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UNIVERSITY OF LEEDS
Institute for Transport Studies

PEER REVIEW OF PROPOSALS FOR UPDATED VALUES OF TRAVEL TIME SAVINGS

Prepared for the Department for Transport

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Arup URS Consortium,
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1. Background

On 29 May 2013, DfT commissioned a Peer Review and Audit of their updating work on the values of travel time savings for use in appraisal. An interim report was required by 7 June with a final report by 14 June. Owing to the timeliness and clarity of the materials provided and the speed with which queries were addressed, we were able to meet this schedule. Thanks are due to the project sponsor, Adam Spencer. The work has been carried out by ITS, University of Leeds and John Bates Services as sub-contractors to URS Arup under Lot 2 of the T-TEAR Framework Contract.

2. Objectives

The scope of this piece of work was clearly defined in the brief. The first task is to conduct a peer review of the methodology used by the Department to update the appraisal values of time, restricted to the following questions :

- Has the Department followed an appropriate methodological approach for updating the business values using a Cost Saving Approach?
- Has the Department followed correct methodology for updating the non-work values of travel time savings?

The second task is, within the given methodology, to audit the updating calculations. This requires checking that the spreadsheet formulae used are consistent with guidance and that the calculations and results are internally consistent and correct.

In practice there is a degree of overlap between the peer review and audit tasks especially in the area of how data sources such as the National Travel Survey have been used and we have therefore addressed these questions in a single report.

3. Business value of travel time savings

3.1. Overview of method

The DfT has updated its values of business travel time savings:

- Using the cost saving method (CSM) – that is the value of business time savings are equivalent to the full hourly costs of employment (labour costs plus labour related overheads);
- For each mode;
- Weighted by distance.

As part of this peer review these three aspects have been taken as given – that is modal values are required, the CSM assumptions are to be adopted and the values of travel time savings are to be distance weighted. This peer review considers whether appropriate data sources have been accessed, whether the data has been used appropriately and whether the calculations have been correctly undertaken. The latter stage has been referred to as an audit.

In essence, what the two methods being employed by the DfT to estimate BVTTS aim to derive is the distance weighted average hourly wage of travellers (including any mark-up for labour related overheads). Which method is preferred is also reviewed below.

3.2. Method B2 : The National Travel Survey Income-based approach

This method uses the National Travel Survey (NTS) as the source of income data. Respondents to the NTS indicate in which band their gross personal income lies. Using data on trip rates and average distances by mode and income, plus average hours worked by income band then makes it possible to calculate average hourly earnings by mode. This then needs to be converted to full labour related employment costs, to the correct price year and to market prices. This, in summary, is the method the DfT have defined as B2.

3.2.1. Calculation audit

We have used the data supplied in the DfT's spreadsheets and have reproduced the results reported within them. The mechanics of the calculations for method B2 are therefore confirmed as robust.

3.2.2. Review of data sources and their use

TRIP RATES AND DISTANCES.

The NTS has been used as the source of data for business trip rates and average distance travelled by mode and the NTS' personal gross income band. This level of disaggregation is quite fine particularly for the lightly used modes. The NTS is the best source of information on trip rates and distances. Particular consideration has been given to aggregating income bands where sample sizes are too small to give robust estimates of mean trip rates and average trip distances. These data are used to estimate the distance weights by income category by mode. Whilst these aggregations represent a statistical improvement on the method of calculating mean trip rates and distances, given the non-linearities between earnings and distance, we are not clear what the implications of the aggregation process are on the final values derived without conducting further research. However, this in our view is secondary to the main issue, which is that the data is sufficiently representative of travel, though we do note some small sample sizes for certain modes (e.g. motorcycle).

To maximise the size of the sample 3 years of NTS data has been pooled. The years are 2008-2010. Pooling three years of data is a good compromise between maximising the sample size and reducing the effects of time trends.

The data cleaning process eliminated those whose gross personal income is less than £1,000 per year. This resulted in 2% fewer trips across the sample, but was most acute for bus. Other than that all adult respondents were considered 'in-sample'. There is an argument that the sample should have been restricted to those who are properly immersed in the labour market – that is those aged between 21 and 60 years old and who are either self-employed or employed on a full or part time basis. It would have been interesting to see if focusing on only those who we are confident are fully immersed in the labour market would alter the results of the analysis.

HOURLY WAGE

A key aspect of the method is the derivation of an hourly wage for business travellers, which is then used to calculate a distance weighted average by mode. As the NTS does not give explicit information on hourly wages a series of steps have to be adopted.

- Identification of the mean of each of the gross income bands in the NTS.
- Conversion from gross annual income from all sources to gross annual earned income.

- Identification of the mean hours worked for each income band in the NTS, and conversion of the above to an hourly rate.

We discuss the data sources used for each of these steps in turn.

Mean of income band. As we are interested in the distance weighted mean hourly wage of travellers ideally the mean value for each of the income bands should be used. A number of data sources would lend themselves to providing such a statistic for gross personal income from all sources: the Family Resource Survey, the Labour Force Survey and possibly the British Household Panel Survey[1]. The Family Resource Survey has been used by the DfT and is considered appropriate. The statistic used by the DfT is the median of the income band and not the mean. With an income distribution skewed to the right, trip rate distribution and distance travelled distribution this has the potential of leading to an underestimate of the mean value of travel time savings by mode.

Internal checks undertaken by the DfT indicate that the use of the mid-points rather than the median of the income bands for the closed income bands, whilst not adjusting the use of the median value for the open high ended band £70,000 and more) would increase the average distance weighted BVTTS by 1%. They also report that increasing the higher end band to £140,000 has a much more marked effect. Our additional tests indicate that using the same mid-points but increasing the estimate of the mean for higher rate band to £105,000[2] would increase the BVTTS by 3.2% for the average business traveller and 4.2% for rail.

Gross income from all sources and earned income. The accompanying documentation to the B2 method does not discuss this issue; however, it is clear that the method as applied treats the NTS variable *gross personal income* as a proxy for *gross personal earned income*. Our view is that without any follow up survey to those responding to the NTS it is impossible to know how people respond to the question on gross income – do they answer correctly with gross income from all sources, do they only report gross earned income, do single parents count child benefit as part of their personal income whilst two adult families do not? Furthermore how accurate is their reporting? In the absence of such a follow-up survey/question it is our view therefore that the NTS variable *gross personal income* should be interpreted as it is asked – that is it is representative of gross personal income and not gross personal *earned* income.

The issue then arises as to how gross and earned income differ. We have undertaken a very brief analysis of the BHPS income data for 2007-2008[3], and this suggests the difference could be significant (see Table 1). Across the Wave 18 BHPS dataset, for households active in the labour market, 15% of household income comes from unearned sources. Even in households with only full-time workers the proportion is significant at 7%. We can also see that the proportion of unearned income increases as household incomes fall. We have not undertaken any secondary analysis on the BHPS to explore the reason for these differences between income groups or economic units, nor have we tried to examine how gross personal income

[1] The best dataset on earned income is ASHE, but as we are interested in personal income from all sources this is not an appropriate dataset to be used to determine the mean of each income band.

[2] We have analysed head of households' gross earned income from employment in the BHPS Sept 2007 to Sept 2008 for those earning £70,000 or more (£1,346 per week) and the mean gross earned income is £98,724 (equivalent to £1,899 per week). From the BHPS we have identified that households with gross income of greater than £70,000 receive 6% of their income from unearned sources – implying a mean gross personal income from all sources of £104,931 on average.

[3] UK Data Archive Study Number 3909, British Household Panel Survey Derived Current and Annual Net Household Income Variables, Waves 1-18, 1991-2009. Downloaded from the UK Data Archive. Accessed 31st May 2013.

from all sources differs from gross earned income due to the resource constraints of this review.

Table 1: Unearned income as a percentage of earned income by household economic status

	Earned income less than £5,000	Earned income £5,000 - £9,999	Earned income £10,000 - £14,999	Earned income £15,000 - £19,999	Earned income £20,000 - £24,999	Earned income £25,000 – £29,999	Earned income £30,000 - £34,499	Earned income £35,000 - £39,999	Earned income £40,000 - £49,999	Earned income £50,000 – £59,999	Earned income £60,000 - £69,999	Earned income £70,000 or more	Total
Self employed	512%	57%	87%	38%	38%	13%	23%	12%	10%	9%	5%	8%	18%
Single or couple all in full time work	205%	60%	26%	18%	8%	7%	7%	7%	4%	4%	5%	5%	7%
Couple, one in full-time work, one part-time	354%	93%	45%	33%	26%	17%	14%	9%	8%	6%	5%	7%	11%
Couple, one in full-time work, one not working	390%	118%	69%	51%	33%	27%	18%	12%	17%	10%	14%	6%	23%
One or more in part time work	417%	168%	102%	62%	32%	35%	27%	22%	25%	17%	1%	16%	81%
head or spouse aged 60 or over	---	---	---	---	---	---	---	---	---	---	---	---	---
head or spouse unemployed	---	---	---	---	---	---	---	---	---	---	---	---	---
Other	---	---	---	---	---	---	---	---	---	---	---	---	---
Total	403%	129%	61%	35%	23%	16%	13%	9%	8%	6%	6%	6%	15%
Count (for income band)	159	232	306	394	320	353	332	330	502	300	189	296	3769

Note: households potentially not fully immersed in the labour market have been excluded (e.g. where head or spouse is over 60yrs old, head or spouse is unemployed or household is categorised as 'other').
Source: BHPS 2007-2008 Derived Current and Annual Net Household Income Variables, Waves 1-18, 1991-2009. Variables: total annual household income (rfihhyr), total annual household labour income (rhhyrlg), household economic status (recstat1).

Hours worked. Estimates of hours worked by income have been obtained from the Labour Force Survey (LFS). An alternative source of hours worked would be ASHE. The advantage of the LFS over ASHE is that unpaid overtime hours are recorded in the LFS.

The mean hours worked by income band was supplied to the DfT by the LFS team. The income banding unfortunately did not exactly coincide with the NTS income banding. The NTS income banding is finer at lower income levels. Ideally a finer banding from the LFS would have been provided. In the absence of this the hours worked from the LFS banding has been mapped onto the NTS income bands. Thus the average hours worked for those earning less than £5,000 and between £5,000 and less than £10,000 have been assumed to be the same at 16.8 hours per week. This appears to be an appropriate use of the data. An annualisation factor of 52.1 has been used to give an estimate of hours worked per week. This is on advice from the LFS team that indicated the variable analysed is actual hours worked in the previous week (i.e. if people were on holiday it would be zero). This also appears sensible[4].

One problem of merging the LFS income bands with the NTS bands occurs at low income levels where the implied hourly wage can appear unrealistically low. Using the data in the DfT spreadsheet we calculated implied hourly rates for each income band. These are as in **Table 2**. Here we can see that the hourly rates for those earning less than £5,000 are below the minimum wage in 2009 (£5.80 for adults 22 and over in 2009). These implied hourly rates also raise the question as to how well this method captures the hourly rates of part-time workers from the higher socio-economic classes who travel the most (see **Table 4** and **Figure 2**).

Table 2: Implied hourly rates by income band

NTS income band	Median income per band	Annual hours worked	Implied hourly wage
Less than £5,000	£3,000	874	£3.43
£5,000 - £9,999	£7,591	874	£8.68
£10,000 - £14,999	£12,353	1,692	£7.30
£15,000 - £19,999	£17,331	1,692	£10.25
£20,000 - £24,999	£22,300	1,864	£11.97
£25,000 - £29,999	£27,228	1,864	£14.61
£30,000 - £34,499	£32,212	1,955	£16.48
£35,000 - £39,999	£37,244	1,955	£19.05
£40,000 - £49,999	£43,859	2,015	£21.77
£50,000 - £59,999	£53,756	2,109	£25.49
£60,000 - £69,999	£63,958	2,186	£29.26
£70,000 or more	£95,501	2,285	£41.80

LABOUR RELATED OVERHEADS

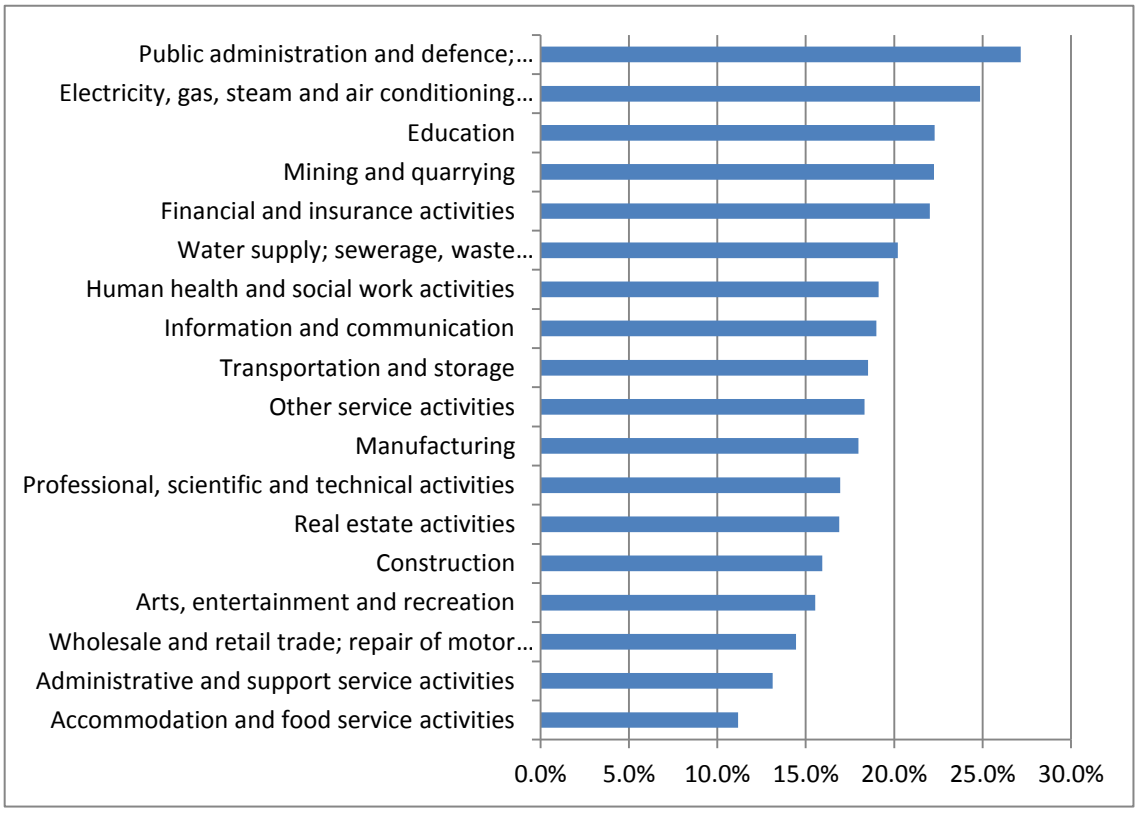
Labour related overheads have been estimated from the most up to date Labour Cost Survey (LCS). The LCS identifies total employment costs and wage/salary costs by industrial sector. The DfT has calculated that the weighted average of non-wage labour costs as a proportion of wages across all sectors of the economy is 18.5%. This however disguises some significant

[4] We note that as holiday periods tend to be clustered together and the fieldwork is not likely to coincide with these then this annualisation factor maybe slightly too high (therefore underestimating hourly wage rates and the BVTTS). Fieldwork for the LFS does not occur evenly throughout the year, but instead occurs in 'waves'. Fieldwork for the first quarter survey occurs in January and March for example.

variation from 11% to 27% (see **Figure 1**). Given that business travellers are typically drawn from the higher income sector of the labour market where non-wage reimbursement is relevant (e.g. employers' pension contributions), we might expect the mark-up on wage costs to total employment costs to be higher for the average person travelling on employers' business than across the whole economy.

It would have been interesting if the NTS had been used to derive distance weighted proportions by industrial sector which could then be used to derive an average mark-up on wage costs.

Figure 1: Non-wage labour costs as a proportion of wages



SCALING FACTORS

The income data has been interpreted as representing 2009 prices, based on the fact that it derives from the 2008-2010 NTS for income data and the 2009 LFS for hours data. This seems reasonable. The price base for appraisal is however 2010, so the 2009 wage estimates need to be scaled to 2010 estimates. Here the DfT has used the HMT GDP deflator and GDP/capita series IHXW (which is in constant prices), whilst assuming a wage GDP/capita elasticity of 1. This gives a compound growth rate of 3.8% between 2009 and 2010. These resource cost estimates of hourly wage rates plus mark-ups for nonwage labour costs have then been converted to market prices using the standard resource/market price factor.

In scaling to 2010 values using changes in GDP/capita the key issue that has to be examined is the assumption of a wage GDP/capita elasticity of 1. Changes in earnings are in themselves a measure of changes in labour productivity, whilst changes in GDP/capita are also a measure of

changes in productivity but the two are not necessarily equal. We have used ASHE to consider how wages have adjusted over this period[5]. This dataset would suggest a lower figure of 1.5%. The implication is that wages have increased at less than the rate of GDP/capita, which is to be expected during a period of increasing unemployment.

3.2.3. Source of difference between webTAG 3.5.6 and proposed new B2 values

We conclude the review of method B2 with a comparison against average wage rates in the UK for 2010 and the status quo (i.e. existing webTAG values). Average wage rates in the UK are in resource costs and obviously do not include a mark-up for non-wage labour costs. From the DfT spreadsheet the relevant figure is a distance weighted average hourly wage of business travellers of £18.46 (2009 prices)[6]. In comparison, the average hourly wage in the UK in 2009 was £15.05. For comparison we have also estimated a trip weighted equivalent average hourly wage which is £15.45. The estimates of the BVTTS therefore seem very much in line with current wage rates in the UK – they are slightly higher than average reflecting the greater distances travelled by the higher earners, but of a similar and believable order of magnitude.

Turning to the comparison between B2 and current WebTAG values,there is quite a substantial difference, with the B2 values showing a drop of almost 21% for the average all working value (see **Table 3**).

Table 3: Business values of travel time savings by mode by method

	Market prices (2010 £)		
	Existing webTAG guidance	**Values from NTS method B2**	**Difference**
Mode			
Car Driver	33.74	27.01	-20.0%
Car Passenger	24.17	20.48	-15.3%
PSV passenger	25.81	16.59	-35.7%
Taxi & Minicab passenger	57.06	26.08	-54.3%
Surface Rail passenger	47.18	31.89	-32.4%
LT Underground passenger	45.90	26.22	-42.9%
Walker	37.83	20.83	-44.9%
Cyclist	21.70	20.74	-4.4%
Motorcyclist	30.53	23.06	-24.5%
Average all working	34.12	27.02	-20.8%

The DfT has undertaken an analysis as to the source of difference between the existing WebTAG values and the proposed new ones. For Method B2 their analysis, broadly speaking, indicates that just over half the difference is attributed to a change in the pattern of travel by those travelling on employers' business and the majority of the remainder due to a more accurate representation of hours worked. They also find that the estimated mean income in the upper income band has not increased in line with either average earnings or changes in nominal GDP/capita. If it had the mean income in the upper income band would be in the region of £140,000 rather than £95,501 from the FRS. We find these explanations credible and consequently prefer B2 to the existing guidance, taking the general approach of the CSM as a given. Further research is needed to understand why patterns of EB travel behaviour have

[5] Annual Survey of Hours and Earnings: analysis conducted through the Nomis web portal www.nomisweb.co.uk.

[6] The equivalent BVTTS value scaled to 2010 market prices and including non-wage labour costs is £27.02.

changed, and what it means for projecting BVTTS values over a 60 year appraisal period using a wage-GDP/capita elasticity of 1.

Our review of method B2 (NTS income) has identified a number of issues that, individually, appear to affect the calculated BVTTS values by a few percentage points. These issues may work against each other cancelling each other out to a certain extent, so it is hard to say what the exact magnitude of the collective change is nor even the direction of change. Where we have been able to test them, the changes are small relative to the difference between B2 and current WebTAG values. We have made suggestions for improving the estimation method in further research section of the final chapter of this review.

3.3. Method B3: The Annual Survey of Hours and Earnings income based approach

This method uses the Annual Survey of Hours and Earnings (ASHE) as the source of income data. This is a survey of employers and annually covers 1% of the workforce. It does not include the self-employed. It is also regarded as one of the best sources of earnings data. The income data is linked to travel characteristics (from NTS data) to derive distance weighted hourly values.. The link is made through the socio-economic classification variable (NS-SEC) as the NTS does not have an occupation variable. This then needs to be converted to full labour related employment costs, to the correct price year and to market prices. This, in summary, is the method the DfT have defined as B3. It is potentially a very attractive method as it utilises the best source of hourly earnings data in the UK.

3.3.1. Calculation audit

We have used the data supplied in the DfT's spreadsheets and have reproduced the results reported within them. The mechanics of the calculations for method B3 are therefore confirmed as robust.

3.3.2. Review of data sources and their use

TRIP RATES AND DISTANCES

The NTS 2008-2010 is used as a source of trip rates and average distance by mode and by NS-SEC group. The most disaggregate 8-classification form of the NS-SEC in the NTS has been used. A different approach to data cleaning has been adopted compared to the NTS income method (B2) – as cases with reported incomes less than £1,000 have been retained, whilst cases who have never worked, are long term unemployed or have no NS-SEC classification have been removed. The same comments as made with respect to method B2 therefore also apply – i.e. a robust approach has been adopted to sampling by mode and NS-SEC segment though it may also have been prudent to restrict the in-sample to only those fully immersed in the labour market, rather than utilising the full NTS dataset. We also note that it is unusual (for purposes of comparison) to adopt different data cleaning strategies between methods.

We have compared the NS-SEC proportions across England and Wales with those associated with travel (distance weighted) (see **Table 4**). It is clear from this table that travel is concentrated in the higher socio-economic classifications.

Table 4: Comparison between Census 2011 distribution of NS-SEC classes and NTS distance weighted.

	Census 2011 (England and Wales)	NTS distance weighted proportions
Large employers and higher managerial occupations	2.8%	15.9%
Higher professional occupation	9.3%	15.4%
Lower managerial and professional occupations	24.4%	40.5%
Intermediate occupations	14.9%	4.8%
Small employers and own account workers	11.0%	10.3%
Lower supervisory and technical occupations	8.1%	5.0%
Semi-routine occupations	16.5%	4.5%
Routine occupations	13.0%	3.6%

HOURLY WAGE

The hourly wage is derived directly from ASHE 2011. As the standard ASHE tables do not disaggregate by NS-SEC, only by standard occupational classification (SOC), the average hourly wage for each of the NS-SEC classification has been derived. This derivation uses average wages and job numbers by occupational classification contained in ASHE Table 14.5a. This process appears sensible and uses the correct mapping relationships between NS-SEC and the SOCs. ASHE Table 14.5a is also the appropriate source of hourly wage data by SOC.

This hourly wage is then converted to full employment costs using the factor from the LCS and to 2010 prices using changes in GDP/capita, the GDP deflator and a wage-GDP/capita elasticity of 1. Finally it is converted to market prices using the WebTAG market/resource conversion factor. Comments made with respect to method B2 also apply here. That is the LCS is an appropriate source of non-earnings employment costs, though instead of an average factor across the UK being used a distance weighted average by industry could have been used. Similarly actual changes in wage rates could have been used to convert from 2011 hourly wages to 2010 hourly wages – rather than using GDP/capita and assuming a GDP/capita - wage elasticity of 1. To examine the validity of this elasticity we have again used ASHE to consider how wages have adjusted between 2010 and 2011. These data indicate that wages in the UK increased by 1% over this period, whilst the unity wage-GDP/capita elasticity assumption used by the DfT suggest they should have increased by 2.5%. .

3.3.3. Comparison of NTS income (B2) and ASHE income (B3) methods

Both the NTS income method (B2) and the ASHE income method (B3) result in substantially lower values of travel time savings than are currently in use: -20.8% and -26.2% respectively.

We have already concluded that method B2 (NTS income method) represents an improvement on the status quo (i.e. the values currently contained in webTAG). Given method B3 uses the latest travel data and also up to date hourly earnings data we consider that it too represents an improvement on the status quo.

We now therefore turn to the question as to whether the method B2 or method B3 is preferred given the current data. A comparison of the values derived from both methods is contained in **Table 5**. What can be seen is that in addition to giving a lower 'average' value there is less variation in the modal values using ASHE income data compared to the NTS data.

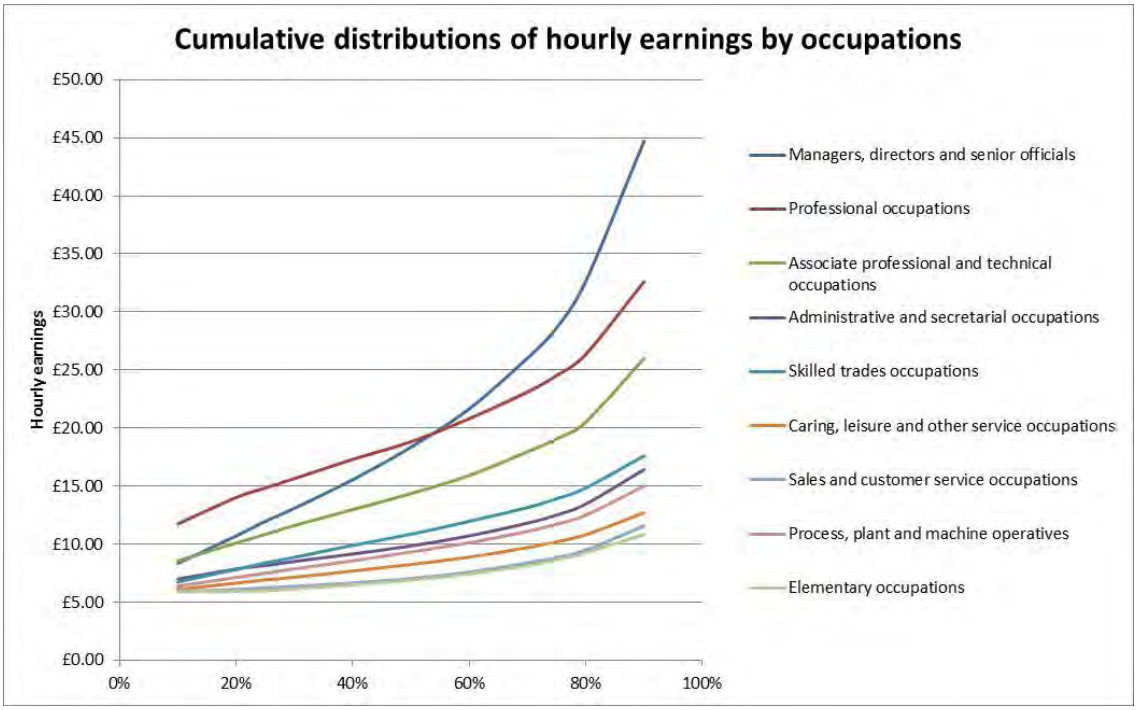
Table 5: Business values of travel time savings by mode by method

	Market prices (2010 prices and values)		Difference
	NTS method (B2)	ASHE method (B3)	
Mode			
Car/van driver	£27.01	£25.44	-5.8%
Car/van passenger	£20.48	£20.44	-0.2%
PSV Passenger	£16.59	£20.46	23.3%
Taxi / Minicab	£26.08	£24.95	-4.3%
Surface rail	£31.89	£27.23	-14.6%
London Underground	£26.22	£24.50	-6.6%
Walk	£20.83	£21.43	2.9%
Bicycle	£20.74	£21.45	3.4%
Motorcycle	£23.06	£19.08	-17.3%
All	**£27.02**	**£25.17**	**6.8%**

We consider that this lack of variation occurs due to the large income variations within the 'higher' standard occupational classes (SOCs) (see **Figure 2**) and NS-SEC classes (see **Figure 3**). More than 72% of business travel (distance weighted) is concentrated in the first 3 socio-economic classifications in table 4 with the 'lower managerial and professional occupations' alone contributing 41% of total business travel (distance weighted). Effectively therefore we are describing almost half the business travelling sample with a single hourly earnings figure using the ASHE income method. As a consequence the modal variation in BVTTS using the ASHE income method is unrealistically narrow. BVTTS values for low income modes (e.g. buses) are therefore expected to be overestimated and those for high income modes are underestimated with the B3 method.

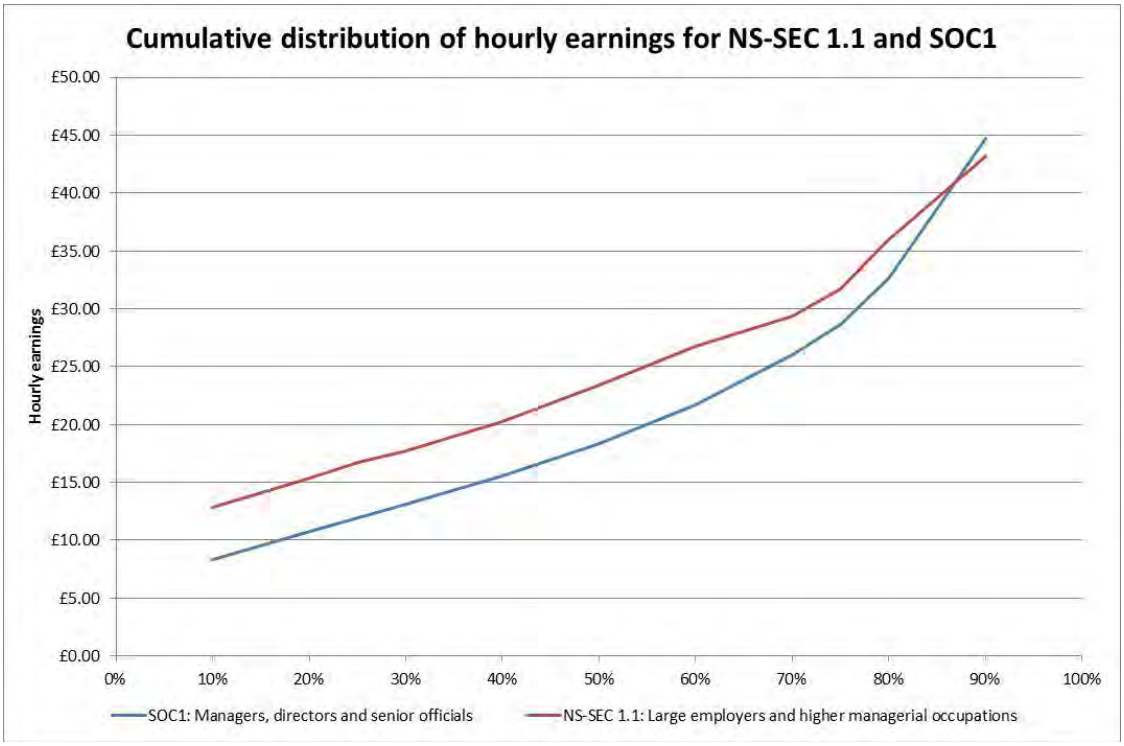
Therefore, on the grounds of the lack of variation, we conclude that Method B2 as calculated by DfT is preferred to Method B3.

Figure 2: Cumulative distributions of hourly earnings by occupations



Source: ASHE 2011 Table 14.5a

Figure 3: Cumulative distributions of hourly earnings for NS-SEC1.1 and SOC1



Source: ASHE 2011 Table 14.5a for SOC 1, and own calculations for NS-SEC 1.1 based on ASHE 2011

4. Professional drivers value of travel time savings

This is the most straightforward category, as it involves no use of travel data. Table 13 of the DfT note 130528 Business vot method note lists the four categories and their 4-digit SOCs. The mean hourly wage is provided directly from the appropriate rows of the spreadsheet REVISED – Occupation (4) Table 14.5a Hourly Pay - Gross 2010.xls.

To add on the implied mark-up for non-wage costs, the results from the Labour Cost Survey for NACE category H (Transportation and Storage) – to which they all belong – are used, available from spreadsheet 130212 2008LCS data.xls. This is 18.5%. Finally, the overall conversion to market price, as recommended in WebTAG Unit 3.5.6 para 1.1.9, is applied.

These calculations are all correct.

5. Non-work value of travel time savings

5.1. Background

Current recommended VTTS as in WebTAG 3.5.6 (the latest issue being August 2012) relies heavily on a re-analysis by the University of Leeds Institute for Transport Studies, together with John Bates Services, of the data collected in 1994, specifically for highway values, by Accent Marketing and Hague Consulting Group [AHCG]. The ITS/Bates study reported in 2003. With respect to the calculation of VoT, it made a series of recommendations (references in square brackets refer to the relevant sections in the Final Report).

In the first place [§5.4] the recommended model of non-working VoT for the purposes of demonstrating the variation in values was:

$$\text{VTTS} = [\beta_\tau/\beta_c] \cdot \left(\frac{Inc}{Inc_0}\right)^{\eta_{Inc}} \cdot \left(\frac{C}{C_0}\right)^{\eta_C}, \qquad (1)$$

where Inc is household income in £'000 pa and C is journey cost in pence (both in 1994 prices), and Inc_0 and C_0 take the fixed values 35 and 100 respectively. The estimated values for the parameters β_τ, β_c, η_{Inc}, η_c are given in the table below (with t-ratios in brackets), separately for the Commuting and "Other" purposes:

Table 6: Parameters for Implementing Non-Work Value of Time Formula

		Commute	Other
$\Delta\tau$	β_τ	-0.10098 (-15.07)	-0.08292 (-19.33)
Δc	β_c	-0.02473 (-14.84)	-0.02227 (-18.51)
Income Elasticity	η_{Inc}	0.35878 (7.58)	0.15681 (5.49)
Cost Elasticity	η_C	0.42130 (9.08)	0.31473 (11.86)

Source: Mackie *et al* (2003)

In principle this formula allows the VoT to be calculated for any combination of traveller income and journey **cost**. Implicitly, these will be in 1994 values and 1994 prices.

Two further issues are then required before the formula can be **implemented**. The first is to produce an appropriately weighted average value, and the second is to deal with changes over time. Both of these are independent of the VoT formula for a given income/cost combination.

It was clear from the analysis that the AHCG sample distribution was not representative [§5.2], and particularly in relation to journey length. Unfortunately, the actual distance travelled was not available in the data. It was therefore necessary to construct a "bridge" between the AHCG reported costs and journey distance, both to correct for representativity and to find a way of applying the preferred model in relation to data sets which do not contain the relevant information on cost.

For this purpose, a relationship was derived [§5.3] which suggested that the cost per mile had the average value of 13.2 pence (1994 prices), and that for most of the data a linear assumption between distance and (reported) cost was justified. On this basis, C in the VoT formula can be interpreted as distance (in miles) and the value of C_0 can be converted to D_0 = 100/13.2 = 7.58 miles (12.2 Km). This allows the cost elasticity to be re-interpreted as a distance elasticity.

To correct for representativity, the NTS was chosen, since it classifies all journeys by journey distance. DfT was able to provide tabulations from NTS for the six years 1995/2000 giving information on the distribution of all the variables of interest (that is, income, distance, purpose and mode). This allowed the chosen model to be applied directly to the NTS data for 252 "cells", based on household income in 21 bands, and journey distance in 12 bands.

In carrying out the calculation of representative values, three significant issues were identified [§7.3]:

- modal variation
- weighting - (trip vs distance)
- model stability - treatment of income growth

On modal variation, while there was some empirical evidence for modal variation in VTTS which generally accorded with intuition, it was not particularly strong. On this basis it was assumed that the estimated car driver VoT models could be applied to all (mechanised) modes (in respect of in-vehicle time).

On weighting, it was judged that a distance-weighting was preferable to a trip-weighting. This coincided with the Department's conventional approach in the past to **working** values of time. In the case of non-working time, it was unclear what previous practice had been. It was noted that as, in broad terms, journey length tended to increase values of time, using a distance-weighting might suggest an element of double-counting: certainly a distance-weighted average will be higher than a trip-weighted average. Nonetheless, it was argued that a principal aim should be to allow time savings to be aggregated in a way which coincides with the total "value" reflected in individual values of time. [§7.3]

In other words, if N_{yd} is the number of trips in the NTS data that falls into the category of income group y and distance group d, and V_{yd} is the corresponding VoT according to the formula given, then to calculate the average for the combinations $\{y \in Y; d \in \Delta\}$, where Y and Δ are grouped categories of income and distance respectively, we use the formula:

$$\overline{V}\,(Y, \Delta) = \frac{\sum_{y \in Y} \sum_{d \in \Delta} V_{yd} . N_{yd} . D_d}{\sum_{y \in Y} \sum_{d \in \Delta} N_{yd} . D_d} \qquad (2)$$

where D_d is the average distance for distance band d.

In respect of these two points (modal variation and distance weighting), there have been no changes in the methodology. On the third point (model stability), there has been a re-interpretation.

Originally, it was assumed that apart from corrections for the price level in which income is measured, the models for the VTTS relationships could be taken as temporally stable, so that they could be applied to data for years other than the one in which the underlying data was collected (end-1994). The NTS data related, on average, to a later year than the estimated VoT relationship, and it was argued at the time that no correction needed to be made for the fact that some income growth would have occurred. In line with these recommendations from the ITS/Bates Report, the 2002 values in WebTAG 3.5.6 made no adjustment for the growth of real GDP/head for the three years 1994-1997. However, subsequent analysis carrying out a re-weighting with more recent NTS data for the years 2002-2005 concluded that this adjustment **should** have been made, and that the (weighted) VoT formula should be construed as providing **1994** values.

The second issue is then how such an average should be adjusted. Based on the "meta-analysis" independently carried out by Wardman, the ITS/Bates Report recommended [§6.8] that while for working time, growth should be in line with income, for non-working time an elasticity of 0.8 should be used. It was noted that this was a higher elasticity than was revealed in the cross-sectional analysis, but it represented a move away from earlier existing practice, which had assumed a value of 1.0.

Hence, for a re-basing, the (slightly amended) recommendations imply:

a. calculate VTTS for a given for a given combination of income and distance as

$$VoT = G^{\alpha} K \left[\frac{\beta_{\tau}}{\beta_{c}}\right]\left(\frac{I}{I_{0}}\right. \qquad (3)$$

where the additional symbols have the following meaning:

- G is the real growth in GDP/capita relative to 1994, and α is the elasticity of VOT to GDP/capita for non-work travel (currently recommended in ITS/Bates as 0.8)
- K is a correction factor for inflation between 1994 and the year of update
- Inc′ represents the household income in £'000 p.a. based on local data
- Inc′0 is set equal to K' multiplied by 35
- K′ is a correction for inflation between 1994 and the year in while the local data is collected

b. apply the weighting according to eq (2)

Eq (3) is set out in TAG 3.10.2, Annex A.

5.2. The Task

DfT has updated the non-work values of travel time savings with NTS-derived weights consistent with those used in the parallel business value of time calculations, and is seeking a peer review of the methods and data sources used. Accordingly they have provided working notes and spreadsheets.

Subsequently, in connection with changes in the income elasticity, a further note "130605_change_in_non-work_e_v2.doc" was received, citing recent research by ITS, reported in:

META-ANALYSIS OF POST-1994 VALUES OF NON-WORK TRAVEL TIME SAVINGS, Prepared for the Department for Transport, Mark Wardman and Phill Wheat

[130322_VoT_Final_Issued_v2.pdf];

META-ANALYSIS OF UK VALUES OF TRAVEL TIME: AN UPDATE

Pedro A L Abrantes, Mark Wardman [Vot_meta_170610_revision.doc]

[TRA926.pdf] – the same, as published in Transportation Research Part A 45 (2011) 1–17.

In respect of the non-work values, the scope of the project covers two components. The first is to audit the calculations for the non-work values of travel time savings (given the methodology set out by DfT). The second component is a peer review of the methodology, restricted to answering the following question:

- have we followed correct methodology for updating the non-work values (as set out in J Bates paper 2008)?

The aim of the calculation audit is to ensure that the correct input data have been used and that the calculations have been performed correctly (documentation of the intended calculations and the raw input data will be provided). The audit element does not extend to the extraction of the raw data itself nor to the source materials used by Wardman et al to undertake the meta analyses.

The focus of the peer review should be on the data sources used, including the timeliness of the data and their applicability to the way in which they have been used. In the following two sections, we report on the audit and the peer review.[7]

5.3. The Audit

We have worked through every component of equations 2 and 3 above and satisfied ourselves that the Department has interpreted its own guidance for updating correctly and has applied appropriate data sources and that the calculations are internally consistent and correct in their own terms.

The key data sources used are as follows :

The Family Resource Survey supplies median household and individual income for 23 income bands and various aggregations covering the period 2002/3 to 2010/11.

The National Travel Survey is used to supply the trip and mileage pattern which is used to obtain the weighted average values for Commuting and Other which are the required output. NTS data for 2008-10 is used. The income and distance bands have been grouped to some extent and the lowest income group (0-1000 per annum) has been excluded. The results have been examined and produce sensible trip rates

Although we have some comments at a detailed level, these data sources are fit for purpose and have been used appropriately. In order to make use of this data in the recalculations, the Department needs to use “scaling factors” to deal with changes over time for the components of equation 3. Since these are bespoke for the purpose of this work, they are discussed in slightly more detail.

[7] A fully annotated version of the audit has been provided for the DfT’s records and potentially for future use.

SCALING FACTORS[8]:

Some indication of the sources of the GDP deflator and GDP/head are given (as comments in the spreadsheet) but these references have **not** been checked. We have subsequently learnt that the GDP/head series is derived from series IHXW[9], which is in real terms. We have checked the series against ONS data and agree that it is correct (the series in the spreadsheet has been converted to an index – 100 = 2000). The value of K' is based on the ratio of the 2009 to 1994 values of the GDP deflator: this is correct in terms of the new interpretation of inflation (ie, **not** the RPI), since the NTS income relates, on average, to 2009. The value of K is based on the ratio of the 2010 to 1994 values of the GDP deflator: this again is correct (on the same qualification) since 2010 is the required price base. The value of G is based on the ratio of the 2010 to 1994 values of the GDP/head index: this is correct since 2010 is the required value base. D0 is taken as 7.58 (miles), as in the ITS/Bates Report (p 58). Inc'0 is correctly taken as 35 * K'. α is taken as 1, rather than the 0.8 value previously used (see below). Apart from the qualifications in this paragraph, everything in this sheet is in order.

MILEAGE WEIGHTS AND NEW AVERAGE VOT CALCULATIONS

The declared formula in the 2008 Bates paper makes use of Eq 2 and the associated notation discussed earlier:

$$\bar{V}\,(Y, \Delta) = \frac{\sum_{y \in Y}\sum_{d \in \Delta} V_{yd} . N_{yd} . D_d}{\sum_{y \in Y}\sum_{d \in \Delta} N_{yd} . D_d}$$

In the new analysis, we do not have N_{yd} directly – rather we have the number of individuals in each income band y [N_{y^*}], and the number of trips per person in each income and distance cell [t_{yd}, say], (in the upper part of the sheet "NTS Data"). We do have D_d directly (in the lower part of the sheet "NTS Data").

There are no differences in the New VoT calcs formulae between the two purposes, apart from the additional number of distance bands – 12, rather than 10 – which affects the number of rows in each part of the calculations. In what follows, we describe the Commute version.

The first part of the calculations (rows 1-13) carries out the calculation $t_{yd}.D_d$ for each [y,d] cell. The second part of the calculations (rows 14-26) multiplies $t_{yd}.D_d$ by the weighted nos. of individuals N_{y^*} for each [y,d] cell. This therefore gives the correct "weighting" quantity $N_{yd}.D_d$ as in the formula above. The next set of calculations (rows 27-39) merely normalises these weights by dividing by the equivalent of the denominator in the formula above, so that they sum to 1.

The values of V_{yd} are then calculated in rows 40-53. The spreadsheet formula (eg for cell B43, representing the first income band and the first distance band) is equivalent to

$$=G^{\wedge}\ \alpha\ *K*\beta_\tau/\beta_c*(Inc_y/\ Inc'0)^{\wedge}\eta_{Inc}*(D_d/\ D0)^{\wedge}\eta_c$$

which correctly reproduces the formula from WebTAG 3.10.2:

[8] these remarks apply equally to the **Commute** and **Other** files
[9] Gross domestic product (Average) per head, CVM market prices

$$VoT = G^{\alpha} K \left[\frac{\beta_t}{\beta_c} \right] \left(\frac{1}{I} \right.$$

Weighted averages are then obtained by means of the "SUMPRODUCT" function. At the moment, this is only done for all incomes and distances. The outcome relative to the WebTAG recommended 2010 values is a change from £6.46 to £6.93 for Commute, and from £5.71 to £6.19 for Other.

Thus, for both Commute and Other, the outcome VoT has risen: for commute by 7.3% and for Other by 8.4%. This is largely the result of the changed elasticity to GDP assumption (α): if we revert to 0.8, we obtain values of £6.51 and £5.82 (0.8% and 1.9% increases respectively) .The differential is of course magnified as we roll forward over the appraisal period, since the income elasticity going forward is also taken to be 1. This points up the importance of the assumption, while also indicating that the changes over time in the NTS data play very little role (as was concluded in the Bates 2008 paper, comparing NTS 1995-2000 with NTS 2002-05). This is unlike the working time values where the changes in the NTS data play a significant role.

The change from the RPI to the GDP deflator will also have had some impact: from a reading of 3.5.6 it appears that the previous (2002) values, which were based on the RPI, have only been updated from 2002 onwards, so that the implied values for G and K in the period 1994-2002 are still using RPI as a deflator.

On the basis of the foregoing, from an **audit** point of view the conclusions are as follows:

- the calculations have been carried out correctly in respect of the updated methodology set out in the Bates 2008 and reproduced, with minor notational variants, in Annex A of WebTAG 3.10.2
- the main spreadsheets (130528 commute.xls and 130528 other.xls) are well constructed and easily auditable. It would probably be better to integrate the two into a single spreadsheet
- the GDP deflator and GDP/capita series should be explicitly referenced (again, we note that these have not been checked), as should the model parameters for the VTTS calculation

On the general methodology, aside from the income elasticity which we discuss later, there are some minor issues which should be noted:

- In the earlier calculations carried out by Bates and David Reams of DfT, midpoints were used for the "closed" income bands, and appropriate assumptions for the lowest and highest. Although it is very unlikely that the results are sensitive to this, it is not clear that the more complex process of appealing to the FRS data to determine the **medians** of the bands is worth the effort.
- On a similar point, the NTS data provided has been aggregated to avoid cells where the sample is insufficient (this is similar to the aggregation process adopted for the BVTTS values – see §3.2.2). It is uncertain what impact this has on the derived results, , given that the data is not being used in its disaggregated state, but merely as a weighting measure. However, the main requirement is to ensure that there is sufficient "coverage" of the income and distance range (given the non-linearity of the VTTS formula), and it is judged that in this respect the data is adequate.
- The shift from the RPI to the GDP deflator does not appear to have any consequences for the methodology, though some of the conclusions in the Bates 2008 note might be marginally affected if they were re-worked using the GDP deflator. It is not proposed, however, that this is worth doing.

Hence, the only outstanding issue of significance is the change in the income elasticity. We defer this to the next section, which is the Peer Review.

5.4. Peer Review

As noted, the focus of the peer review should be on the data sources used, including the timeliness of the data and their applicability to the way in which they have been used.

We have no significant comments to make on the data sources used, aside from the few points already made at the end of the previous section. The NTS data is timely, being as close as possible to the date to which the VTTS values are to refer. We therefore turn to the questions regarding the income elasticity. For this, we consider the evidence in the documents by Wardman and Wheat, Abrantes and Wardman, as well as the DfT note.

The current assumption of 0.8 rests on the arguments and evidence reviewed in §7.5 of the ITS/Bates Report, and subsequently summarised in recommendation R11. It is worth recalling the argument *verbatim*:

> 'In terms of the implications for growth in the value of time over time, these comparisons cannot be considered conclusive. In Section 6.5 we considered the limited further evidence available, and based on the meta-analysis data set suggested on balance a temporal elasticity with respect to GDP of 0.72 (+ 43%) for all data and 0.82 (+40%) for in-vehicle time data. However, this analysis was not able to take into account the temporal effect of distance. Over time, there has been a tendency to longer journeys (associated in particular with more car ownership). Over the period covered by the meta-analysis (1963-2000), TSGB2001 indicates (Table 9.1) that total distance travelled by mechanised modes (including cycle, but excluding walk) has increased by 2.3% pa, and allowing for the population growth of 0.29%pa gives a distance per head growth of 2.0% pa.
>
> Allowing for the effect of increases in trip length over time adds a small amount (+0.03 to +0.08) to the above elasticities. However, the proportion of this journey length effect which is due to GDP growth, as opposed to other trends such as the following real cost of motoring, is not clear. Any chosen intertemporal elasticity is likely to be a mixture of a 'pure' income effect and other trends over time which cannot easily be separated.
>
> We conclude that the evidence as a whole tends to support an intertemporal elasticity for non-working time of somewhat less than unity, probably in the range of 0.5 to 1.'

We should note that cross-sectional estimates of the income elasticity are by general agreement lower (nearer to 0.5), but there are reasons to expect different results, as discussed in §6.8 of the ITS/Bates Report. Other relevant evidence is that of "Repeat Studies", discussed in §6.7 of the ITS/Bates Report: these have found, if anything, a tendency for estimated VTS to **decline** over time.

The relevant section from Abrantes and Wardman is (from §4.3):

> 'The measure of income used was an official, seasonally adjusted national index of gross domestic product (GDP) per person. A highly significant GDP per capita elasticity of 0.899 (±24%) was estimated which is in line with the widespread convention of increasing values of time in line with income but is considerably above those found in the meta-analysis of Shires and de Jong (2009), covering 1299 IVT values across 30 countries, which ranged between 0.47 for business travel and 0.68 for commuting. The inevitable approximations in adjusting income across countries as well as cultural differences could have influenced these income elasticities. Our inter-temporal elasticity is also somewhat larger than the cross-sectional income elasticities centring around 0.5 typically obtained from disaggregate behavioural studies (Wardman, 2001b).

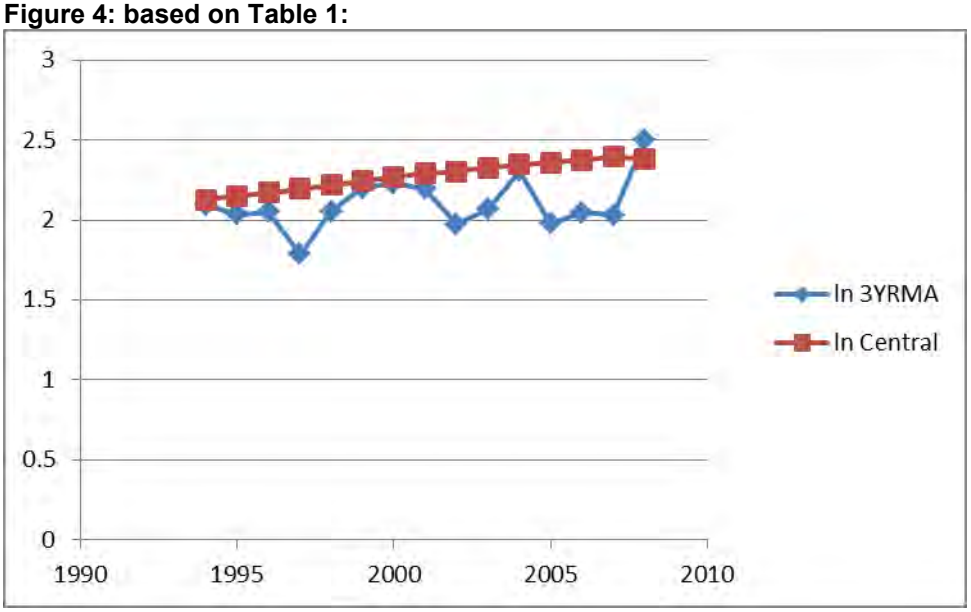
> There are reasons why cross-sectional income elasticities might be lower, such as those who strive for higher incomes placing a greater valuation on money, but it should also be noted that exact repeat studies have observed little or no increase in the real value of time over time (Hague Consulting Group et al., 1999; Gunn, 2001; Tapley et al., 2007). The latter could, of course, be consistent with an income elasticity of one if there are offsetting effects over time on the marginal utility of time, such as travellers becoming more resigned to congestion or the comfort of vehicles and the opportunity to use travel time productively increasing significantly over time.'

The value of 0.899 corresponds with the value ("for all data") of 0.72 from the previous work (Wardman, 2004). The comparable result for in-vehicle time only (given in Table 16 of Abrantes and Wardman) is 1.04. This suggests that the additional studies added to the meta-analysis data set since the 2004 work, from which the value of 0.82 was derived, has led to an increase to 1.04. The methodology appears to be comparable in both studies.

These results are reviewed in Wardman and Wheat [W&W], but not added to, for various reasons. However, the data is presented in a rather different way, which – with some difficulty! – yields different insights, though it is difficult to draw authoritative conclusions.

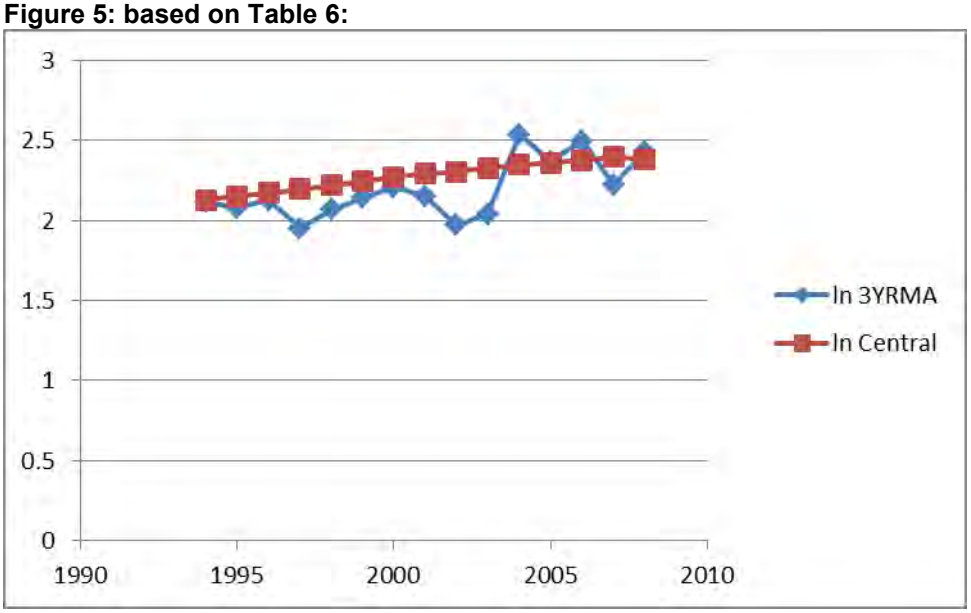
Essentially, we are interested in the apparent trend over time. A simple way to see this is to plot the logarithms of a) the 3 year moving average [3YR_MA] reported by W&W against b) the "Central" estimate of the appraisal value. When this is done for Tables 1 and 6 (car values only)[10], the following diagrams are obtained:

Figure 4: based on Table 1:



[10] Table 1 covers values of time for car, for both commuting and other purposes, and all values from relevant studies, while Table 6 covers car values of time but an average is taken for each study rather than using each individual observation

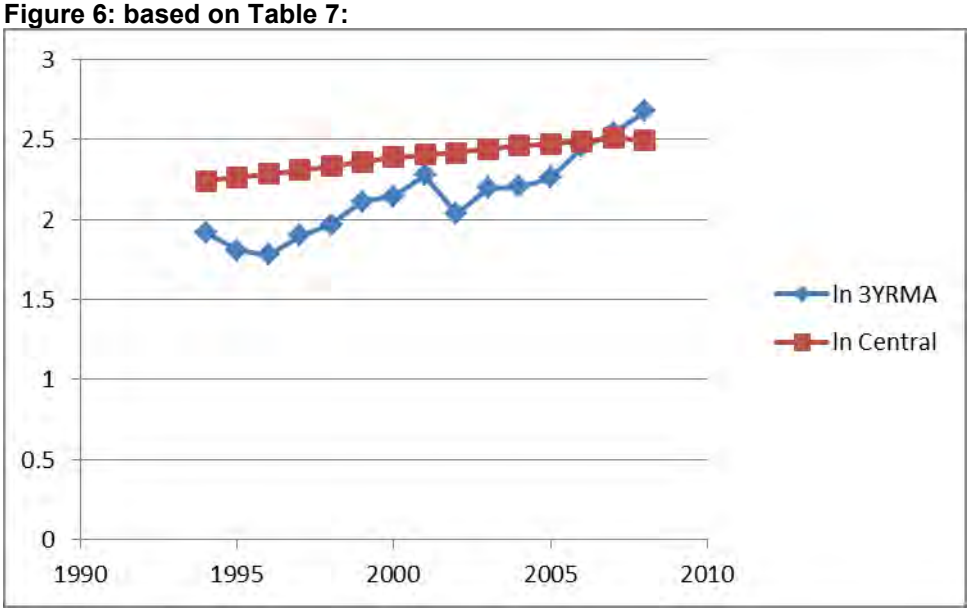
Figure 5: based on Table 6:



There seems no *a priori* evidence from this that the car VTTS trend is out of line with the appraisal value. However, the fact that even after calculating a 3-year moving average there is considerable fluctuation in the "observed" (meta-analysis) data suggests that we should proceed with caution. We return to this below.

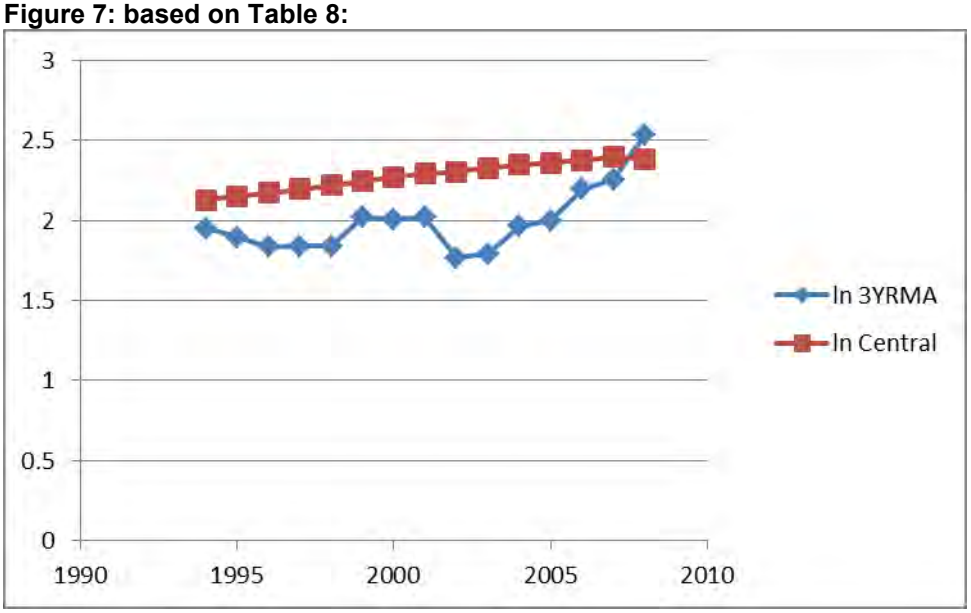
By contrast, if we turn to Tables 7 and 8, where the results are for Commuting and Other respectively[11], but for **all** modes, there is evidence of a higher elasticity/trend, particularly for the commuting purpose:

Figure 6: based on Table 7:



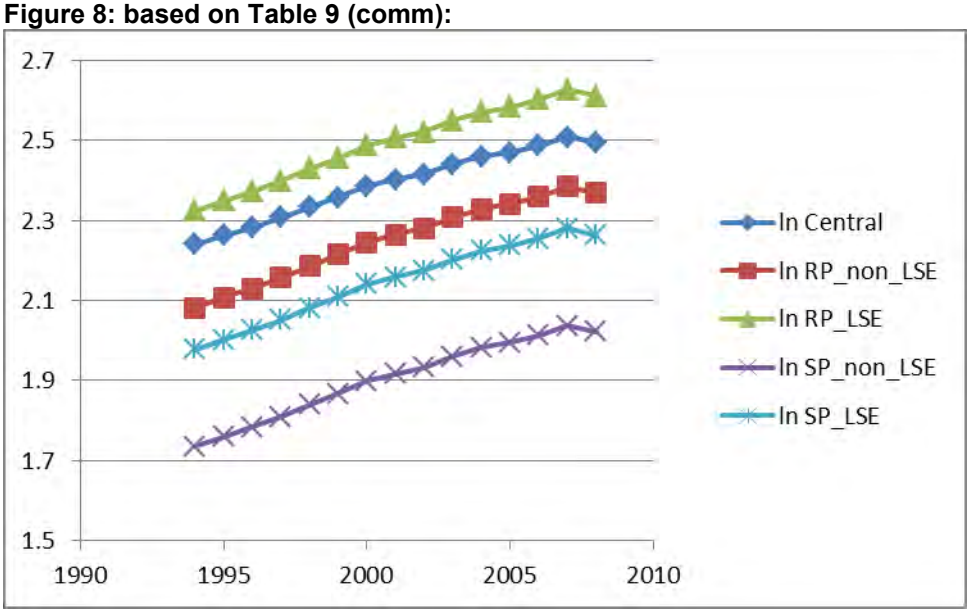
[11] Table 7 covers commuting trips for all modes and using an average value for each study, while Table 8 covers other trips, again with an average value used per study

Figure 7: based on Table 8:



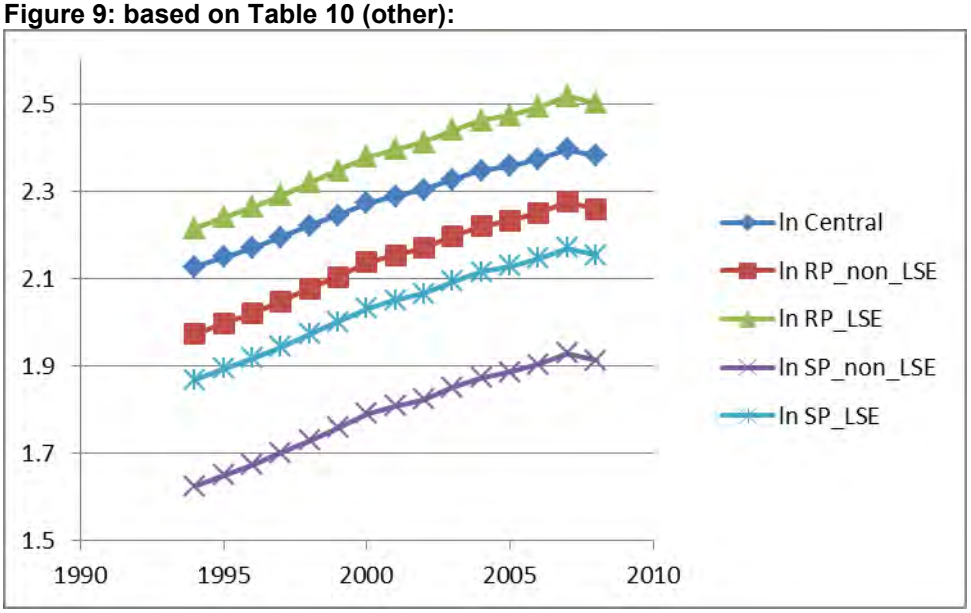
This might suggest that it is the non-car modes which are driving the result. This would seem to be in line with the final Tables of W&W (9 and 10)[12], which again are for car only. These suggest that "there is a very close degree of correspondence, both in absolute values and trend, between the official values and the average of the RP values". However, concentrating only on the mean values, and plotting the logarithmic relationships again, it is hard to see any significant difference in **trend**, whether between the RP, the SP or the official values.

Figure 8: based on Table 9 (comm):



[12]these compare the official appraisal values for each year with the values that are implied by the meta-model in Abrantes and Wardman

Figure 9: based on Table 10 (other):



The key conclusions drawn by W&W appear to be along the following lines (highlighting the relevant text in respect of changes over time):

> 'The findings indicate that the appraisal values of time in 1994 were larger than what is SP dominated UK evidence, although we can see that even in the observations for 1994 only there is a large spread in individual valuations and we concede that there might be other uncontrolled for extraneous influences. But if these factors, especially within the car values of time, introduce unwanted noise which blurs the analysis but which is essentially having a random effect, the evidence if anything points to values larger than the other UK evidence.
>
> The figures for car in Table 6 are most relevant, since this is the market upon which the appraisal values are based. The degree of correspondence between the appraisal values and the meta-values for 1994, the year from which the appraisal values stem, is closer for car than for the other comparisons made, although the appraisal values are still larger and the correspondence would be slightly worse if the commuting appraisal values were used.
>
> As for variations over time, there is a greater degree of consistency between growth in the appraisal values, which are assumed to grow with a GDP elasticity of 0.8, and the trend growth in the samples of meta-values. Car travel, and indeed travel by other modes, will have become more comfortable over time with more opportunities to spend travel time usefully, and this would be expected to exert a downward influence on values of time over time, but the evidence does not support this. Presumably there are also countervailing influences which act to increase the value of time over time, such as more difficult and crowded travelling conditions. This suggests that either these factors are cancelling each other out or the GDP elasticity represents the net impact of a number of correlated factors, such as income growth, comfort and travel conditions.
>
> There is no support, either from the meta-analysis or from the analysis of samples of meta-values presented here, for the GDP elasticity varying over time. However, we note that the meta-analysis recovered a GDP elasticity of 1.06 for commuting and 0.9 for other, and that the results here are consistent with this finding, particularly the commuting values, to have a stronger trend than the official central values over the time period analysed.
>
> We also point out that the above GDP elasticity values are for all the variables in our data set. When restricted to in-vehicle time, the GDP elasticity increases to 1.04 from the 0.9 for all variables. This difference is consistent with the 0.823 for in-vehicle time

and 0.723 for all variables estimated for the GDP elasticity in the 2003 work that influenced current recommendations (Mackie et al., 2003).

We have recognised that extraneous influences, such as the effects from RP data, London and the South East and SP presentation format apparent in the meta-analysis, could be having a bearing in the tabulations presented, but further segmentations would result in very small samples sizes from which it would be extremely difficult to draw conclusive results. One way to overcome this is to use the Abrantes and Wardman (2011) meta-model estimated to all this data to predict what the value of time would be.

When we do this, we find that the official values, which are based on SP data, coincide very closely with what the meta-model would imply for RP data. If we are prepared to accept that values implied from RP evidence represent the 'truth', then we can only conclude that the Department's official values closely represent the best available evidence. The only issue then is the GDP elasticity going forward. Should we wish to argue that only SP methods can provide robust estimates, then the official values appear to be substantially larger than other SP based valuations.'

On this basis, we return to Table 6, which relates to car only. A simple approach would be to regress the 3-year moving average directly on GDP/head, to deduce an elasticity, using the relationship:

$$VTTS_{car,t}^{MA} = \alpha.GDP_t^{\eta}$$

When this is done (using unweighted logarithmic regression) for the period 1994-2008, we obtain an elasticity of 1.059 (t ratio = 2.96), which appears to support the higher elasticity of 1 for car as well. However, if we successively step back one year, removing the most recent data, we obtain the following pattern of results:

Table 7: Estimated GDP Elasticities for Different Periods of Meta-Analysis Data

Period for Meta-Analysis VTTS data	Estimated elasticity to GDP/head (*t ratio*)
1994-2008	+1.040 (*2.92*)
1994-2007	+.952 (*2.48*)
1994-2006	+1.094 (*2.55*)
1994-2005	+.848 (*1.85*)
1994-2004	+.662 (*1.28*)
1994-2003	–.052 (*-0.16*)

This strongly suggests that it is the data since 2003 which is driving the higher elasticity: over the period 1994 to 2003 there is in fact no indication of a relationship with GDP at all. This apparent instability naturally implies reservations about the representativeness of the meta data (modes, purposes, journey length, urban/rural, London/non-London) to the market as a whole. This is, of course, inherent in the method. But it does raise questions as to the confidence we should place in the analysis in this context.

Our provisional view is that, if we were now making the judgment required in §7.5 of the 2004 Report, we would be driven by the now existing evidence towards a value of 1.0. However, given the currently recommended value of 0.8, and its general acceptance, it is not clear that the additional evidence (ie, over and above that existing at the time of the ITS/Bates Report) is strong enough to change it.

Perhaps there is more that can be teased out of the meta-analysis, though it appears that W&W have gone near the limits of what can reasonably be deduced. On a five point scale (Strong Support ; Weak Support ; Neutral ; Weak Anti ; Strong Anti) we conclude there is Weak Support for a move to 1. Given that the income elasticity is used in conjunction with the base values, our preference as peer reviewers would be for the DfT to leave adjustment of the income elasticity for a comprehensive review of the value set *in toto*. We note that extending the assumption forward over the appraisal period will make a significant difference to the appraisal values and hence the NPV of the schemes.

We have given less attention to the level of the values, concentrating on the growth over time. There is an indication from Tables 7 and 8 of W and W that for all modes combined, the official values have been on the high side, compared with the studies in the meta-analysis. This suggests that a re-assessment of **non-car** modes might be in order: as noted at the outset, the evidence at the time of the ITS/Bates report for modal variation in non-work VTTS was not particularly strong, but this might no longer be the case.

6. Conclusions and further research

With respect to the business values of travel time savings we have concluded that the values derived from both methods (B2 and B3) are preferred compared to those currently in WebTAG, and we have also concluded that method B2 (NTS based) is preferred to method B3 (ASHE based). So, we concur with the DfT's view and confirm the validity of the DfT's calculations for business travellers.Separately, we confirm that the DfT's approach and calculations for professional drivers' time is appropriate.

Regarding the updating of the non-working time values for commuting and other purposes, again it is confirmed that the updating calculations have been performed correctly. A few detailed comments are made but nothing has been found which requires immediate attention in audit terms. It turns out that, unlike for business travel, the mileage weights from NTS have been very stable over time so there is very little change to the values of non working time on that account.

The DfT has, as part of this work, reviewed its current assumption based on the 2003 report that the income elasticity of the value of travel time savings is 0.8. Based on meta-analysis work by Wardman et al, the DfT considers that the evidence now supports a value of 1. We concur that the evidence since 2003 does point in that direction but we have reservations about the strength of that evidence. Overall, we think it would be preferable to reconsider the income elasticity value alongside the base values to which it is applied, and would therefore prefer to see no change at this point.

As already mentioned method B2 (NTS income) for measuring BVTTS represents a substantial improvement on the status quo. Up to date NTS travel data has been utilised and hours data from the LFS has also been used. The use of NTS income data does however still pose challenges in deriving the hourly rate of travellers in terms of the hours worked by individuals and how much earnings comprise of their total personal income. It is possible that further analysis of the LFS or other datasets (e.g. BHPS) may shed light on this. Given that business travel is very much concentrated amongst certain occupational and socio-economic classes in the longer term the best way to address this issue could be to amend the NTS questions so that hourly earnings can be derived more easily. We have also identified as areas of further research the derivation of a distance weighted industry average for non-wage costs (rather than the economy wide average), the use of mean instead of median values for each income band, the use of changes in actual earnings rather than GDP/capita as a scaling factor between years and restricting the NTS analysis for this purpose to those who are fully immersed in the labour market. On the latter a focus on those who work full-time may also get round the difficulty of the derivation of hourly rates at low annual income levels where there is a mixture of full-time workers with low hourly rates and part-time workers with high hourly rates. Given the non-

linearities between BVTTS (and non work time) and income and trip distance further research on the impact of the level of segmentation on the average value derived would be of interest – as there exists a tension between disaggregating as finely as possible to pick up these non-linearities and increasing the level of confidence in the results by avoiding small sample sizes. Although these issues are less high profile than some broader questions relating to the Cost Saving Approach, they are nonetheless significant in deriving the best practicable estimates of a large component of transport user benefits.

Further research is also recommended on the appropriate income elasticity to use over time for non-working time values. While the meta-analysis dataset is of considerable value in this respect, it is potentially subject to the random introduction of new studies. Consideration should be given to other methods as well.