	65.4	201.5	67.1	111.1	123.7	148.0
Average	0.1	66.4	44.4	1.6	31.8	22.7	12.8	10.0	1.0	2.1	2.8	10.9
2020	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**M'way**	**A roads**	**Other**	
1	0.0	1.3	12.7	0.0	0.9	2.3	0.5	2.3	0.0	0.4	0.2	1.2
2	0.0	4.3	27.5	0.0	3.0	9.1	1.8	8.8	0.0	1.3	1.3	2.8
3	0.6	22.2	50.4	1.1	24.1	20.7	11.3	18.7	1.5	3.5	7.1	9.6
4	14.9	101.9	119.0	19.7	87.0	84.2	40.5	81.0	19.5	42.3	27.5	56.7
5	0.0	262.4	226.2	65.7	223.4	266.1	77.9	230.2	85.1	123.1	157.4	190.6
Average	0.4	89.6	55.9	2.8	41.2	28.9	16.4	12.1	1.8	2.8	3.7	14.1

Congestion band	London			Inner and outer conurbations			Other urban		Rural			Weighted average
2025	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**M'way**	**A roads**	**Other**	
1	0.0	1.5	13.0	0.0	1.0	2.4	0.6	2.4	0.0	0.5	0.2	1.3
2	0.0	4.7	29.7	0.0	3.3	9.6	2.0	9.5	0.0	1.4	1.7	3.4
3	1.7	24.8	55.7	2.4	26.0	22.6	12.6	20.4	2.5	3.8	7.6	10.3
4	19.0	104.8	131.4	21.9	96.9	95.4	42.9	79.4	20.9	43.9	27.9	56.8
5	0.0	362.1	275.4	74.6	267.8	333.8	92.1	271.1	90.3	142.1	209.3	237.3
Average	1.0	127.6	68.8	5.0	51.4	38.6	20.8	14.5	3.4	3.7	5.2	18.6
2030	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**M'way**	**A roads**	**Other**	
1	0.0	1.6	15.1	0.0	1.0	2.7	0.6	2.6	0.0	0.6	0.3	1.4
2	0.0	4.9	35.0	0.0	3.7	10.7	2.2	10.3	0.0	1.5	1.9	3.9
3	2.3	25.7	58.6	2.8	30.0	24.7	14.2	22.3	4.6	4.1	8.2	11.6
4	20.7	111.7	142.6	25.6	104.8	104.2	47.4	86.0	23.9	47.9	29.0	59.6
5	0.0	411.3	317.9	84.0	314.1	396.3	108.3	307.0	100.6	164.5	247.6	273.2
Average	1.7	157.3	82.4	7.0	63.0	47.2	25.6	16.7	5.8	4.6	6.5	22.9
2035	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**Other**	**M'way**	**A roads**	**M'way**	**A roads**	**Other**	
1	0.0	1.7	17.7	0.0	1.1	3.0	0.7	2.9	0.0	0.6	0.3	1.6
2	0.0	5.4	39.1	0.1	4.1	11.6	2.3	11.2	0.0	1.7	2.1	4.3
3	3.3	28.2	65.6	4.2	32.6	26.7	15.8	24.6	8.0	4.7	9.4	13.8
4	23.0	129.3	155.5	28.7	114.7	111.5	52.2	89.7	27.5	52.6	31.6	62.9
5	0.0	501.7	371.6	91.1	393.1	465.6	127.9	356.7	112.8	187.6	285.5	321.5
Average	2.9	200.9	98.5	10.5	80.0	58.5	31.7	19.6	9.8	5.8	7.8	28.8

Table 12 Marginal external congestion costs for use in sensitivity testing, 2010 prices

A.14 Applying these values in a sensitivity test would likely be a two-stage process:

1 First apply the non-work values and the business values by mode in Table 10; then

2 If distance-based information is available (for example, from standard TUBA outputs) adjust the results by distance-band, based on the average values by mode and the values by distance-band in Table 10.

A.15 Alternatively, where TUBA, or appraisal spreadsheets that produce similar results by distance-band, are used, the appraisal could be run three times (once for each distance band) with the appropriate business values by distance from Table 10 used as inputs. The results from each run of the appraisal for the relevant distance-bands could then be combined to give the total business time saving benefits.

Presenting the sensitivity testing results

A.16 The processes above will produce adjusted estimates of the time saving and reliability benefits of a project. If there are other categories of benefit that are based on multipliers of the value of time (such as rail crowding benefits), then they should also be adjusted in a similar manner.

A.17 The adjusted time saving (and other) benefits should then be combined with other elements of the appraisal, such as estimates of accident and environmental impacts, to produce a Benefit-Cost Ratio. This sensitivity test BCR (and an explanation of how the test was undertaken) should be reported in the business case, and, if significant, noted in the key risks and uncertainties in Value for Money advice.