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VALUES OF TRAVEL TIME IN EUROPE: REVIEW AND META-ANALYSIS

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Abstract

This paper reports the most extensive meta-analysis of values of time yet conducted, covering 3109 monetary valuations assembled from 389 European studies conducted between 1963 and 2011. It aims to explain how valuations vary across studies, including over time and between countries. In addition to the customary coverage of in-vehicle time in review studies, this paper covers valuations of walk time, wait time, service headway, parking space search time, departure time switching, time in congested traffic, schedule delay early and late, mean lateness and the standard deviation of travel time. Valuations are found to vary with type of time, GDP, distance, journey purpose, mode, the monetary numeraire and a number of factors related to estimation. Model output values of time compare favourably with earnings data, replicate well official recommended values obtained from major national studies, and are transferable across countries. These implied monetary values serve as very useful benchmarks against which new evidence can be assessed and provide parameters and values for countries and contexts where there is no other such evidence.

Keywords:

Meta-analysis, Review of Values of Travel Time, European Values of Travel Time

Highlights:

- Largest ever meta-analysis of valuations of time extending across whole of Europe
- Covers wide range of time related attributes other than just in-vehicle time
- Effects of numerous influential variables on valuations quantified
- Valuations implied by meta-model correspond well with official recommendations
- Valuations implied by meta-model benchmark well against earnings

1. INTRODUCTION

The value of travel time is one of the most important parameters of transport planning and several countries and some international organisations have official values so that transport projects, programmes and policies are evaluated on a consistent basis (Mackie et al., 2014). So-called national studies[1] have been conducted in Denmark, Germany, Netherlands, New Zealand, Norway, Sweden, Switzerland and the United Kingdom, in many cases on more than one occasion, and this evidence is backed up with a whole host of specific studies exploring valuations of a wide range of time related variables in contexts as diverse as high speed rail, new toll roads, light rapid transit schemes, congestion pricing, quality improvements to local bus services and inter-urban train services, and infrastructure improvements for cyclists and pedestrians.

This wealth of evidence makes possible the research reported in this paper, which we contend is the largest review and meta-analysis yet of valuations of travel time related attributes. It covers European wide passenger valuations of in-vehicle time (IVT), walk time, wait time, headway, parking space search time, changes in departure time, time spent in congested traffic conditions and travel time variability as measured by schedule delay early (SDE) and late (SDL), mean lateness on timetable or expected arrival time, and the standard deviation of travel time (SD).

Meta-analysis is essentially the study of studies. The quantitative explanation that it provides of inter-study variations, in this case of monetary valuations of time-related travel attributes, can yield methodological insights and provide important evidence on spatial and inter-temporal variations that might not be possible by other means. In this specific context, it provides country specific valuations where there is a dearth of evidence and otherwise allows an assessment of existing evidence.

The structure of this paper is as follows. Section 2 covers the assembly of the data and section 3 provides a description of the key features of the data. Section 4 summarises some of the valuation evidence prior to the meta-analysis that is reported in section 5. Illustrative implied values are presented in section 6, along with comparison against official values from national studies, and section 7 provides concluding remarks and recommendations.

2. DATA ASSEMBLY

This study builds upon two previous streams of meta-analyses. The Abrantes and Wardman (2011) study covers British evidence on valuations of time, walk, wait, departure time changes, search time, congested travel time and headway, over the period 1963 to 2008, building upon three previous studies and exploiting a considerable amount of 'grey' literature. We have here added UK valuations relating to travel time reliability and some post 2008 evidence.

The Shires and de Jong (2009) data set covers European IVT evidence over the period 1990 to 2004 that is indisputably in the public domain. It also included UK valuations as well as some non-

[1] We compare the findings of our meta-analysis with those of national studies in section 6.3.

European evidence which have each been removed. We have here added earlier and more recent studies along with evidence from unpublished sources for the 1990 to 2004 period and valuations other than for IVT throughout.

Table 1 lists for each attribute covered the number of valuations and studies. Overall, we have 3109 monetary values from 389 studies covering 1963 to 2011. In addition, we cover in section 6 values from some recent national studies conducted subsequent to the data assembled here.

IVT is public transport travel time and also car travel time where there is no distinction made between time spent in free flow traffic, and, however defined, time spent in congested traffic conditions[2]. Search time is similar in nature and is the time that car drivers spend searching for a parking space. Access time is the time spent getting to and from main modes where the study did not distinguish the specific mode used whereas walk time relates to time spent accessing/egressing a main mode on foot and not to walking as a mode in its own right. We distinguish between wait time at the start of a public transport journey and wait time where an interchange is required, noting that the values of wait time were directly estimated and not deduced from valuations of headway between services which form a separate category[3].

Departure time changes, which can be earlier, later or a mixture of the two incur inconvenience but apply to journey planning decisions at the origin in a context of certainty rather than the decisions that might be associated with a behavioural response to travel time uncertainty. In contrast , the reliability variables relate to the destination in a context of uncertainty. Late arrival time is mean lateness on timetable, SDE and SDL respectively relate to the disutility of arriving before or after the preferred arrival time expressed as expected values across a set of arrival times, and SD is a common measure of travel time variability.

Table 1: Attributes, Studies and Monetary Valuations

	UK		**Non-UK European**		**Total**	
Attribute	*Studies*	*Valuation Estimates*	*Studies*	*Valuation Estimates*	*Studies*	*Valuation Estimates*
In-Vehicle Time (IVT)	218	974	145	703	361	1677 (54%)
Congested Time	9	29	15	46	24	75 (2%)
Free Flow Time	9	39	15	48	24	87 (3%)
Walk Time	80	257	28	68	108	325 (10%)
Access time	26	85	13	37	39	122 (4%)
Wait Time	24	65	21	58	45	123 (4%)
Interchange Wait	6	15	3	15	9	30 (1%)
Search Time	5	9	4	12	9	21 (1%)
Headway	69	216	30	108	99	324 (10%)

[2] We note that studies have increasingly distinguished different degrees of car congestion, as discussed in the review of international evidence by Wardman and Ibáňez (2012), but here we simply distinguish values for free flow and congested traffic conditions.
[3] A few studies reported values of wait time when in fact they had estimated values of headway.

Departure Time Early	10	36	4	13	14	49 (2%)
Departure Time Late	10	40	4	13	14	53 (2%)
Departure Time Both	7	29	0	0	7	29 (1%)
Late Arrival	9	24	9	20	18	44 (1%)
Schedule Delay Early (SDE)	2	4	11	43	13	47 (2%)
Schedule Delay Late (SDL)	4	15	11	44	15	59 (2%)
Standard Deviation (SD)	6	25	4	19	10	44 (1%)
Total	236	1862	157	1247	389	3109

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As expected, valuations of IVT dominate, forming over 50% of the UK and European data sets. This is followed by walk time and headway, each with 10%, and the combined reliability terms, combined wait times, combined departure time changes, and access time valuations each with around 5%.

3. DATA CHARACTERISTICS

We here summarise some of the key features of the assembled valuation evidence. We only draw multiple observations per study when the segmentation is based on a variable whose effect we are interested in exploring, such as distance, mode or journey purpose. Slightly over half of the studies (52%) yield five or less valuations, perhaps surprising given that most studies value more than one time-related attribute and segmentations, particularly by journey purpose and to a lesser extent mode and distance, are commonplace. Only 8% of studies yield more than 20 observations.

Monetary values have been obtained for 26 countries as set out in Table 2. The UK provides almost 60% of the monetary values[4], followed by the Netherlands with around 8%. Denmark, Norway and Sweden are the next three most prominent, each with around 5% or more of the total. France, Italy and Germany each provide less than 2%.

Table 2: Valuations and Studies by Country

Country	Studies	Valuation Estimates	Country	Stud	Valuation Estimates
Albania	1	2	Moldova	1	1
Austria	2	24	Netherlands	24	247
Belarus	1	1	Norway	15	163
Belgium	2	7	Poland	7	19
Croatia	1	3	Portugal	2	16
Denmark	12	198	Romania	1	4
Finland	4	10	Russia	1	2
France	7	47	Serbia	1	11
Germany	10	52	Spain	14	92
Greece	6	31	Sweden	20	140

[4] The UK evidence dominates as this has been accumulated since 1995 in four prior studies.

Irish Republic	5	25	Switzerland	10	88
Italy	14	55	Ukraine	1	1
Latvia	1	8	United Kingdom	233	1862

Note: Two studies each have valuations for four countries and one has valuations for two countries, , and hence the number of studies listed in this table is 396 as opposed to the total of 389 covered.

The most common segmentation factor in transport planning is journey purpose. Table 3 illustrates the distribution of values across purposes for five broad categorisations of the variables. Commuting, other trips and no distinction by trip purpose (NoPurp) have broadly similar proportions. The relatively low number of behavioural values for business travel[5] may be due to the widespread use of wage rate based approaches to value business travel time savings rather than estimates from choice data. Not surprisingly, the commuting market has a relatively large proportion of the travel time variability and departure time change valuations.

Table 3: Number of Valuations by Purpose (Row Percentages)

	Business	Commute	Other	NoPurp	Total
Time	299 (16%)	515 (28%)	555 (30%)	491 (26%)	1860
OVT	31 (5%)	202 (34%)	148 (25%)	219 (36%)	600
Headway	42 (13%)	67 (21%)	94 (29%)	121 (37%)	324
Departure Time Changes	25 (19%)	44 (34%)	26 (20%)	36 (27%)	131
Rely	31 (16%)	72 (37%)	44 (23%)	47 (24%)	194
Total	428 (14%)	900 (29%)	867 (28%)	914 (29%)	3109

Note: Commute includes peak and Other includes off-peak. Time covers IVT, search, free flow and congested time. OVT (out-of-vehicle time) covers walk, wait and access time. Rely covers *SDE*, *SDL*, S*D* and late arrival.

We distinguished between users of specific modes (mode used) regardless of which mode is being valued and the valuations of those modes (mode valued) regardless of the mode that was used[6]. Car is by far the largest single mode both used and valued in our data set but not to the extent of its dominance of travel. It represents as a single mode 40% of user values and 30% of the modal values. Rail, including metro, provides around 20% of users and 25% of values whilst the corresponding figures for bus are all around 15%. The remainder cover a mix of mode used and mode valued, with car and public transport combined providing 12% of users and 10% of mode valuations being the largest combined category.

[5] Business travel in this review is restricted to so-called briefcase travellers who are transacting business.

[6] So a car user might in a mode choice exercise value, say, train travel time or in an abstract choice context value car travel time or indeed time spent on, say, train.

A common segmentation is by distance. Table 4 presents the distribution of values by distance band. Most valuations are for journeys less than 25km but there is a good spread across different distances to support analysis of its effect.

Table 4: Number of Valuations by Overall Journey Distance (Km) Band (Row Percentages)

	0-10km	11-25km	26-100km	101-250km	> 250km	Total
Time	479 (26%)	561 (30%)	398 (21%)	265 (14%)	157 (9%)	1860
OVT	300 (50%)	177 (29%)	64 (11%)	29 (5%)	30 (5%)	600
Headway	104 (32%)	82 (25%)	66 (20%)	32 (10%)	40 (13%)	324
Dep Time Change	17 (13%)	12 (9%)	54 (41%)	35 (27%)	13 (10%)	131
Reliability	14 (7%)	90 (46%)	61 (32%)	23 (12%)	6 (3%)	194
Total	914 (29%)	922 (30%)	643 (21%)	384 (12%)	246 (8%)	3109

As for the choice context examined, mode choice forms 53% overall, but falls from 68% prior to 1990 to 32% after 2000. The other main context is abstract choice, where the options are not real-world alternatives, which forms 32% overall but increasing from 26% prior to 1990 to 43% since 2000. Values from Revealed Preference (RP) data represent 12% of valuations and 18% of studies, ranging from 26% of studies in 1963-1990 to 12% in the most recent period.

4. SUMMARY VALUATIONS

Prior to reporting the meta-analysis of the assembled valuations, it would seem 'customary' to provide some summary statistics relating to that evidence. Comparing money valuations across studies so disparate in terms of incomes, living costs, currencies and varying exchange rates is fraught with difficulties and might be misleading. Any illustrative valuations need to be obtained from closely controlled comparisons and we do this by:

- Adjusting valuations for income growth and comparing against country specific income levels;
- Benchmarking the valuation evidence against earnings;
- Examining 'within-study' variations in valuations.

We could also compare 'time multipliers', which are valuations expressed in equivalent units of IVT and hence control for the monetary dimension, but the detailed issues involved here are beyond the scope of this paper. Nonetheless, the Appendix provides summary statistics for all the time multipliers in our assembled data and compares them with the multipliers implied by the subsequently estimated meta-model.

4.1 Variations in Values across Countries

In line with widespread official practice, we adjusted for the purposes of this exercise all our values of time (IVT and free flow) using a local GDP (gross domestic product) per capita elasticity of one to 2010 income levels. This isolates the temporal dimension enabling us to obtain insights into the cross-sectional variations by country income which is an important issue in the transferability of values. We regressed the **mean** income adjusted 2010 values grouped by country and purpose on the GDP_PPP (purchasing power parity) figures for 2010. We used GDP_PPP since it accounts for differences in purchasing power between countries which can be expected to impact on willingness to pay for time savings

The number of countries for which we had business, commute, other and *NoPurp* valuations was 17, 19, 20 and 21 respectively, making 77 observations in total. The model is estimated in double-log form, with weighting by the number of observations in each country/purpose cell, and hence the estimated parameters reported in Table 5 are interpreted as elasticities. The goodness of fit is respectable, given the diverse nature of studies, and the elasticities are precisely estimated, providing strong support for money valuations varying across countries in line with GDP variations after allowing for purchasing power parity[7]. Moreover, GDP_PPP elasticities so close to one for each journey purpose strongly support the widespread convention in official appraisal guidance of increasing values of time in direct proportion to income.

Table 5: Regression of Mean Values of Time on GDP_PPP

Variable	Coeff (t)
Constant	-7.777 (3.6)[8]
GDP_PPP-Business	1.098 (5.1)
GDP_PPP-Commute	0.982 (4.6)
GDP_PPP-Leisure	0.995 (4.7)
GDP_PPP-NoPurp	0.977 (4.6)
Adjusted R^2	0.578
Observations	77

4.2 Values of Time and Earnings

Another dimension to pursue here is the common practice of expressing values of time relative to earnings. Transport appraisal worldwide has for many years and in almost all 'practising' countries adopted the Cost Savings Approach (CSA) of equating the valuation of business travel time savings to the gross wage rate plus the marginal costs of employment (Wardman et al., 2015). The pioneering willingness to pay studies of non-business travel time savings also tended to link the estimated valuations to income, not least as a means of assessing how reasonable the then novel estimates were, and the value of time was widely regarded to be around 25% of the net of tax wage rate which roughly translates into a figure a little over 30% of the gross wage rate. Although there are variations by distance and by mode, the Mackie et al. (2014) review of appraisal practice in seven countries reports official values for non-business trips varying around this figure of 30%.

[7] Replacing GDP_PPP with GDP per capita reduced the business elasticity to around 0.7 and the other elasticities to around 0.6 but with a worse fit.

[8] The exponential of this term provides a small multiplier but this is simply a function of the large GDP_PPP figures used. The same applies for the main meta-model reported in Table 8.

We sourced gross labour cost figures back on a consistent basis to 1980 for most countries in our data set[9]. These are around 25% larger than the gross wage rate and cover 1787 (96%) of our 1860 values of IVT and free flow, congested and search time. Table 6 reports the valuations expressed relative to the gross labour costs segmented by journey purpose and by time period.

The business values exceed the gross labour costs generally by some margin. However, business travellers tend to have higher wage rates than the national average. In a review of business travel values, Wardman et al. (2015) suggested an uplift of 32% of national gross labour costs to allow for the higher incomes of business travellers, whereupon the willingness-to-pay business values here are not greatly different to what would be implied by the CSA. We note though that the business valuations are lower in the most recent period and this might be due to the digital revolution and the ability to use travel time in a more productive fashion.

The valuations for other trips may be larger than for commuting due to the generally longer journeys. Nonetheless, after accounting for the non-wage elements of gross labour cost, the non-business valuations are in the range of 30-0% of the wage rate and this seems very plausible[10].

Table 6: Valuations of Time Variables Relative to Gross Labour Costs

Purpose	All Years	Up to 1990	1991-2000	2001 and After
Business	1.39(0.08)[286]	1.49(0.12)[56]	1.58(0.17)[114]	1.15(0.07)[116]
Commuting	0.42(0.02)[484]	0.51(0.04)[94]	0.38(0.02)[198]	0.44(0.02)[192]
Other	0.48(0.02)[542]	0.50(0.05)[85]	0.45(0.04)[271]	0.54(0.03)[186]
No Purp	0.42(0.02)[475]	0.64(0.07)[80]	0.32(0.02)[196]	0.43(0.03)[199]

Note: Figures are mean ratio, standard error of the mean ( ) and number of observations [ ].

4.3 Within Study Insights into Variations in Monetary Valuations

We now turn to within-study variations in values of the *Time* variables where comparisons are based on the isolation of all key influences other than those we are interested in. This is done by selecting valuations from the same study which differ in terms of only one of the main variables of interest which can be mode used, mode being valued, journey purpose, whether the valuation relates to an urban or inter-urban trip, and whether the valuation was obtained from an RP or SP model[11]. Table 7 reports the primary influences insofar as sample sizes sensibly allow.

[9] https://stats.oecd.org/Index.aspx?DataSetCode=ULC_ANN#

[10] We had expected there might be some variations in these ratios between Western and Eastern European countries but this was not the case.

[11] Urban trips are taken to be those of 30km or less, although some discretion is applied in cases where the journey might be longer but are clearly being made within a built-up area.

Table 7: 'All Else Equal' Within Study Variations in Monetary Values

Value Ratio	Segment	Mean(SE)[Obs]	Value Ratio	Segment	Mean(SE)[Obs]
RP/SP	Business	1.46(0.17)[20]	Train Valued/Car Valued	Commute	0.94(0.09)[49]
	Non-Business	1.38(0.09)[64]		Other	0.73(0.08)[55]
Inter-urban/ Urban	Business	1.96(0.29)[19]		Business	1.10(0.09)[43]
	Non-Business	1.43(0.08)[112]		Urban	0.88(0.05)[115]
	Car	1.11(0.06)[65]		Inter	0.96(0.06)[98]
	Bus	1.50(0.33)[6]		Car User	0.93(0.06)[76]
	Train	1.40(0.11)[30]		Train User	0.83(0.14)[14]
Business/Other	Car Urban	2.13(0.11)[135]	Bus Valued/Car Valued	Commute	1.35(0.18)[30]
	Car Inter	1.97(0.09)[107]		Other	0.72(0.08)[19]
	Train Inter	2.58(0.13)[105]		Urban	1.04(0.07)[87]
Commuting/Other	Car	1.08(0.03)[216]		Inter	0.88(0.06)[12]
	Train	1.13(0.04)[62]		Car User	1.10(0.09)[42]
	Bus	1.37(0.05)[37]	Metro Valued/Car Valued	Commute	0.96(0.19)[19]
Car User/Bus User	Commute	1.63(0.21)[19]		Other	0.66(0.08)[15]
	Other	2.06(0.52)[17]		Car User	0.94(0.23)[13]
Car User/Train User	All	1.32(0.20)[40]		Car/PT User	0.81(0.09)[33]
Bus User/Train User	All	0.76(0.06)[16]	Train Valued/ Bus Valued	Commute	0.81(0.07)[12]
Train/Air User	All	0.72(0.09)[12]		Other	0.68(0.07)[17]
Air Valued/ Train Valued	All	1.62(0.21)[27]		Urban	0.76(0.05)[32]
Metro Valued/Bus Valued	All	0.80(0.04)[26]		Inter	0.98(0.05)[19]

Note: Figures are mean value of time, standard error of the mean ( ) and number of observations [ ].

There have long been concerns about whether stated responses to hypothetical scenarios are consistent with actual choices in real-world contexts. We find the RP valuations to be significantly larger than the SP valuations, for both business and non-business trips, and this is consistent with key international evidence in the area (Brownstone and Small, 2005; Hensher, 2010) This is presumably due to more strategic SP response bias with regard to prices which can be much more readily varied by authorities and operators than journey times can be. There is a possible additional effect for business trips surrounding company policy. Since RP valuations may well be driven more by company policy, they can be expected to be larger than e SP based valuations where the latter include an element of business travellers' personal willingness to pay given uncertainties in company policy or ambiguity in what the SP exercise required them to consider. Offsetting this though is an opposite incentive of 'free riding' given that business travellers are not spending their own money.

The conventional wisdom is that values of time increase with journey duration. Our summary evidence is that valuations are indeed larger for longer distance inter-urban journeys, particularly for business. The latter though is not necessarily inconsistent with the CSA to the extent that longer distance trips are made more by those with higher incomes. The largest variation by mode is for bus, and we might expect the 'more discretionary' inter-urban bus market to be a different mix of travellers to the 'more captive' short-distance urban bus market, with rail also exhibiting a large differential presumably for the same reason.

Journey purpose segmentations are, not surprisingly, based on a large amount of evidence. Business valuations are much larger than for other trips, perhaps less than might be expected given the discussion and results in section 4.2, yet there is not a great deal of difference between commuting and other trips even though commuters have higher incomes, greater time constraints and travel in worse conditions. Possible factors in the latter case are that valuation studies have not been clear on what type of time variation is actually being valued and within a given distance category the other trips might tend to be longer.

As expected, due to self-selection relating in part to income differences, car users have higher values than train users who in turn have higher values than bus users, and the ratios are broadly consistent. Unsurprisingly, train users have lower values than air users.

Turning to the mode valued itself, the inherent features of different modes, such as comfort, privacy, environment, ambience and the ability to undertake worthwhile activities while travelling will impact on the marginal utility of time spent travelling in that mode and hence upon the value of time. There is a lot of evidence on variations in mode valued. Without discussing each of the reported relativities, the evidence indicates that, as a generalisation, train is regarded to be superior quality given its lower value of time even amongst car users, followed by Metro then car with bus regarded as the most inferior quality. In the specific market of very long distance travel, air travel is quite clearly inferior to rail.

In conclusion, the within study variations in monetary valuations are generally not trivial and are in line with expectations, but some confounding effects may remain which we would wish the meta-analysis to address. It is to this that we now turn.

5. META-ANALYSIS

Meta-analysis is the statistical analysis of the outcomes of numerous studies with, in this context, the aim of quantifying the principal drivers of value of time variation, ideally avoiding the confounding effects that might be apparent in the simple cross-tabulations of traditional reviews. It can provide methodological insights whilst it is particularly well suited to informing how valuations vary over time, critical in appraisal, and in this context across countries, and its 'forecast outputs' serve as a useful benchmark for assessing new evidence and providing appraisal values where none otherwise exist.

5.1 Modelling Approach

The monetary values have been expressed in € per minute in 2010 prices. In European countries that have never adopted the €[12], which together form 80% of our observations, the valuations were

[12] In our data set, these are the EU countries of Croatia, Denmark, Latvia, Poland, Romania, Sweden and United Kingdom, along with Non-EU countries of Albania, Belarus, Moldova, Norway, Russia, Serbia, Switzerland and Ukraine.

adjusted to 2010 prices in the local currency and then converted to € at the prevailing 2010 exchange rate. Where a currency was subsequently replaced by the €, which occurs in 8% of cases, we have used the official exchange rate at the time of conversion along with local price indices. In the remaining 12% of cases, the values were estimated in euros and have then been converted to 2010 prices.

The model used to explain variations in monetary values (V) takes the form:

$$V = \tau \prod_{i=1}^{n} X_i^{\alpha_i} e^{\sum_{j=1}^{p} \sum_{k=1}^{q_p - 1} \beta_{jk} Z_{jk}} \qquad (1)$$

where there are n continuous variables (X_i) and p categorical variables having q_p categories (Z_{jk}). We specify q_p-1 dummy variables for a categorical variable of q categories and their coefficient estimates are interpreted relative to the arbitrarily omitted category. The α_i are interpreted as elasticities and the exponential of β_{jk} denotes the proportionate effect on the valuation of a particular category relative to its omitted category. A logarithmic transformation of equation 1 allows its parameters to be estimated by ordinary least squares.

We also included 'fixed effect' dummy variables, not specified in equation 1 above, whose purpose was to detect study specific influences which will undoubtedly exist. Key issues here are: omitted relevant factors in our meta-model, particularly because of the inherent inability to examine detailed study features; a poor quality study for data, design or analysis reasons; and the approximations involved in converting currencies. We retained estimated fixed effects with t ratios in excess of two and this increased the R^2 goodness of fit from 0.50, which is quite respectable given the disparate nature of the studies, to an impressive 0.70, with the most noticeable change in parameter estimates being the GDP elasticity increasing from 0.65 (±21%[13]) to 0.99 (±16%). A random effects model yielded somewhat inferior fit and parameter estimates. In addition, 'outlier' observations with standardised residuals outside the range ±2 were removed, again on the grounds of the inevitable challenges in making cross-country comparisons of disparate studies. Removing the 5% of observations which might be deemed to be of 'poorest quality' increased the goodness of fit to an excellent 0.78 but with no large changes in parameter estimates.

Table 8 reports our preferred model, estimated to 2960 monetary valuations, with the exception of the fixed effects coefficient estimates for 183 (47%) of the 389 studies. The latter averaged -0.27 and when taken across all studies would reduce the implied values of time by only 12%. Whilst we have retained a few coefficient estimates deemed important that were not significant at the 5% level, the t ratios, as with the goodness of fit, are mostly impressive and imply relatively narrow confidence intervals. We now discuss in turn the findings for each of the main categories in Table 8[14].

[13] 95% confidence interval expressed as a proportion of the central estimate.

[14] We do not routinely compare our results with other evidence since there is not only a considerable amount of it but the analysis reported here is a synthesis of that evidence! We do though compare with relevant review evidence.

Table 8: Meta-Model Results (2010 incomes and prices, € per minute)

Variable	Coeff(t)	Effect	Variable	Coeff (t)	Effect
Constant	-12.430 (18.2)		**Mode Used**		
Attribute Specific			Bus	-0.373 (10.4)	-31%
Walk	0.370 (11.8)	+45%	Air	0.334 (4.1)	+40%
Wait	0.405 (8.8)	+50%	CarRail	0.381 (8.4)	+46%
Search	0.537 (4.8)	+71%	+CarDepChange	-0.262 (2.1)	-23%
IntWait	0.402 (4.1)	+50%	**Mode Valued (IVT)**		
Access	0.464 (8.0)	+59%	Air	0.555 (6.3)	+74%
FreeFlow	-0.352 (6.1)	-30%	RailAir	0.688 (2.9)	+99%
Congested	n.s.		**Numeraire**		
Headway	-0.459 (14.6)	-37%	Toll	-0.281 (5.2)	-25%
DepChangeEarly	-1.109 (8.3)	-67%	Fuel	0.131 (3.7)	+14%
DepChangeLate	-0.843 (6.5)	-57%	**SP Presentation**		
DepChangeBoth	-1.172 (6.8)	-69%	Cards	-0.284 (4.5)	-25%
Late	1.119 (13.9)	+206%	CAPI	-0.287 (9.5)	-25%
SD	-0.298 (3.3)	-26%	Adaptive	-0.894 (7.2)	-59%
SDE	-0.088 (1.1)	-8%	**SP Replications**		
SDL	0.680 (8.5)	+97%	Repeat Choices	-0.007 (2.2)	
+IncludeSD	-0.333 (2.7)	-28%	**Choice Context**		
Inter-Urban			Abstract Choice	-0.128 (4.5)	-12%
Time	0.324 (10.7)	+38%	**Study Aim**		
OVT	0.486 (6.7)	+63%	Yes	0.100 (3.7)	+11%
DepChange	1.281 (9.7)	+260%	**Values per Study**		
Rely	0.188 (2.1)	+21%	Number	0.005 (4.7)	
Income (euros)			**Data Type**		
GDP_PPP	1.031 (15.2)		RP	-0.069 (1.4)	-7%
+ PreEuro	0.034 (6.9)		**Country Specific**		
+ EB	0.079 (9.3)		Austria	-1.217 (5.4)	-70%
+ CarUsers	0.025 (8.2)		Italy	-0.315 (3.7)	-27%
Purpose			Spain	0.283 (4.8)	+33%
CommPeak	0.127 (5.3)	+14%	Switzerland	0.198 (3.1)	+22%
NoPurp	0.161 (5.8)	+17%	UK	-0.490 (16.0)	-39%
+ EBSP	-0.173 (2.1)	-16%	Adjusted R^2	0.782	
+ EBForecasting	0.151 (2.8)	+16%	Observations	2960	
+ EBOVT	-0.272 (2.7)	-24%			
+ EBTrainUser	0.282 (4.5)	+33%			

Note: t statistics in brackets. Coefficient names prefixed with + are incremental interaction effects to be added to the base. The continuous variables for SP replications and values per study were entered in absolute form, in contrast to a logarithmic form for income. The other terms are categorical and represented by dummy variables, including the study specific fixed effects.

5.2 Attribute Specific Coefficients (Urban Travel)[15]

Dummy variables were specified for 15 of the 16 time-related attributes, with IVT serving as an arbitrary but sensible base. The coefficient for congested car time was far from significant, indicating that it can be taken to have the same value as IVT in general, all other things equal, with car time spent in free flow traffic conditions having a 30% lower value than other forms of IVT, presumably due to a preference for car travel. The premium attached here to congested car travel time is therefore a little less than in the international review of Wardman and Ibáňez (2012).

Walk and wait time[16] are respectively valued 45% and 50% more highly than IVT, somewhat less than the factor of two commonly applied in transport appraisal around the world. Interchange wait time (*IntWait*) was, perhaps reassuringly, found to have the same premium as wait time whilst access time to public transport modes (*Access*) has a slightly larger value than walk time and this may be because of the interchange effect and greater uncertainties involved in accessing by modes other than walk. The car parking space search time coefficient (*Search*) was highly significant and its multiplier of 71% is consistent with an element of congested car travel time multiplier along with annoyance at being unable to find a parking space.

Service headway was found to have, on average, a value that is 63% of IVT. Assuming random arrivals, whereupon wait time is half the headway, combined with our value of wait time estimated to be 50% larger than the value of IVT implies a minute of headway valued at 75% of IVT. We would expect the latter number to be larger than the 63% since in an urban context, public transport users do not always arrive randomly for services. ,

With regard to switching departure time, we distinguished between earlier departures (*DepChangeEarly*), later departures (*DepChangeLate*) and instances where no distinction was made (*DepChangeBoth*). There is not a great deal of difference between each, with perhaps some evidence that departing earlier is worse than departing later, which might be understandable for, say, early morning commuting or business trips. Unfortunately, the data rarely lets us differentiate outward and return journeys between which we might expect this value to vary somewhat. Whilst departure time changes have relatively low values for urban trips, as we shall see they are somewhat more important for inter-urban travel.

Late time is, as expected, relatively highly valued, with an impact coefficient 3.1 times larger than IVT reflecting the penalties and inconvenience of arriving late. SDE has a lower value than IVT, on the grounds that it would be possible for some to spend the early time more usefully than travel time. SDL is valued at almost twice IVT. The standard deviation of travel time (*SD*) is valued around two thirds of IVT and this seems reasonable; Wardman (2014) reports what is termed the reliability ratio to be in official guidance between 0.42 and 0.69 depending upon mode in Norway, between 0.4 and

[15] The implied time multipliers are not just a function of these attribute specific coefficients but also depend upon other parameters in the model as is clear in the discussion in subsequent sections. We return to the issue of time multipliers in section 6.4.

[16] These values are based on waiting time rather than deduced from service headway based valuations which we consider below.

1.1 across journey purpose in the Netherlands and 0.8 for car travel in Great Britain,[17] although note that our reliability ratio would be smaller for inter-urban trips as discussed in the next section.

A few models which estimate *SDE* and *SDL* also specify *SD* in the utility function*,* and vice-versa. As might be expected, the values of *SDE* and *SDL* were lower where *SD* is also included *(+IncludeSD*), although surprisingly no significant effect could be obtained on *SD* when *SDE* and *SDL* were also included in the reported utility function.

We would expect the value of late arrival time to be less than the value of SDL, on the grounds that late arrival on timetable can actually move a public transport user closer to their preferred arrival time due to fixed departure time constraints. This is clearly not the case here. A contributory factor could be that the explicit presentation of late time in SP exercises, in terms of being X minutes late one in Y journeys, induces more strategic bias, whereas late time is only implicit in the multiple presented journeys that underpin SDL estimation and this SP exercise is more complex which might exacerbate the problem. A further explanation is that studies valuing late time have estimated mean lateness on the basis that the (Y-1)/Y journeys are all on time. However, if respondents perceived there to be a degree of lateness with the Y-1 journeys, then the value of the implied late time will have been overestimated. Finally, late time is often presented as relating to a specific journey, whereupon there is no chance to mitigate the consequences by changing departure time, whereas the presenting a distribution of possible travel times across journeys would seem to invite such mitigation and hence a lower implied valuation.

5.3 Inter-Urban Travel

One of the most common features of the empirical literature is that valuations are larger for longer journeys, and this is clearly apparent for the *Time* variables in the within study variations reported in Table 7. Our preference here is to distinguish between urban and inter-urban trips, rather than specify a distance elasticity as in our previous meta-analysis studies, for two main reasons. Firstly, it is easier to apply a distinction between urban and inter-urban trips in appraisal, modelling and forecasting practice than it is to differentiate continuously by distance. Secondly, our distance evidence is not always precise, either because the study did not report the distance or the valuation covered a range of distances.

The reported inter-urban incremental effects were specified for the combined *Time*, *OVT*, and *Rely* categories set out in the note to Table 3 along with an effect for departure time changes (*DepChange*). The incremental effect for headway was far from significant.

All four significant incremental terms indicate monetary valuations to be larger to varying degrees for longer journeys. Behind this general finding are the greater time pressures on longer distance trips and making them for more important reasons which underpins the willingness to make costlier

[17] However, the recent UK value of travel time savings and reliability study (Department for Transport (2015)) advocated a reliability ratio of 0.4 rather than 0.8 for car travel which broadly fits with our findings across all trip lengths.

and longer journeys. Further contributory factors are that higher income individuals with larger valuations form a greater proportion of longer distance trips, although we cannot control for this here, and a 'proportionality' effect whereby a given monetary valuation might have a lesser impact on longer journeys since it is less in proportionate terms.

The incremental effect for *Time* at 38% is strong, and will additionally contain an element relating to the increasing discomfort of travel time on longer distance journeys. We also have to acknowledge that the widely used SP studies tend to offer larger time variations for longer journeys and the evidence in this area indicates that these yield larger unit values[18]. In contrast though, there might also here be a proportionality effect whereby travellers regard a given change in time to have a lesser impact on longer distance journeys where the proportionate changes are smaller.

The incremental inter-urban effect for *OVT* of 63% is somewhat larger than for *Time* and we find this surprising. One explanation is that on longer distance journeys there has been more care paid to presenting realistic variations in these variables than in the urban context whilst it might be that *OVT* is deemed particularly onerous when added on to an already long journey in *Time* terms.

We find it plausible that departure time change valuations are very much larger for longer distance journeys, given that much more planning is involved for such less frequently made trips and also because the departure time variations tend to be larger in SP exercises dealing with inter-urban trips. Unsurprisingly, headway is relatively less important for longer distance journeys, partly because of planning but also because high frequencies are not expected. It is also entirely expected that reliability values do not increase greatly for inter-urban trips since these are inherently more unreliable and hence more expected, accepted, accommodated or mitigated.

Turning to the valuations in equivalent units of IVT, the walk, wait, interchange wait and access time values are respectively 70%, 76%, 76% and 87% larger than IVT values for inter-urban journeys, nearer to the convention of a doubling relative to IVT but still somewhat short. Headway falls from being 37% lower than IVT for urban trips to being 54% lower for inter-urban trips. Earlier and later departure time shifts have multipliers of 0.86 and 1.12 respectively for inter-urban trips, whilst the respective values for late time, SDE, SDL and SD are 2.67, 0.80, 1.72 and 0.65.

For reference, an equivalent meta-model that specified distance elasticities for our broad categories of variables found the elasticities and their 95% confidence intervals to be 0.133 (±18%) for *Time*, 0.153 (±31%) for *OVT*, 0.417 (±22%) for *DepTime,* 0.120 (±71%) for *Rely* and very small and far from significant for headway. These are in line with the reported findings for the urban and inter-urban distinction.

We note that the Shires and de Jong (2009) international meta-analysis indicated higher values for long distance IVT of 19% for commuting and 35% leisure trips. These are lower than our value of 38% for all trips.

[18] The assembled data does not distinguish size and sign effects.

5.4 Income

This is the key influential variable as far as monetary values are concerned, and official appraisal practice in many countries increases values of time directly in line with income[19].

The measure of income used in our reported model is per capita gross domestic product (GDP) based on purchasing power parity (PPP) exchange rates (*GDP_PPP*[20]) and expressed in 2010 prices. World Bank data goes back to 1980, which covers 98% of our sample. For the remainder, we adjusted the 1980 *GDP_PPP* figure in line with local variations in real GDP per capita pre-1980.

The base *GDP_PPP* elasticity of 1.031 is very precisely estimated, with a 95% confidence interval relative to the central estimate of only ±13%. Given that we have had to convert the vast majority of the values to euros, and the greater uncertainties that this introduces as we go farther back in time, we specified various incremental effects on the *GDP_PPP* elasticity. These related to the pre-1980 years where we have had to construct our own *GDP_PPP* data, the pre-Euro (1999) years and more recent instances where we have to convert from local currencies to euros. Alongside these, we tested income elasticity variations by different regions of Europe and by time attribute, mode, purpose and different decades.

The only significant incremental effects, although in each case highly so, were for the pre-Euro period (*PreEuro*)[21], for employer's business trips (*EB*) and for car users (*CarUsers*). Although it is conceivable that these latter two groupings have intrinsically higher income elasticities, a contributory factor here might be that their incomes are growing faster than the national average and hence the incremental effect compensates for it. However, offsetting effects are the movement of relatively low income individuals into car ownership and use and indeed in more recent years into business travel (Department for Transport, 2013).

The *EB* interaction on the income elasticity was favoured over an absolute incremental effect of EB on values on the grounds of an improved goodness of fit. The implied larger *EB* values depend upon local income levels although not by a great amount; for example, the premium would be around 2 in Serbia, 2.15 in Slovakia and 2.3 in Norway. These figures are reasonable compared to expectations and the summary ratios in section 4. The incremental GDP effect for car users implies that they have values around 30% larger than other users on this account.

We also estimated models based on GDP per capita. The base elasticity was lower, at 0.72 with a very precise 95% confidence interval of ±15%, and an EB elasticity of 0.79. Using per capita GDP at PPP exchange rates has the effect of raising the real incomes of poorer countries relative to richer

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[19] This is despite a wealth of cross-sectional evidence indicating that the income elasticity is somewhat less than one and the lack of convincing support for the convention from almost all exact repeat studies (Accent et al., 1999; Börjesson et al., 2012; Gunn et al., 1999; Significance et al., 2013; Tapley et al., 2007)

[20] Figures in Table 9 illustrate how this varies across European countries.

[21] It is reassuring that there were no other significant incremental effects relating to the various adjustments to monetary values that are necessary

countries, because the cost of living is lower in the former countries, and this explains why our *GDP_PPP* elasticity is larger than our GDP per capita elasticity. Not only do we find it sensible to allow for differences in purchasing power, but the reported model had a better fit to the data.

The international meta-analysis of Shires and de Jong (2009) obtained GDP per capita elasticities of 0.47 for business, 0.67 for commuting and 0.52 for other trips. It was reported that these were practically the same when the time trend variables were removed. These figures are lower both than the adjustments for income widely used in official appraisal practice and the estimates we have obtained in this study.

We do not have in our data set income levels for each study covered since many of them do not give it. Whilst we recognise that this would be very valuable information, from our earliest work in this area we soon realised that local income figures were so sparsely provided that it was not from a meta-analysis perspective worth collecting the evidence that was available. It might reasonably be argued that the income differentials for urban areas and large metropolises will distort our findings, although offsetting this is the higher cost of living in these areas. We specified dummy variables for studies that covered these areas but no significant effects were apparent.

5.5 Journey Purpose

We would expect a premium for business travel valuations, and this was linked to income as discussed in the previous section. In addition, we uncovered four other business travel value interactions.

Business valuations are influenced by whether the estimation method was SP (*EBSP*), in which case the value is more likely to represent a lower personal than company value, and whether the business value was obtained from a study whose purpose was to forecast behaviour rather than to value attribute improvements (*EBForecasting*), whereupon the valuation is larger because our impression is that in these studies respondents were more likely to be instructed to consider company policy. However, the variations are relatively minor. In addition, business travellers by train (*EBTrainUser*) have values 33% larger than other business travellers which we take to be because this category is dominated by relatively high income 'briefcase' travellers, and we discerned a 24% lower valuation of OVT for business travellers (*EBOVT*), presumably related to some companies regarding all forms of travel time as dead time and hence equally valued.

Relative to a base category of leisure and off-peak travel, commuters and peak travellers (*CommPeak*) are found to have values 14% larger all else equal[22], broadly in line with the within-study variations of Table 7. Given this is presumably a combination of commuters' higher incomes and more congested and crowded travel conditions, we find the premium to be on the small side, although we have already noted the type of time being valued is sometimes ambiguous whilst trips for other purposes may well be longer than for commuting within either the urban or inter-urban

[22] We found in more detailed models that peak and commuting travel had similar coefficients as was also the case for leisure and off-peak. For parsimony we therefore combined categories.

categories. Shires and de Jong (2009) find the premium on average across EU countries to be 19% for modes other than bus and 40% for bus. Where the reported valuations made no distinction by purpose (*NoPurp*), the value is, as would be expected, larger than for the leisure travel base.

5.6 Mode Used

We distinguish between mode used and mode valued. Mode used here relates to the characteristics of the travellers, with income being a key differentiator, and mode valued relates to the intrinsic features of the mode itself. Shires and de Jong (2009) do not clearly distinguish mode used and mode valued in their analysis.

As is to be expected given their generally lower incomes, bus users have values 31% lower than other user groups, including a variety of combinations, except for values estimated for car and rail users jointly and also air users. The joint car and rail category have values that are 46% larger than the base whilst for air the figure is 40% larger, presumably due to their relatively high incomes. A range of interactions was tested but the only significant effect found was that departure time changes have a slightly lower value (-23%) for car users (*CarDepChange*).

The car user interaction on income discussed in section 5.4 will give slightly higher values for car users than for train whilst train users on business trips have higher values than their car driving counterparts. Otherwise than these, no significant difference between users of these two modes was discerned. Overall, the meta-analysis results and within-study variations are in this context broadly consistent.

5.7 Mode Valued (IVT)

The value of IVT might vary by mode due to differences in comfort, privacy, the ability to use travel time in a worthwhile manner, externalities due to the environment and security, and décor. There were strong variations largely in line with expectations in the within-study variation analysis of Table 7, although not all were significant. Nonetheless, it is surprising why the meta-analysis recovers so few effects, with air travel having values 74% larger, presumably due to the less comfortable travelling conditions and perhaps also a fear factor by some and a larger effect attributed where air is jointly valued with rail travel. We might expect journey length to have a bearing on mode values but none of the estimated interactions were statistically significant.

5.8 Numeraire for the Value of Time

What is termed the numeraire reflects the monetary units in which the valuation is expressed. We distinguished between a wide range of numeraires, including combinations of different monetary instruments. We have uncovered effects of the expected form for whether the numeraire related to toll charge or to fuel costs. The former yields values that are 25% lower, presumably reflecting protest responses against charging for the use of road space, whilst the latter increases values by 14%, reflecting the failure of some respondents to account fully for fuel cost in their decision making. That these effects bound other cost numeraires, such as public transport fares and parking charges, which are either less objectionable or paid for at the point of use, is encouraging.

5.9 SP Presentation Format

Our data covers six categories of SP presentation: pen and paper, cards, computer assisted personal interview (CAPI), internet, telephone and adaptive. The internet and CAPI both involve computer presentations and differ only in regard to the presence of an interviewer whilst adaptive is a design variant on the computerised presentation where the trade-offs offered are recursively amended in the light of previous responses.

There was no discernible difference in valuations according to whether the SP presentation was pen and paper, internet or telephone. However, cards and CAPI were both somewhat lower, with the adaptive approach very much lower. The latter tends to amend the trade-offs through changing the cost variations, and this might attract undue attention to the cost coefficient thereby reducing the value of time. Whilst we can appreciate that internet samples, at least farther back in time, are atypical, possibly leading to higher valuations because of differences in income and social class, and telephone based SP presentations have their limitations, it is not entirely clear why the CAPI and cards methods yield somewhat lower valuations than the self-completion pen and paper approach. This uncertainty would be a conundrum for practical application of our meta-model were it not for the possibility of basing recommended valuations upon RP evidence thereby avoiding having to select a preferred SP presentation coefficient.

5.10 SP Replications

With respect to the number of comparisons in SP exercises (Repeat Choices), a significant negative effect was obtained. It may be that as respondents become fatigued they choose to pay more attention to cost rather than time attributes[23]. However, the effect is minor; increasing the number of comparisons from 8 to 16 would only reduce the estimated value of time by around 5%. The other two dimensions of SP design in our data set, relating to the number of alternatives and the number of variables, did not have a significant impact on the values of time.

5.11 Choice Context

The choice contexts covered were mode, route, abstract, time of day, mode and destination, and mode and route. The only significant effect related to abstract choice contexts, where there is less confounding with extraneous real world influences, and then the values were only 12% lower. It is reassuring that there is little difference, on average, according to choice context.

[23] Although note that some have found that learning effects are more prevalent (eg, Hess et al., (2012))

5.12 Study Aim

This relates solely to SP exercises and is based on the hypothesis that where the purpose of the study is transparently to value the variable in question then there is the unwanted effect of providing respondents an incentive to exaggerate valuations (strategic bias and compliance bias). There is a degree of correlation here with the number of attributes, since the more attributes there are then the less transparent (better masked) will be the purpose of the study and the smaller will the bias.
Transparency is based on our subjective assessment of the purpose of the study and its likely perception. A significant effect was recovered, with valuations 11% higher where we considered that the aim of the study was to value the variable in question. Again though, this is not a large effect.

5.13 Values per Study

As the number of valuations per study increases, so the values increase. This may be associated with better quality studies, including national studies, which tend to yield large numbers of values. Nonetheless, doubling the number of values from the mean of 8 per study would only result in values 4% larger.

5.14 Data Type

A longstanding concern is the extent to which respondents' stated preferences reflect their actual preferences, given the artificial nature of SP and respondents not being committed to behave in accordance with their stated preference. The notion of strategic bias, where respondents aim to influence policy makers by deliberately distorting their answers, is a potentially serious problem.

We might expect that any strategic bias would lead to an oversensitivity to cost, since this is the most amenable to change by operators and authorities and is the one that does most commonly change. This would lead to lower monetary values in SP than RP studies and this has been observed throughout our various UK meta-analyses. On first inspection, these new results would not seem to be consistent with this hypothesis and the previous findings, since the coefficient relating to RP data is negative, although not significant at the 5% level, and indicates lower values by 7% all else equal. However, all else is not equal.

Two of the most respected means of presenting SP exercises (cards and CAPI) are associated with values around 25% lower. In addition to this, the mean number of SP choices of 10 would reduce the values by 7% although offset by the SP study aim being transparent causing values to be 11% larger. On balance, though, and also bearing in mind the evidence in Table 7 where overall the SP values were somewhat lower, we feel that there is here further evidence that SP valuations are lower than RP although not by a large amount and not as much as the meta-analysis of Shires and de Jong (2009) which found SP valuations to be at least 25% lower than corresponding RP valuations for non-business trips.

5.15 Country Specific Effects

We thought it prudent to test whether there were any residual country specific effects on the grounds that transferability across countries is here a critical issue. Across the 26 countries for which valuations were obtained, only five country specific coefficients were significant.

The largest variation applies to Austria, but then there is here a very limited evidence base and the variations do not seem credible. We can appreciate that the higher Swiss values might be due to that country's high standard of living that is not adequately accounted for. Of greatest concern, not least because it is based on by far the largest country-specific evidence base in our data set and with a long and distinguished track record of valuation studies, is that the UK incremental effect denotes its values to be on average 39% lower and it is estimated with a very large degree of confidence. There could be a number of factors at work here, including the greater emphasis on SP results, 'grey' literature and older studies in the assembled UK evidence. Whilst this is not a desirable finding, it is worth pointing out that applying the 39% discount would imply UK values that tend to compare less favourably with official values and would be less credible as a proportion of the wage rate.

5.16 Non-Significant Effects

Other than the levels within particular variables already discussed as not having a significant effect, a number of main effects were tested that were found to be insignificant. These were: the publication status of the study, the year of publication and whether the evidence was drawn from a so-called national study; the estimation method, including whether allowance was made for repeat observations per person in SP data and for random preference heterogeneity; sample size; the number of variables and alternatives in an SP exercise, and whether non-traders or 'irrationals' had been omitted from the estimation sample; and whether the valuation was for residents of major metropolitan or urban areas.

In addition, a large number of interactions between the key variables of journey purpose, urban or inter-urban, mode, income and broad groupings of time-related attributes were tested but, as is clear from Table 8, only a few significant effects were obtained. Examples of other more specific and indeed important interactions that were tested but did not yield significant findings are: the values of time on public transport modes and time period, on the grounds of the digital revolution; whether values differed between North-Western Europe, Southern Europe and Eastern Europe, as found in the meta-analysis of Shires and de Jong (2009); the impact on business valuations of mode, attribute and journey length to test the properties of the standard CSA approach; and exploring whether data type had a differential influence on broad categories of attribute valuations.

5.17 The Question of Study Quality

A criticism that is often directed at meta-analysis is that it does not control for inevitable differences in the quality of the data collected and of its analysis within the numerous assembled studies, and hence this issue merits specific attention. It emerged though that for a number of reasons, as discussed below, such variations in 'study robustness' do not unduly concern us here.

Firstly, the precision of valuation estimates can be taken to be, in some measure, a function of the quality of the data and analysis. Whilst variances of the estimated valuations are not reported in all studies, sample size can nonetheless be taken as a reasonable proxy for precision and we used it in weighted estimation. This search for the best fit returned a model that placed almost no weight on the sample size with, as might then be expected, very little effect on the coefficient estimates. Nor did the meta-analysis discern a significant influence from sample size on the estimated valuations.

Secondly, we have removed those observations where the standardised residual lies outside the range ±2 which can be taken to represent the 5% poorest quality observations. Whilst this procedure is more objective than the contentious process of removing those valuations that on inspection seem not to fit with the rest of the data, it was found to make little difference to the results.

Thirdly, study specific fixed effects were included in the meta-model and these will, amongst other things, discern systematic effects on valuations due to quality factors.

Fourthly, where studies have estimated revised models in order to overcome 'deficiencies' or perhaps to recover models which correspond more closely with accepted evidence, we feel that there is a tendency to provide some justification for this. Common examples are the removal of individuals whose responses fail 'logic tests' or which exhibit non-trading behaviour. We recorded such instances and tested whether the valuations differed according to such omissions but no remotely significant effects were apparent.

Fifthly, it can be argued that th*e* quality of a study tends to have random effect on the estimated valuations. Why should poor studies always produce lower or higher values? If quality is a random effect, it will be contained within the error term and not bias our coefficient estimates.

Finally, and importantly, we have pointed out that there were no significant variations in values according to publication status or whether they were from a national study, both of which might be taken to be a proxy for quality.

6. APPLICATION OF THE META-MODEL

We here use our estimated meta-model to provide illustrative values of time for European countries as well as comparing them with expectations and official recommendations.

6.1 Implied Valuations of IVT

Our preferred formulation of the meta-model for the value of IVT (VoIVT), expressed in the estimated units of € per minute, is set out as equation 2:

$$VoIVT = e^{-12.596-0.352FF+0.127C+0.282EBTU-0.373BU+0.334AU+0.555AV+0.324I}$$
$$\times GDP\_PPP^{1.031+0.079EB+0.025CU} \quad (2)$$

where C denotes commuting, FF is free flow time for car, EB is an employer's business trip with EBTU employer's business for a train user, BU, AU and CU are bus user, air user and car user respectively, AV is air valued, I represents an inter-urban trip, and GDP_PPP is per capita gross domestic product based on purchasing power parity.

The first term (-12.596) is made up of the weighted average constant across all studies inclusive of the fixed effects which is -12.557, the values per study term based on the average of 5 values per RP study which is 0.030, and the RP term of -0.069. We take the appropriate income effect to exclude the *PreEuro* term. The numeraire is costs other than toll or fuel, since we regard both these effects to be distortionary, whilst SP specific terms drop out since we take it as preferable to base the valuations on RP evidence[24].

Table 9 presents the implied values of travel time across countries for a range of key market segments. Large variations can be observed, following the level of GDP_PPP per capita in euros which is reported in the second column and the gross labour costs in euros which is provided in the third column. In addition, there are, as expected, large within country variations according to journey purpose, distance, type of time, distance band and mode.

The penultimate row (U.K. -39%) gives the U.K. values reduced by the large country specific effect in our estimated model. Applying this discount implies valuations that tend to be implausibly small compared to earnings. These U.K discounted figures does not enter our subsequent calculations.

We should point out that our implied values are somewhat lower than those implied by the largest previous international meta-analysis of Shires and de Jong (2009), particularly when it is borne in mind that the latter report values in 2003 € per hour prices and incomes in contrast to our 2010 equivalents. For the then EU 25 countries, the Shires and de Jong hourly values for short distance commuting average €8.84 for bus and €10.69 for other modes whereas our values average €4.95 for bus and for car €6.51 for free flow and €9.25 for congested time. The pattern is little different for short distance trips for other purposes, where Shires and de Jong report averages of €6.32 for bus and €8.97 for other modes and our results for car are €5.73 for free flow and €8.15 for congested traffic. At the other extreme, Shires and de Jong's model implies an average of €24.00 for business travel for car and train whereas our model's averages range from €12.75 for urban car travel in free flow traffic to €25.80 for inter-urban rail. Subsequent benchmarking against earnings and official recommendations would indicate that our new results are more reliable, and it is to such evidence that we now turn.

[24] Of course, implied valuations can be obtained using different sets of assumptions.

Table 9: Implied Values of Time (€ per hour 2010 incomes and prices)

	GDP_PPP per capita	Gross Labour Cost	Car Commute		Car Other			Car EB			Train EB	Bus Comm	Air EB
			Urban Free Flow	Urban Cong	Urban Free Flow	Urban Cong	Inter Free	Urban Free	Urban Cong	Inter Free	Inter	Urban	Inter
Austria	27925	28.0	8.04	11.43	7.08	10.06	9.79	15.89	22.59	21.97	32.06	6.09	58.83
Belgium	26290	35.3	7.54	10.72	6.64	9.44	9.18	14.84	21.10	20.52	29.99	5.72	55.02
Bulgaria	9733	3.1	2.64	3.75	2.33	3.31	3.22	4.80	6.83	6.64	9.95	2.06	18.26
Croatia	13499	8.6	3.73	5.30	3.28	4.67	4.54	6.96	9.90	9.63	14.31	2.88	26.25
Cyprus	22142	17.7	6.29	8.94	5.54	7.88	7.66	12.21	17.36	16.88	24.78	4.80	45.47
Czech Rep	17617	9.8	4.94	7.02	4.35	6.19	6.02	9.42	13.39	13.02	19.23	3.79	35.28
Denmark	28030	36.7	8.07	11.47	7.11	10.10	9.82	15.96	22.69	22.06	32.20	6.12	59.08
Estonia	14227	7.6	3.94	5.61	3.47	4.94	4.80	7.39	10.51	10.22	15.17	3.04	27.83
Finland	25461	28.8	7.29	10.36	6.42	9.13	8.88	14.31	20.34	19.78	28.94	5.54	53.10
France	23807	32.6	6.79	9.65	5.98	8.50	8.27	13.26	18.85	18.33	26.86	5.17	49.28
Germany	26107	28.8	7.48	10.64	6.59	9.37	9.11	14.72	20.93	20.35	29.75	5.68	54.60
Greece	19830	17.0	5.60	7.96	4.93	7.01	6.82	10.77	15.32	14.90	21.93	4.28	40.23
Hungary	14341	7.0	3.98	5.65	3.50	4.98	4.84	7.46	10.60	10.31	15.30	3.06	28.08
Ireland	28248	28.9	8.13	11.57	7.16	10.19	9.91	16.10	22.89	22.26	32.48	6.16	59.59
Italy	22263	26.8	6.33	8.99	5.57	7.92	7.70	12.29	17.47	16.99	24.93	4.82	45.75
Latvia	11366	5.5	3.11	4.42	2.74	3.90	3.79	5.73	8.15	7.92	11.82	2.41	21.69
Lithuania	12674	5.4	3.49	4.96	3.07	4.37	4.25	6.48	9.22	8.96	13.34	2.70	24.48
Luxembourg	60120	32.9	18.06	25.68	15.91	22.62	21.99	37.94	53.95	52.46	75.11	13.43	137.81
Macedonia	7852	3.3	2.10	2.99	1.85	2.64	2.56	3.76	5.35	5.20	7.84	1.65	14.39
Malta	18382	11.9	5.17	7.35	4.55	6.47	6.29	9.89	14.06	13.67	20.16	3.96	36.99
Netherlands	29432	31.1	8.49	12.08	7.48	10.64	10.34	16.87	23.98	23.32	33.99	6.43	62.37
Norway	39945	41.6	11.73	16.68	10.33	14.69	14.28	23.85	33.92	32.98	47.71	8.81	87.54
Poland	13890	7.2	3.84	5.47	3.39	4.81	4.68	7.19	10.23	9.94	14.77	2.97	27.10
Portugal	17751	12.6	4.98	7.08	4.39	6.24	6.06	9.50	13.51	13.14	19.39	3.82	35.58
Romania	10143	4.1	2.76	3.92	2.43	3.45	3.36	5.03	7.16	6.96	10.42	2.14	19.12
Serbia	7929	4.9	2.13	3.02	1.87	2.66	2.59	3.81	5.41	5.26	7.93	1.66	14.55
Slovakia	16230	7.7	4.53	6.44	3.99	5.67	5.52	8.58	12.20	11.87	17.55	3.48	32.21
Slovenia	18798	14.6	5.29	7.52	4.66	6.63	6.44	10.14	14.42	14.02	20.66	4.05	37.92
Spain	22259	20.7	6.32	8.99	5.57	7.92	7.70	12.28	17.47	16.98	24.93	4.82	45.74
Sweden	27449	33.6	7.89	11.22	6.95	9.88	9.61	15.58	22.16	21.55	31.46	5.99	57.72
Switzerland	32376	50.1	9.39	13.36	8.27	11.76	11.44	18.79	26.72	25.98	37.78	7.10	69.33
U.K.	24909	20.0	7.12	10.13	6.27	8.92	8.67	13.96	19.84	19.30	28.24	5.41	51.82
U.K. -39%	24909	20.0	4.34	6.18	3.82	5.44	5.29	8.52	12.10	11.77	17.23	3.30	31.61
% GLC			41%	58%	36%	51%	50%	78%	110%	107%	159%	31%	289%

6.2 Comparison with 'Expectations'

The final row (%GLC) in Table 9 denotes the mean ratio of each country's valuation relative to its Gross Labour Costs (GLC)[25]. We find these ratios to be highly credible. For example, the non-business values across modes and for free flow time are in the region of 30% to 50%. As for business travel, the car valuations vary around GLC with the rail values larger. They are not greatly different to what the CSA would imply, although that of itself is not sufficient to validate the CSA approach.

6.3 Comparison with National Studies

It is informative to compare our results with official IVT valuation recommendations to be used in transport scheme appraisal that have been drawn from major national studies. It provides a good indication of the confidence that can be placed in using our model in predictive mode for countries and circumstances where official values do not exist and indeed of the robustness of our model results in general. We distinguish here between:

- The evidence of national studies whose results are contained in our data set (section 6.3.1)
- The evidence of national studies conducted subsequent to our data collection (section 6.3.2)

6.3.1 Comparison with Included Official Valuations

Table 10 compares values of time implied by our meta-model with official values based on six studies that are included in our data set that covers publication years up to 2011. The official values have been adjusted to 2010 income levels using a GDP elasticity of one, although this is not used in all these countries by the national authorities, with the year of estimation provided in brackets.

On the whole, there is a very acceptable degree of consistency, despite hindrances to comparison because: our results for car distinguish between free flow and congested time whereas there is an element of ambiguity about official values; the distinction between short and long is 100km for Sweden and Norway but 30km in our model; and indeed some countries make no distinction in official values by distance.

The main divergences seem to be for the challenging area of business travel time valuation, where the official values are based on a mix of the wage rate, a discount on the wage rate for rail values in Sweden on account of productive use of travel time, and the longstanding practice in the Netherlands of using the Hensher equation which contains both employer and employee based components. Here the meta-model values tend to be less than the official values, with the exception of air travel where its implied values somewhat exceed official values.

[25] This excludes the UK -39% values which are given for reference. Each country has the same weight in calculating the mean.

Table 10: Official Values of Time from Studies Included in Meta-Data and Implied Meta-Model Values of Time (€ per hour 2010 incomes and prices)

	Commute			Other			Business		
	Official	Urban	Inter	Official	Urban	Inter	Official	Urban	Inter
Norway (2009)	Ramjerdi and Flügel (2010)								
Car Short (<100km)	11.70	11.73/16.68		10.01	10.33/14.69		49.40	23.85/33.92	
Car Long (>100km)	26.00		16.22/23.06	18.98		14.28/20.31	49.40		32.98/46.90
PT (Bus/Train) Short (<100km)	7.80	8.81/12.80		5.98	7.76/11.27		49.40	17.92/34.50	
Train Long (>100km)	20.28		17.69	11.96		15.58	49.40		47.71
Bus Long (>100km)	13.39		12.18	9.49		10.73	49.40		24.78
Air	37.44		43.04	23.40		37.90	57.85		87.54
Netherlands (1997)	Hague Consulting Group (1998)								
Car	10.51	8.49/12.08	11.74/16.70	7.27	7.48/10.64	10.34/14.71	36.43	16.87/23.98	23.32/33.16
Train	10.58	9.34	12.91	6.52	8.22	11.37	22.40	24.58	33.99
Bus/Tram	9.85	6.43/9.34		6.22	5.66/8.22		17.16	12.77/24.58	
Sweden (2008)	Trafikverket (2012)								
Car Long (>100km)	10.96		10.91/15.51	10.96		9.61/13.66	29.54		21.55/30.64
Bus Long (>100km)	3.96		8.28	3.96		7.29	29.54		16.34
Train Long (>100km)	7.41		12.02	7.41		10.58	25.07		31.46
Air				17.56		29.23	29.54		57.72
Car Short (<100km)	8.83	7.89/11.22		5.99	6.95/9.88		29.54	15.58/22.16	
Bus Short (<100km)	5.38	5.99		3.35	5.27		29.54	11.82	
Train Short (<100km)	7.00	8.69		5.38	7.65		25.07	22.75	
Denmark (2004)	Fosgerau et al. (2007)								
Car	11.87	8.07/11.47	11.15/15.86	11.87	7.11/10.10	9.82/13.97			
PT (Bus/Train)	11.87	6.12/8.88		11.87	5.39/7.82				
Switzerland (2003)	Swiss Association of Road and Transportation Experts (2009) for Commuting and Leisure, and Axhausen et al. (2006) for business								
Car	26.70	9.39/13.36		6.19	8.27/11.76		37.87	18.79/26.72	25.98/36.95
PT (Bus/Train)	16.19	7.10/10.30		8.72	6.25/9.07		35.31	14.19/27.33	
United Kingdom (1994)	Mackie et al., (2003)								
Car	8.17	7.12/10.13	9.85/14.00	7.25	6.27/8.92	8.67/12.33	32.47	13.96/19.84	19.30/27.44
Train							38.35	20.43	28.24

Note: For car, two values are given of which the first relates to free flow time and the second to congested time. In other cases where two values are given, they respectively relate to the two modes referred to in the first column. The Swiss values for commuting and other trips vary by distance and we report an urban value of 5km.

Table 11 summarises the relationship between the official values and the values implied by our meta-model. We have simply taken averages of the congested and free flow values from the meta-model for car travel. For countries that did not distinguish official values between urban and inter-urban trips, we take the urban value from the meta-model for comparison given that the vast majority of trips are urban.

Table 11: Summary of Official and Meta-Model Values for Studies in Meta-Model

	Official	Meta
Commuting	13.29(1.86)[20]	12.43(1.78)[20]
Other Trips	9.54(1.12)[21]	11.82(1.72)[21]
Business	36.13(2.50)[20]	29.59(3.89)[20]
All	19.49(1.86)[61]	17.86(1.83)[61]

Note: Figures are mean value, standard error of the mean ( ) and number of observations [ ].

The values for commuting trips are very similar and for other trips are respectably similar. The mean values are far from significantly different for these two purpose. The difference between the business values is largest, although little different in proportionate terms to other trips, and even here it is not significant at the 5% level. Across all the 61 possible comparisons that can be made in Table 10, the correlation between the official and meta values is a very respectable 0.77. This increases to 0.82 for commuting and 0.87 for other trips. The figure of 0.53 for employer's business is probably explained by the previous discussion on business valuations.

6.3.2 Comparison with Subsequent Official Valuations

Table 12 presents our implied valuations of IVT alongside the official values that have emerged since the end of our data collection in 2011 (Significance et al., 2013; CGSP, 2013; Axhausen et al., 2014; Department for Transport, 2015). The same caveats apply here regarding distinctions between car free flow and congested time, distance bandings, and indeed official values not distinguishing by distance. In addition, for France and the U.K. some official values cover two or more modes. The Netherlands business valuations again follow the Hensher equation whilst the German and U.K. business values are based on SP willingness-to-pay evidence.

Table 12: Official Values of Time from Studies Not Included in Meta-Data and Implied Meta-Model Values of Time (€ per hour 2010 incomes and prices)

	Commute			Other			Business		
	Official	Urban	Inter	Official	Urban	Inter	Official	Urban	Inter
Netherlands (2011)	Significance et al. (2013)								
Car	9.25	8.49/12.08	11.74/16.70	7.50	7.48/10.64	10.34/14.71	26.25	16.87/23.98	23.32/33.16
Train	11.50	9.34	12.91	7.00	8.22	11.37	19.75	24.58	33.99
Bus/Tram	7.75	6.43/9.34		6.00	5.66/8.22		19.00	12.77/24.58	
Air				47.00		27.66	85.75		62.37
Germany (2012)	Axhausen et al. (2014)								
Car Short (<50km)	4.20	7.48/10.64		3.49/3.97[a]	6.59/9.37		6.01	14.72/20.93	
PT (Bus/Train) Short (<50km)	3.89	5.68/8.25		3.85/4.73[a]	5.01/7.27		4.65	11.18/21.52	
Car Long (>50km)	9.58		10.35/14.71	9.26/9.46[a]		9.11/12.96	12.11		20.35/28.94
Train Long (>50km)	8.21		11.41	8.44/9.31[a]		10.05	11.06		29.75
Air Long				22.89		24.45	33.87		54.60
France (2013)	CGSP (2013)								
All Urban (All of France)[b]	10.0	8.22[d]/5.17		6.8	7.24[d]/4.55		17.5	16.06[d]/10.09	
All Urban (Ile-de-France)[c]	12.6	8.22[d]/7.50		8.7	7.24[d]/6.61		22.3	16.06[d]/19.43	
Car[e]				14.4		8.27/11.76	32.7		18.33/26.06
Coach[e]				12.1		6.29	27.6		13.95
Train[e]				22.7		9.14	43.3		26.86
Air[e]				53.4		22.23	72.9		49.28
United Kingdom (2014)	Department for Transport (2015)								
All Modes[f]	12.51	8.63/7.86/5.41	11.92/10.87/7.49	5.71	7.60/6.93/4.77	10.50/9.57/6.59			
Car Urban 0-50km							12.60	13.96/19.84	
Car Inter-Urban 50-100km							20.38		19.30/27.44
Car Inter-Urban 100km+							31.40		19.30/27.44
Train Urban 0-50km							12.60	20.43	
Train Inter-Urban 50-100km							20.38		28.24
Train Inter-Urban 100km+							45.24		28.24
Bus/LRT Urban							12.60	10.61/20.43	

Note: For car, two values are given of which the first relates to free flow time and the second to congested time.

[a] German values for other distinguish leisure and shopping and we respectively give each of these.

[b] We take this to be car and bus.

[c] We take this to be car and train.

[d] This is the average of the congested and free flow valuations for car.

[e] French values for inter-urban are for the mean distance which are 267km for car, 294km for coach, 331km for train and 1209km for air.

[f] Meta-model values are for car, rail and bus respectively given the official value is for all modes.

Upon inspection of Table 12, the degree of correspondence between our values and official values seems acceptable, although we would point to some low official values for Germany given the gross labour cost of €28.8 per hour reported in Table 9. Table 13 summarises the valuations using the same approach as for Table 11[26]. There is a very close degree of correspondence again for commuting but now also for the business values. Whilst there is a greater divergence between the mean values for other trips, the difference is far from statistically significant.

Table 13: Summary of Official and Meta-Model Values for Studies Not in Meta-Model

	Official	Meta
Commuting	8.95 (0.97) [10]	9.04 (0.60) [10]
Other Trips	15.03 (3.73) [16]	11.22 (1.74) [16]
Business	26.82 (4.32) [22]	25.84 (2.79) [22]
All	19.17 (2.55) [48]	17.43 (1.79) [48]

Note: Figures are mean value, standard error of the mean ( ) and number of observations [ ].

6.4 Time Multiplier Valuations of Non-IVT Attributes

Given their widespread use in transport planning and appraisal, and given that we have covered a very large amount of evidence relating to valuations other than IVT, the insights that this study can provide into time multipliers are of considerable significance. Nonetheless, explicit modelling of time multipliers must remain the subject of another study. Suffice to say here that time multipliers can be obtained by dividing the equation relating to the variable in question by the equation relating to IVT. Thus, for example, the implied time value of walk time (TVWK) in IVT units is:

$$TVWK = e^{0.370 + 0.162I - 0.272EB}$$

where I indicates inter-urban and EB is business travel. This would imply walk time multipliers of 1.10 for urban business travel and 1.45 for urban non-business travel, increasing to 1.30 and 1.70 respectively for inter-urban travel. These would be larger if the numeraire were free flow time, as might be appropriate for car users. The Appendix contains more detail, providing time multipliers implied by our meta-model for all the non-IVT attributes here considered alongside the actual time multipliers in our assembled data.

7. CONCLUSIONS

This study constitutes by some margin the largest value of time meta-analysis yet conducted. It is based on 389 studies covering 26 European countries between 1960 and 2011 yielding 3109 valuations. The most significant previous international study (Shires and de Jong, 2009) covered

[26] With the exception that we were able to use the same weights as were used in arriving at the official all mode values for the United Kingdom. The meta-model would then yield values of 8.34 for commuting and 7.41 for other which are used in the Table 13 calculations.

1250 valuations with some evidence for outside Europe. Our findings contrast somewhat with the latter study, not least in terms of the valuations implied by the meta-model. Moreover, we here additionally cover a significant amount of evidence relating to out-of-vehicle time, departure time changes, service headway and various reliability measures.

Our analysis has discerned variations in valuations according to a wide range of influential variables, including journey purpose, mode used and mode valued, type of data, attribute, whether the trip was urban or inter-urban, and income represented by GDP per capita after adjusting for purchasing power parity. A number of methodological insights are also provided. Importantly though, our model is able to provide credible valuations which compare sensibly with earnings and can replicate the official values drawn from national studies very well. We can therefore have confidence that the meta-model can be used in countries and circumstances where official or other values of IVT do not exist and more generally to benchmark emerging time valuation evidence. Another valuable feature is that the meta-model provides estimates of values of a wide range of time related attributes, either in money terms or else as multipliers relative to IVT as are commonly applied in transport planning.

The value of time evidence covered here is entirely European and we feel that there are two sensible future developments of this work. Firstly, it is obviously appealing to extend the coverage to other developed countries outside Europe, particularly those such as Australia, Chile, the United States, Canada, New Zealand and Japan where there is a long established practice of estimating the value of travel time savings. Secondly, and more challenging, is to cover evidence from developing countries.

Appendix 1: Valuations in Equivalent Units of In-Vehicle Time (Time Multipliers)

Table A1 summarises the time multiplier evidence that we assembled, which we term actual, alongside the multipliers implied by our meta-model as discussed in section 6.4. We here distinguish by distance band since this is the principal influence on the implied time multipliers.

Note that the number of actual time multipliers does not have to match with the number of monetary values obtained for the equivalent attributes and reported in Table 1 since some studies did not contain time in the choice model, whereupon time multipliers cannot be obtained, and some studies did not include cost in the analysis, whereupon time multipliers exist but there are no monetary valuations.

Table A1: Multipliers by Distance Band

ATRRIBUTE	ACTUAL MULTIPLIERS		IMPLIED BY META-MODEL	
	Urban	Inter-Urban	Urban	Inter-Urban
Congested Time	1.66 (0.08) [52]	1.34 (0.08) [23]	1.42	1.42
Walk Time	1.68 (0.04) [329]	1.50 (0.12) [15]	1.45	1.70
Access time	1.49 (0.08) [78]	1.90 (0.10) [66]	1.59	1.87
Wait Time	1.83 (0.07) [124]	1.50 (0.22) [14]	1.50	1.76
Interchange Wait	1.77 {0.11) [16]	1.94 (0.21) [10]	1.49	1.76
Search Time	1.85 (0.22) [23]	1.85 (0.00) [1]	1.71	1.71
Headway	0.78 (0.03) [225]	0.54 (0.04) [104]	0.63	0.46
Departure Time Early	0.53 (0.08) [32]	0.64 (0.13) [12]	0.33	0.86
Departure Time Late	0.62 (0.10) [34]	0.74 (0.09) [13]	0.43	1.12
Departure Time Both	0.54 (0.07) [12]	1.34 (0.39) [4]	0.31	0.81
Late Arrival	4.43 (0.47) [32]	1.96 (0.24) [5]	3.06	2.67
Schedule Delay Early	0.83 (0.07) [48]	0.63 (0.20) [6]	0.92	0.80
Schedule Delay Late	1.90 (0.14) [47]	1.61 (0.20) [19]	1.97	1.72
Standard Deviation	0.75 (0.08) [28]	1.16 (0.22) [17]	0.74	0.65

Note: The figures for the actual multipliers denote the mean, the standard error of the mean ( ) and the number of observations [ ]. The congestion multiplier is defined with respect to free flow time whereas all other multipliers are with respect to IVT. There are a few variations in the implied multipliers by other factors: departure time shift multipliers would be 23% lower for car users whilst walk, wait, access and interchange wait time multipliers would be 24% lower for business travel.

We do not here provide a detailed account of the multipliers in Table A1, although we point to sections 5.2 and 5.3 for important discussion. Suffice to say that the multipliers are reasonable. We note that the variation between the urban and inter-urban multipliers is broadly but not entirely consistent between the actual and implied values, but of course other factors will be at play. Moreover, ignoring the difference between urban and inter-urban, there is close correspondence between the actual and implied multipliers. Indeed, we note that the correlation between the two sets of multipliers for urban journeys is 0.96, with a corresponding figure of 0.84 for inter-urban journeys.

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