UNIVERSITY OF LEEDS

EUROPEAN WIDE META-ANALYSIS OF VALUES OF TRAVEL TIME

FINAL REPORT TO THE EUROPEAN INVESTMENT BANK

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Executive Summary

Value of Travel Time and its Practical Use

The value of travel time is an exchange rate between time and money: it is the rate at which a traveller is indifferent between marginal changes in travel time and travel cost. It is a very important concept, not only in transport research, but also in practical decision-making regarding transport projects, pricing and policy.

In many countries, and also in an international context, decisions upon whether a transport project (e.g. a new bridge or a railway line) should be funded and which of these projects should be prioritised are to a greater or lesser degree based on cost-benefit analysis of these projects. Very often the main benefits are the travel time savings that the project would bring.

In cost-benefit analysis, the impacts of a project are measured in money units. The travel time benefits are in the first instance measured in time units. Values of travel time are used to convert these into money units so that they can be included in the cost-benefit analysis alongside other monetised benefits and the financial costs. Several countries and some international organisations have official values of travel time, so that the same values are used in the evaluation of many or all transport projects.

Furthermore, values of travel time are also used inside many transport models to represent how travellers trade-off time against money in making mode and route choices and other travel decisions.

The Added Value of Meta-Analysis

Given that it is a value of so much interest, and arguably the most important parameter of transport planning, many studies have been carried out that report estimates of the value of travel time. Several reviews of the international literature on values of travel time have been carried out. Initially, such studies just calculated mean values for a few categories, such as journey purpose or mode. More recently, the technique of meta-analysis has been applied to provide more insight. Meta-analysis is the statistical analysis of the outcomes of previous studies. The method originated in epidemiology and medicine. It looks for patterns in the outcomes of past studies, by explaining these outcomes in terms of the characteristics of the travellers and journeys investigated in each study and the method of investigation used. This enable two types of result, both of which we here provide:

- Identification and quantification of the principal drivers of value of time variation across many studies;

- predictions of values of time for other situations (e.g. other countries).

Aim and Scope of our Study

The purpose of the study is:

> *to provide values of travel time for the economic appraisal of transport projects performed by the European Investment Bank.*

We here report the largest meta-analysis of values of time yet undertaken. It focuses on European values of time, building upon previous streams of work in this area. We collected 3109 monetary values from 389 studies and 26 European countries that reported between 1960 and 2011.

Only passenger transport values of travel time are covered in this study. Whilst the main emphasis is on the value of in-vehicle time (the time spent in the car, train, bus or plane during the journey), and indeed this forms the majority of the data set, we have also covered valuations of other components of travel time that can be important in transport project appraisal and/or transport models. These are walk time, wait time, parking space search time, waiting at interchange, access to public transport time, free flow time, congested time, headway, departure time shift, schedule delay early and late, the standard deviation of travel time and late arrival time (for definitions, please see the Glossary of Terms on the next page).

Method and Key Results

A model has been developed to explain variations in values of time across studies, countries and time periods. This underpins our recommended values of time and takes the form of a single equation.

We find that the value of travel time depends on a number of variables, including:

- GDP per capita, with elasticities in the range 0.7 to 0.85 (so for instance a 10% higher GDP per capita leads to 7 to 8% higher values of travel time)
- Distance of the overall journey, with elasticities in the range 0.14 to 0.20 and also some other effects for inter-urban journeys
- Commuting trip values are 16% higher than leisure trips but somewhat lower than for business trips
- Mode used, with bus users having somewhat lower values and air users having noticeably higher values, and mode valued, with train having slightly lower values regardless of user type and air being associated with very much larger values.

The model also provides a number of methodological insights, such as how values vary with data type, means of presentation, estimation method, choice context, the dimensions of Stated Preference exercises, study aim, and the monetary numeraire in which the valuation is expressed. A series of multipliers have also been reported to enable the appraisal of changes in a wide range of time attributes other than IVT.

The estimated equation was used to provide a consistent set of new values for each European country. These new monetary valuations have been compared to those of the RAND Europe study conducted for the European Investment Bank in 2004. The new values of travel time, which are based on a much larger data base, are generally smaller, but have a larger spread by income and more variation according to distance.

Contents

Glossary of Terms

IVT	In-Vehicle Time – the time spent in car, train, bus or plane during the journey
Free Flow Time	In-Vehicle Time for car that is spent in free flow (no congestion) traffic conditions
Congested Time	In-Vehicle Time for car that is spent in congested traffic conditions
Walk Time	The amount of walk time involved in an overall journey getting to or from the main mode of transport
Wait Time	Time spent waiting for public transport modes (and distinct from different levels of service headway which imply different amount of wait time)
Access Time	The time spent getting to or from public transport modes by whatever mode
Interchange Wait	Time spent waiting at an interchange rail station or bus terminal/stop
Search Time	The time spent driving around searching for a vacant car parking space
Headway	The minutes between the departures of public transport modes
Departure Time Shift	Departing (usually from home) at a different time than for the reference (eg, current) journey
Late	The amount of minutes late arrival at the destination station or parking place
SDE	Schedule Delay Early – the average amount of time that arrivals are early relative to the preferred arrival time
SDL	Schedule Delay Late – the average amount of time that arrivals are late relative to the preferred arrival time
StdDev	The standard deviation of travel time
OVT	Walk time, wait time, access time and interchange wait time
RP	Revealed Preference – the actual choices people make in real world market places
SP	Stated Preference – travellers' responses to hypothetical travel scenarios
Attributes	These are the travel variables (eg, time, cost, headway, late arrival) that influence travel behaviour and are used to explain choices in RP and SP models
Alternatives	These are the options (eg, modes, routes) amongst which travellers choose
Repetitions	The number of different choices or rankings that respondents make in an SP exercise
Ranking	Placing travel alternatives in order of preference
Numeraire	The equivalent monetary units (eg, toll charge, petrol cost, parking charge, public transport costs) in which monetary values are expressed
CAPI	Computer assisted personal interview
Cards	The presentation of SP choice scenarios or alternatives in a card format
EB, Business	Trips for employer's business
Commuting	Trips to or from the respondent's place of work
Other	Trips for leisure purposes
No Distinction	Trips for a variety of purposes where no distinction is made between specific purposes
Distance	The overall journey distance (in kilometres), not the distance of, say, the walk trip
Mode Used	Valuations relating to the mode actually used by the traveller
Mode Valued	Valuations relating to the mode valued regardless of mode used for the actual journey

1. INTRODUCTION

The research reported here is concerned with the valuation of travel time and time related attributes and how this varies across different contexts within Europe and also over time. It takes the form of a meta-analysis of a large data set of valuations, complemented with a discussion of the key features of and trends in studies and valuations.

1.1 Background and Context

We are here building upon two prior significant streams of meta-analyses of time valuations. A series of studies by Wardman, with Abrantes and Wardman (2011) being the most recent (**A&W**), have focussed on UK evidence for valuations of in-vehicle time (IVT) and also a range of other travel attributes in the passenger market. In contrast, a series of studies involving de Jong[1], with Shires and de Jong (2009) being the most recent (**S&deJ**), has taken an international view and covered the freight as well as passenger market but focussing on the valuations of IVT. Another distinction is that the latter studies concentrate on evidence indisputably in the public domain, such as journal articles, conference papers and published reports of major studies, whilst the former studies make considerable use of unpublished evidence.

1.2 Aims and Scope

The principal aims of the research are to:

- Conduct by far the most extensive review of European wide evidence on the values of IVT **and** other time related attributes. This would constitute the largest meta-analysis of values of time ever conducted;
- Develop a model that explains how values of time vary across countries and can be used to provide value of time recommendations;
- Cover a range of time values other than IVT which has been the primary or sole focus of most reviews;
- Review the EIB value of time database for EU countries.

This study covers:

- Passenger valuations only;

[1] This includes the original work of this nature for the EIB conducted by RAND Europe (De Jong, Kroes, Plasmeijer, Vermeulen, Boon and den Boer (2004) Value of Time and Value of Safety Guidelines for Transport Project. Prepared for the European Investment Bank).

- Valuations of IVT, walk time, wait time, headway, parking space search time, departure time switching, time spent in congested traffic conditions, reliability and late arrival time;

- Grey literature covering studies by consultants, academics and in-house personnel that are not in the public domain[2];

- All European countries where evidence can be identified and obtained.

This research has been conducted with a view to providing useful data for the economic appraisal of transport projects performed by the European Investment Bank.

1.3 Method

This study is not of the classic literature review form, whereby the methods and outcomes of many studies are summarised and synthesised. Rather it takes the form of a meta-analysis (study of studies) where values of time and relevant explanatory variables are assembled in a large data set and quantitative analysis is undertaken to understand why and to what extent the valuations vary.

1.4 Structure of Report

Section 2 sets out how we have gone about assembling the data. The key characteristics of the valuations and studies assembled are reported in section 3, and included in this is a discussion methodological trends. Section 4 outlines and discusses the actual valuations obtained prior to the formal meta-analysis of the monetary valuations that is reported in section 5. Section 6 uses the meta-model to estimate values of time split by mode, distance and journey purpose for European countries. These values are compared with:

- those currently used by EIB, and based on the original RAND Europe study;

- those obtained from the subsequent development of that work in the **S&deJ** study;

- official values from various countries, including those where 'national' studies have been conducted.

Section 6 also reports valuations of the various attributes in IVT units. Concluding remarks are provided in section 7.

[2] The success of the UK value of time meta-analyses owes much to sourcing high quality grey literature.

2. DATA ASSEMBLY

This study has built upon previous work by covering more studies and also extended the coverage in terms of the factors that are used to explain how values of time vary across the many studies that we have identified. This section explains how this study advances on previous work and also records the sources of the additional evidence assembled.

2.1 Adding to the Previous Data Sets

This study builds upon two previous meta-analyses as mentioned. The data sets are combined and enhanced in the following ways

The **A&W** data set covers British evidence on valuations of time, walk, wait, departure time shift, search time, congested travel time and headway, over the period 1960 to 2008. To this has been added valuations relating to travel time reliability since these were not previously covered.

The **A&W** data set contains information about a range of study features to use as explanatory variables in the meta-analysis. These are: the year to which the value relates; sample size; numeraire, in the form of the monetary variable used to gauge sensitivity to price; distance; type of data upon which the valuation is estimated, the number of variables per alternatives in the Stated Preference (SP) design, where used, along with the number of scenarios evaluated and the means of presenting the exercise; journey purpose; choice context; mode used and mode valued; region; whether non-traders were omitted from SP data sets; purpose of the study, and whether the main aim of the study was to value the variable in question and source of the evidence.

To this has been added information on the type of model used in estimation and the number of alternatives contained in the SP design.

The **SdeJ** data set covered European evidence over the period 1996 to 2003, including UK valuations as well as freight and international evidence. For each study, it collected information on: country; data type; estimation method; year and sample size; type of value of time (Resource/Behavioural or both); journey purpose; mode and whether the journey was long distance or not.

In order to provide a firmer basis for robust estimation of the inter-temporal income elasticity, studies prior to 1996 have been added to the **SdeJ** data set, as have more recent studies, evidence from unpublished sources and a wider range studies for the 1996 to 2003 period. In addition, valuations other than IVT have been included for all studies where estimated and reported.

To be consistent with the enhanced **A&W** data set, we have added to the **S&deJ** data set those variables in the former that were not originally contained in the latter.

2.2 Identification of Studies

The wide range of academic journals that we have reviewed are the Journal of Transport Economics and Policy, Transportation Research Parts A, B and E, Transportation, Transport Reviews, Transport Policy, European Transportation Research Review, Transportation Planning and Technology, Journal of Air Transport Management, Research in Transportation Economics, International Journal of Transport Economics, Journal of Choice Modelling, European Journal of Transportation Infrastructure Research, Transportation Research Record, Transport Europi and the Journal of Transport Geography.

The conference proceedings we have reviewed are the European Transport Conference and its predecessor the PTRC Summer Annual Conference, the World Conference on Transportation Research, the Conference of the International Association of Travel Behaviour Research, the annual Transportation Research Board Conference, the Swiss Transport Research Conference and the International Survey Methods Conference.

We have contacted a large number of academics and consultants across Europe, and beyond where appropriate, and have approached transport organisations such as motorway concessionaires and motorway and public transport operators as well as government agencies. We have also conducted internet based searches.

As a result of this exercise, we have assembled the largest ever data set for meta-analysis of the valuations of travel related attributes.

The full set of studies that we have here drawn upon is set out in Appendix 1.

3. DATA CHARACTERISTICS

Prior to examining the valuations obtained, we describe the characteristics of the data set assembled. Overall, we have 3109 monetary values from 389 studies. In addition, we have 1382 time based valuations (eg, importance of wait time relative to IVT) of attributes other than IVT obtained from 244 studies. There were 120 time valuations from 27 studies where there was no corresponding monetary valuation whilst 21 studies yielded 83 money valuations of non-IVT variables where there was no equivalent IVT valuation.

Table 1 reports the monetary valuations and studies for each attribute data set. To the 226 studies and 1749 valuations in the **A&W** data set and the 9 studies and 133 in the reduced **S&deJ** data set, we add 113 valuations from 10 UK studies that were primarily concerned with valuing travel time variability whilst the search of additional European evidence adds 1114 valuations from 148 studies.

Three of the studies in the New UK data set, adding new evidence on travel time variability valuations, had also provided values of time in the **A&W** data set. One study provides UK and Dutch valuations and hence is included in both the New UK and New European data sets.

Table 1: Attributes, Studies and Monetary Valuations

	A&W		S&deJ		New UK		New European		TOTAL	
Attribute	*Study*	*Value*	*Study*	*Value*	*Study*	*Value*	*Study*	*Value*	*Study*	*Value*
In-Vehicle Time	211	927	9	83	7	47	136	620	361	1677
Congested Time	9	29	-	-	-	-	15	46	24	75
Free Flow Time	9	39	-	-	-	-	15	48	24	87
Walk Time	80	257	2	4	-	-	26	64	108	325
Access time	25	78	-	-	1	7	13	37	39	122
Wait Time	23	64	1	1	1	1	20	57	45	123
Interchange Wait	6	15	1	9	-	-	2	6	9	30
Search Time	5	9	-	-	-	-	4	12	9	21
Headway	67	209	2	18	2	7	28	90	99	324
Departure TIme Early	9	33	-	-	1	3	4	13	14	49
Departure Time Late	9	37	-	-	1	3	4	13	14	53
Departure Time Both	7	29	-	-	-	-	-	-	7	29
Late Arrival	8	23	2	4	1	1	7	16	18	44
Schedule Delay Early	-	-	1	7	2	4	10	36	13	47
Schedule Delay Late	-	-	1	7	4	15	10	37	15	59
Standard Deviation	-	-	-	-	6	25	4	19	10	44
Total	226	1749	9	133	10	113	148	1114	389	3109

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As expected, valuations of IVT dominate, forming over 50% of the total and never less than 40% in any data set. This is followed by walk time and headway, each with 10%, and the combined reliability terms, combined wait times, combined departure time shifts, and access time valuations each with around 5%. In general, we have obtained a good spread of values to support analysis of a broad range of issues.

The corresponding time based valuations are reported in Table 2. The walk and headway valuations form around half of the total, with wait time and access another 20% but generally a reasonable number of each variable.

Table 2: Attributes, Studies and Time Valuations

	P&W		S&deJ		New UK		New European		TOTAL	
Attribute	*Study*	*Value*	*Study*	*Value*	*Study*	*Value*	*Study*	*Value*	*Study*	*Value*
Congested Time	9	29	-	`-	-	-	15	46	23	75
Free Flow Time	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a	n.a.	n.a	n.a.
Walk Time	85	272	2	4	-	-	26	64	113	340
Access time	29	95	-	-	1	7	15	42	45	144
Wait Time	26	76	1	1	1	1	21	58	49	136
Interchange Wait	5	11	1	9	-	-	2	6	8	26
Search Time	6	11	-	-	-	-	5	13	11	24
Headway	71	218	2	14	1	6	28	90	102	328
Departure Time Early	8	27	-	-	1	3	5	14	14	44
Departure Time Late	8	30	-	-	1	3	5	14	14	47
Departure Time Both	4	16	-	-	-	-	-	-	4	16
Late Arrival	6	17	2	4	-	-	7	16	15	37
Schedule Delay Early	-	-	1	7	3	4	12	43	15	54
Schedule Delay Late	-	-	1	7	5	15	12	44	17	66
Standard Deviation	-	-	-	-	7	26	4	19	11	45
Total	151	802	4	46	10	65	81	469	244	1382

The source of the studies is presented in Table 3. The UK study exploited a large amount of research undertaken on behalf of government and industry funders with relatively little obtained from journal articles and published conference papers. In contrast, journal articles and conference papers dominate the Non-UK data set. The two data sets have similar proportions of published reports and unpublished academic reports.

There are a number of reasons for this pattern of results. Firstly, some of the UK studies for operators and government were subsequently published in peer reviewed journals yet we have relied on the greater detail generally provided in the original reports. Secondly, we are more aware of unpublished studies in the UK and have better contacts with those conducting them. Thirdly, UK government and operators do have a strong track record over many years of evidence supported decision making with a tendency to conduct fresh research rather than exploit existing findings

which has led to a large number of good quality studies[3]. Finally, even if UK academics in the field of transport have had the same propensity to publish in academic journal as their European counterparts, which is debatable, the Non-UK studies tend to be more recent and in recent years there has been much stronger incentives for academics to publish their work.

Table 3: Sources of Studies

Source	UK		Non-UK	
	Valuations	Studies	Valuations	Studies
Journal Articles	66 (3%)	17 (7%)	374 (30%)	53 (34%)
Conference Paper	83 (5%)	12 (5%)	448 (36%)	62 (39%)
Published Report	301 (16%)	24 (10%)	242 (19%)	12 (8%)
Unpublished Operator Commissioned	313 (17%)	48 (21%)	81 (7%)	18 (11%)
Unpublished Government Commissioned	980 (53%)	113 (49%)	51 (4%)	6 (4%)
Unpublished Academic	119 (6%)	19 (8%)	51 (4%)	6 (4%)
Total	1862	233	1247	157

Note: Based on the identified monetary values

Table 3 also demonstrates that the average number of valuations per study is very similar between the two main data sets at around 8. Table 4 presents the distribution of valuations per study across the entire sample. We only collect separate valuations for a specific travel attribute from a study where the separate valuations provide additional insights as a result of segmentation according to variables that we intend to use to explain variations in valuations. Over half of the studies yield five or less valuations, perhaps surprising given that most studies value more than one 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.

Table 4: Valuations per Study

Values	Studies
1-2	89 (23%)
3-5	112 (29%)
6-10	99 (25%)
11-20	57 (15%)
21-30	23 (6%)
>30	9 (2%)
Total	389

The coverage of the different European countries is reported in Table 5. Monetary values have been identified and obtained for 26 European countries, with time based valuations for 18 countries.

[3] Indeed, one of the initial motivations for the Wardman meta-analysis initiated in the mid-1990s was a recognition of many unpublished studies in the UK, of high quality, yielding numerous values of time and that much more use could and should be made of them.

The UK provides almost 60% of the monetary values, 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. Moving to more Southern European countries, Spain and Switzerland each have around 3% of the monetary values in our data set, with France, Italy and Germany each providing less than 2%. The pattern of results is similar for the time-based valuations.

Table 5: Valuations and Studies by Country

Country	Money Values		Time Values	
	Study	*Value*	*Study*	*Value*
Albania	1	2	-	-
Austria	2	24	1	11
Belarus	1	1	-	-
Belgium	2	7	3	7
Croatia	1	3	-	-
Denmark	12	198	8	99
Finland	4	10	1	2
France	7	47	3	20
Germany	10	52	4	14
Greece	6	31	1	3
Irish Republic	5	25	2	**3**
Italy	14	55	5	15
Latvia	1	8	1	4
Moldova	1	1	-	-
Netherlands	24	247	13	111
Norway	15	163	12	76
Poland	7	19	-	-
Portugal	2	16	2	6
Romania	1	4	-	-
Russia	1	2	-	-
Serbia	1	11	1	5
Spain	14	92	9	36
Sweden	20	140	13	62
Switzerland	10	88	6	41
Ukraine	1	1	-	-
United Kingdom	233	1862	160	867
Total	396	3109	245	1382

Note: Two studies each have money values for four countries and one has money values for two countries. One study has time values for two countries.

The most common segmentation factor in transport planning is journey purpose. Table 6 illustrates the distribution of values across purposes for five broad categorisations of the monetary variables. The pattern is quite similar across the different variables with commuting, other trips and no distinction having broadly similar figures. The relatively low number of business travellers is presumably due to the use of wage rate based approaches to value travel in the course of business. Not surprisingly, the commuting market has a relatively large proportion of the travel time variability and departure time shift valuations.

Table 6: Valuations by Purpose (Row Percentages)

	Business	Commute	Other	No Dist	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 Shift	25 (19%)	44 (34%)	26 (20%)	36 (27%)	131
Reliability	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. No Dist denotes that no distinction was made by purpose. Time covers IVT, search, free flow and congested time. OVT (out-of-vehicle time) covers walk, wait and access time. Reliability covers the values of Schedule Delay Early (SDE), schedule Delay Late (SDL), standard deviation of travel time (SD) and late arrival.

Table 7 presents the distribution of valuations according to which mode was used (mode used) and which mode to which the value related (mode valued). Thus in a study of motorists route choices, the mode used and mode valued would both be car. In an SP exercise offering car users choices between train and car, mode used would be car and the mode valued would be car and train if a generic time coefficient is estimated but would be separately car and train if mode specific time parameters were estimated. Nonetheless, the differences between the proportions for mode used and mode valued are fairly minor.

Car is by far the largest single mode both used and valued but not to the extent of its dominance of travel. A number of factors contribute to the disproportionately large number of public transport observations, such as there being more variables relating to these modes, the requirements for parameters to input to public transport investment and planning decisions and the presence of public transport modes alongside car in mode choice models.

Well over a half of valuations relate to a specific mode. Joint values are recovered where data is pooled across mode users, as must be the case for RP mode choice models, or generic coefficients are estimated across modes. The largest joint category relates to car and public transport, reflecting RP mode choice modelling and the prevalence of generic parameters.

Table 7: Valuations by Mode Used and Mode Valued (Column Percentages)

	Mode Used All Values	Mode Used IVT Values	Mode Valued All Values	Mode Valued IVT Values
Car	1234 (39.7%)	647 (38.6%)	940 (30.2%)	540 (32.2%)
Bus	378 (12.2%)	181 (10.8%)	390 (12.5%)	194 (11.6%)
Rail	548 (17.6%)	306 (18.2%)	724 (23.3%)	400 (23.9%)
Metro	72 (2.3%)	28 (1.7%)	72 (2.3%)	30 (1.8%)
Tram	11 (0.3%)	5 (0.3%)	73 (2.3%)	39 (2.3%)
Air	42 (1.4%)	30 (1.8%)	50 (1.6%)	32 (1.9%)
Car and Bus	58 (1.9%)	35 (2.1%)	113 (3.6%)	69 (4.1%)
Car and Rail	150 (4.8%)	95 (5.7%)	94 (3.0%)	53 (3.2%)
Bus and Rail	108 (3.5%)	49 (2.9%)	279 (9.0%)	128 (7.6%)
Rail and Air	20 (0.6%)	14 (0.8%)	5 (0.2%)	4 (0.2%)
Car and PT+	337 (10.8%)	211 (12.6%)	221 (7.1%)	128 (7.6%)
PT Modes	65 (2.1%)	25 (1.5%)	118 (3.8%)	40 (2.4%)
Car, PT, Air	69 (2.2%)	45 (2.7%)	21 (0.7%)	17 (1.0%)
Other	17 (0.6%)	6 (0.3%)	9 (0.3%)	3 (0.2%)
Total	3109	1677	3109	1677

Note: PT+ denotes more than one public transport mode. We have not covered walk as a separate mode nor cycle time.

A common segmentation is by distance although even where there is no such segmentation in the reported results we associate with a valuation our best estimate of the journey distance to which it relates. Table 8 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 8: Valuations by Overall Journey Distance (Km) Band (Row Percentages)

	Mean	0-10km	11-25km	26-100km	101-250km	Over 250km	Total
Time	82.6 (3.29)	479 (26%)	561 (30%)	398 (21%)	265 (14%)	157 (9%)	1860
OVT	42.8 (3.88)	300 (50%)	177 (29%)	64 (11%)	29 (5%)	30 (5%)	600
Headway	94.2 (8.87)	104 (32%)	82 (25%)	66 (20%)	32 (10%)	40 (13%)	324
Dep Time Shift	113.8 (12.26)	17 (13%)	12 (9%)	54 (41%)	35 (27%)	13 (10%)	131
Reliability	57.5 (4.97)	14 (7%)	90 (46%)	61 (32%)	23 (12%)	6 (3%)	194
Total	75.87 (2.4)	914 (29%)	922 (30%)	643 (21%)	384 (12%)	246 (8%)	3109

Note: Standard errors of the mean are in brackets

The data upon which the values are estimated are reported in Table 9. Whilst the proportions of values and studies relating to Stated Preference (SP) choice data dominate and are very similar for UK and

Non-UK evidence, it is quite clear that Non-UK studies place more emphasis on Revealed Preference (RP) data and to a lesser extent on joint RP-SP data. SP ranking exercises have found little application in Non-UK studies. The reason for the latter is probably because of the generally later take-up of SP methods on the continent by which time ranking exercises, which had been adopted by transport researchers from early marketing research studies, had largely fallen out of favour. In contrast, joint RP-SP modeling is a more recent innovation and it would seem has been more enthusiastically adopted in Non-UK studies. The amount of evidence taken from joint RP-SP data is less than it might otherwise be because such studies often report stand-alone SP models from which we have extracted values and to additionally included values from joint RP-SP models constitutes an element of double counting.

Table 9: Data Type (Column Percentages)

	Valuations			Studies		
	UK	Non-UK	Total	UK	Non-UK	Total
RP	142 (8%)	237 (19%)	379 (12%)	28 (11%)	49 (28%)	77 (18%)
SP – Choice	1392 (74%)	892 (72%)	2284 (74%)	163 (64%)	108 (61%)	269 (63%)
SP – Ranking	295 (16%)	42 (3%)	337 (11%)	55 (22%)	9 (5%)	64 (15%)
SP – Rating	3 (0%)	6 (0%)	9 (0%)	2 (1%)	3 (2%)	5 (1%)
RP-SP	30 (2%)	70 (6%)	100 (3%)	4 (2%)	7 (4%)	11 (3%)
Total	1862	1247	3109	252	176	426

Note: Some studies yield valuations from more than one type of data.

Table 10 provides a more detailed breakdown of the valuations based on RP data. IVT values provide a larger proportion of the RP evidence than for the data as a whole (54%), as is also the case with wait time compared to 4% overall. As would be expected, valuations related to departure time shifts, travel time variability and lateness form a lower proportion of the RP data than overall.

Table 10: RP Valuations by Type of Time (Column Percentages)

	UK	Non-UK	Total
IVT	74 (52%)	171 (72%)	245 (64%)
Walk	22 (15%)	10 (4%)	32 (8%)
Wait	20 (14%)	13 (5%)	33 (8%)
Interchange Wait	2 (1%)	-	2 (1%)
Access	8 (6%)	15 (6%)	23 (6%)
Search	-	2 (1%)	2 (1%)
Headway	8 (6%)	11 (5%)	19 (5%)
Congested	4 (3%)	4 (2%)	8 (2%)
Free Flow	4 (3%)	4 (2%)	8 (2%)
Late	-	3 (1%)	3 (1%)
SDE	-	2 (1%)	2 (1%)
SDL	-	2 (1%)	2 (1%)

Studies can be undertaken for a number of reasons and with a variety of choice contexts. Overall, studies for the explicit purpose of value of time estimation, including the various so-called national value of time studies which have mainly been undertaken in Northern European, provide fewer observations than studies whose purpose was valuation in general or forecasting. As for choice context, we distinguish mode choice, route choice, abstract choice, where alternatives are 'unlabelled' and have no real world equivalent but are simply A and B or 1 and 2, time of day choice and the combinations of mode and route choice and mode and destination choice. The purpose of the study and the choice context are not independent and hence in Table 11 we provide a cross-tabulation by these two variables for both RP data and SP choice data[4].

The RP data has mainly been used to develop mode choice models in a forecasting context. The RP valuation studies tend to have been for the purposes of validating SP findings. The SP studies have been conducted for a broader range of purposes. Although there is a widespread view that SP parameters should not be used directly for forecasting, they have found extensive use for this purpose where there are no real world choice contexts as with new modes or toll roads.

In the RP context, abstract choice relates to choices between operators and other within mode choices and is, not surprisingly, comparatively rare. As might be expected, abstract choice contexts, without the complications of real-world influences, are popular for SP based valuation.

Table 11: Choice Contexts (Percentages within Data Type)

	RP			SP Choice		
Context	VoT	Valuation	Forecasting	VoT	Valuation	Forecasting
Mode Choice	42 (11.1%)	12 (3.2%)	214 (56.5%)	115 (5.0%)	405 (17.7%)	620 (27.1%)
Route Choice	23 (6.1%)	-	33 (8.7%)	122 (5.3%)	31 (1.4%)	89 (3.9%)
Abstract Choice	5 (1.3%)	4 (1.1%)	16 (4.2%)	274 (12.0%)	421 (18.4%)	131 (5.7%)
Mode-Route	-	-	-	36 (1.6%)	16 (0.7%)	8 (0.4%)
Mode-Destination	-	-	24 (6.3%)	-	-	8 (0.4%)
Time of Day	-	6 (1.6%)	-	-	8 (0.4%)	-
Total	70 (18.5%)	22 (5.8%)	287 (75.7%)	547 (23.9%)	881 (38.6%)	856 (37.5%)

There is a view that European SP exercises are simple and focused around two or three attributes. Table 12 lists the dimensions of SP choice exercises for the six countries with most evidence and the remaining countries. In terms of the number of variables per SP choice exercise (Vars), by far the most common overall is four and indeed the average value is generally around four. There is, however, variation across countries, with two variable SP exercises common in Norway, and Switzerland and Denmark having large proportions with over five attributes.

[4] RP-SP models tend to be based on mode choice but are few in number whilst the ranking and rating exercises are abstract choice.

The number of alternatives per choice exercise (Alts) is very closely centred around two, with the exception of the Netherlands having a somewhat broader spread. The current trend towards three alternatives apparent in some literature, particularly for Australia, South America and to some extent the Netherlands and constituted as the current travel situation plus two other options, is not manifest in our data set.

As for the number of choices offered per SP choice exercise, the most common category overall and for most countries is eight or nine, presumably due to the dominance of orthogonal design plans. Only in the Netherlands do more than twelve choices have any significance whilst Norway has a large proportion of values from choice exercises offering fewer than eight choices.

In conclusion, practice across Europe in terms of design dimensionality is reasonably homogenous.

Table 12: Dimensions of SP Choice Exercises (Column Percentages)

	UK	NL	DK	NO	SE	CH	Other	Total
Vars								
2	126 (9%)	39 (20%)	30 (21%)	72 (51%)	22 (21%)	-	48 (20%)	337 (15%)
3	339 (24%)	46 (24%)	30 (21%)	33 (24%)	16 (15%)	2 (2%)	91 (39%)	557 (24%)
4	649 (47%)	44 (23%)	-	35 (25%)	68 (64%)	40 (51%)	56 (24%)	892 (39%)
5	239 (17%)	18 (10%)	28 (20%)	-	-	7 (9%)	11 (5%)	303 (13%)
>5	39 (3%)	44 (23%)	54 (38%)	-	-	30 (38%)	28 (12%)	195 (9%)
Mean	3.8 (0.03)	4.4 (0.18)	4.6 (0.17)	2.7 (0.07)	3.4 (0.08)	4.8 (0.11)	3.6 (0.10)	3.9 (0.03)
Alts								
2	1233 (88%)	39 (20%)	131 (92%)	110 (79%)	106 (100%)	79 (100%)	183 (78%)	1971 (86%)
3	121 (9%)	46 (24%)	11 (8%)	15 (11%)	-	-	38 (16%)	197 (9%)
4	22 (2%)	44 (23%)	-	15 (11%)	-	-	5 (2%)	92 (4%)
>4	16 (1%)	62 (33%)	-	-	-	-	8 (4%)	24 (1%)
Mean	2.2 (0.02)	2.6 (0.06)	2.1 (0.02)	2.3 (0.06)	2.0 (0.0)	2.0 (0.0)	2.3 (0.04)	2.2 (0.01)
Choices								
<8	89 (6%)	15 (8%)	-	65 (47%)	7 (7%)	4 (5%)	56 (24%)	236 (10%)
8-9	759 (55%)	67 (35%)	114 (80%)	59 (42%)	85 (80%)	31 (39%)	132 (56%)	1247 (55%)
10-12	254 (18%)	50 (26%)	21 (15%)	16 (11%)	12 (11%)	36 (46%)	20 (9%)	409 (18%)
13-16	163 (12%)	59 (31%)	7 (5%)	-	-	8 (10%)	26 (11%)	263 (12%)
>16	127 (9%)	-	-	-	2 (2%)	-	-	129 (6%)
Mean	10.8 (0.11)	10.7(0.27)	8.9 (0.17)	7.6 (0.18)	8.4 (0.20)	10.7 (0.26)	8.9 (0.21)	10.1 (0.08)
Total	1392	191	142	140	106	79	234	2284

Note: Standard error of mean in brackets

Having described the key features of the data assembled in terms of how it varies across studies and values, we now turn to some temporal aspects of the data. This highlights some interesting trends.

The distribution of attribute valuations over time is presented in Table 13. Whilst not all studies in the most recent period will have been published, there is some evidence that the amount of value of

time evidence per period has peaked. This is not surprising, given that there are arguably fewer challenges to address and use can be made of a growing body of previous evidence.

We might have expected the proportion of values relating to time to reduce over time, as studies move towards the more challenging aspects of travel time variability and to areas where there is less evidence. However, the proportion of time values out of the total remains reasonably constant over time although there has clearly been more emphasis on reliability in the most recent decade.

Table 13: Attribute Valuations over Time (Row Percentages)

	1963-1980	1981-1990	1991-2000	2001-2011	Total
Time	43 (2%)	312 (17%)	787 (42%)	718 (39%)	1860
OVT	30 (5%)	103 (17%)	348 (58%)	119 (20%)	600
Headway	-	39 (12%)	161 (50%)	124 (38%)	324
Dep Time Shift	-	36 (27%)	48 (37%)	47 (36%)	131
Reliability	-	19 (10%)	43 (22%)	132 (68%)	194
Total	73 (2%)	509 (16%)	1387 (45%)	1140 (37%)	3109

Table 14 illustrate various trends across three time periods. As far as SP choice exercises are concerned, there is no evidence to support simpler SP exercises over time in terms of the number of variables and alternatives. However, there is a trend towards fewer choices per SP exercise. A contributory factor might be an increased appreciation that data quality might diminish as the number of choices increases, but it might also be due to an increasing desire to accommodate two separate SP exercises within the same study.

There has been a strengthening of the dominance of SP choice methods over time, with ranking applications almost disappearing. RP is much less used than it was in the early years. Pen and paper forms of SP presentation have fallen over time, as is to be expected given the emergence of computer based methods, but it remains the largest single method largely due to its cost effectiveness and the ability, as with on-board surveys, to capture large numbers of respondents. Recent years have seen the internet become a popular means of conducting SP exercises, presumably limiting the growth of CAPI. The presentation of SP exercises on cards, common with ranking exercises, has virtually ceased.

Mode choice applications form a lower proportion of the total over time, partly due to the reduced number of RP applications but also because valuation studies now dominate and for this purpose the abstract choice approach has the clear attraction of avoiding any confounding with real alternatives. The interest in road pricing, new toll roads, travel time choice and reliability issues has driven the increase in the number of route choice studies.

Table 14: Data Characteristics over Time (Column Percentages)

	1963-1990	1991-2000	2001-2011
SP Choice Dimensions			
Variables	3.83:0.06:279	3.72:0.03:1056	4.00:0.05:949
Alternatives	2.16:0.06:279	2.14:0.02:1056	2.32:0.02:949
Choice Repetitions	11.08:0.21:279	10.24:0.09:1056	9.74:0.15:949
Data Type			
RP	151 (26%)	91 (7%)	137 (12%)
SP Choice	279 (48%)	1056 (76%)	949 (83%)
SP Rank	152 (26%)	173 (12%)	12 (1%)
SP Rating	-	8 (1%)	1 (0%)
RP-SP	-	59 (4%)	41 (4%)
SP Presentation			
Pen and Paper	147 (53%)	516 (49%)	383 (40%)
Cards	65 (23%)	99 (10%)	8 (1%)
CAPI	67 (24%)	395 (37%)	319 (34%)
Internet	-	4 (0%)	183 (19%)
Telephone	-	42 (4%)	56 (6%)
Choice Context			
Mode Choice	189 (68%)	646 (61%)	305 (32%)
Route Choice	17 (6%)	58 (6%)	167 (18%)
Abstract Choice	73 (26%)	344 (33%)	409 (43%)
Mode and Route	-	-	60 (6%)
Mode and Destination	-	8 (1%)	-
Time of Day	-	-	8 (1%)

Note: For the SP Choice dimensions, the respective figures are mean, standard error and number of observations. Presentation is for SP choice.

4. VALUATIONS

We now discuss the valuations themselves, distinguishing between those expressed in monetary terms and those in equivalent units of time (IVT).

4.1 Monetary Values

The monetary values are expressed in euros per hour in 2010 prices. The exchange rates used are given in Appendix 2. Monetary values will increase over time as incomes vary and therefore some adjustment by income levels is needed to enable comparison. We have adjusted using a GDP per capita elasticity of unity. Table 15 reports valuations of IVT and free flow time, for which we have the largest number of observations, by country and journey purpose.

Table 15: Time (IVT and Free Flow) Valuations by Country and Purpose

Country	Business	Commute	Other	No Dist	GDP/cap
Albania				2.3:0.2:2	3065
Austria		9.6:3.0:7	21.6:13.2:4	7.2:3:2	37674
Belarus				2.25:0.0:1	4804
Belgium		10.2:4.8:4			35953
Croatia	31.9:0.0:1		13.2:3.1:2		11461
Denmark	30.6:4.2:17	8.4:0.6:28	7.2:0.6:27	9.6:1.2:27	46575
Finland		13.8:3.6:2	9.0:7.2:3	6.6:1.2:3	37093
France	22.2:4.2:5	15.0:1.8:15	13.2:2.4:13	40.2:10.2:2	32882
Germany	42.0:10.8:3	5.4:1.8:5	15.6:4.8:7	7.8:1.2:23	33460
Greece	15.0:3.6:9	12.6:0.6:5	13.8:2.4:12	4.2:1.2:5	22165
Irish Republic		3.0:0.6:4	10.2:2.4:11	37.2:7.2:6	39308
Italy	74.4:16.8:4	15.6:6.0:5	12.0:4.2:11	10.2:1.8:19	28263
Latvia	5.6:0.0:1	4.8:0.0:1	4.9:0.0:1	4.7:0.0:1	8920
Moldova				4.2:0.0:1	1358
Netherlands	41.4:4.2:31	16.8:1.8:71	18.6:4.2:31	25.2:6.0:6	39095
Norway	40.2:7.2:8	18.6:2.4:21	15.6:2.4:14	13.8:1.2:87	70448
Poland	15.2:2.2:7	8.7:0.0:1	12.2:1.7:7	9.2:2.1:4	10244
Portugal	55.2:33.0:2	12.6:0.0:1	16.8:4.2:7		17920
Romania	7.7:1.5:2		3.7:1.5:2		6281
Russia				4.1:0.9:2	8699
Serbia	3.3:1.5:2	4.2:1.5:2	3.3:1.1:2		4390
Spain	34.8:6.0:17	22.2:5.4:9	20.4:4.2:19	33.0:7.8:8	25450
Sweden	28.2:7.8:3	10.8:2.4:27	7.8:1.2:29	13.2:2.4:19	40779
Switzerland	58.2:3.6:7	30.0:5.4:10	25.8:1.8:14	23.4:2.4:22	56219
Ukraine				11.9:0.0:1	2505
United Kingdom	25.8:1.8:164	6.6:0.6:265	8.4:0.6:308	6.6:0.6:276	30119

Note: GDP per capita sourced from World Bank. Figures are mean value of time, standard error and the number of observations.

Generally, business valuations exceed commuting valuations which in turn exceed other values, and this pattern is to be expected. However, confounding effects are that other trips tend to be longer than commuting trips, and values generally increase with distance, whilst business travel values can reflect personal preferences rather than company policy. Valuations for wealthier countries tend to be larger. Given the uncertainties caused by exchange rate adjustments and allowing for income growth, there are attractions in exploring the other valuations as time equivalents and this is done in section 4.2. However, Table 16 does report money valuations for all attributes, split between whether the data is RP or SP and whether it is UK or not.

Table 16: Money Valuations of All Attributes

Attribute	UK		Non-UK	
	RP	SP	RP	SP
In-Vehicle Time	11.4:1.2:74	10.2:0.6:900	20.4:1.2:171	17.4:0.6:532
Free Flow Time	9.0:2.4:4	6.6:0.6:35	14.4:3.6:4	10.8:1.2:44
Congested Time	11.4:1.8:4	10.2:1.2:25	21.6:6.0:4	18.0:3:42
Walk Time	16.8:3.0:22	6.6:0.6:235	19.8:4.8:10	16.2:1.8:58
Access time	19.2:6.6:8	15.0:1.8:77	33:4.8.0:15	30.6:4.8:22
Wait Time	18.0:4.2:20	6.6:0.6:45	33.6:6.0:13	15.6:1.8:45
Interchange Wait	14.4:8.4:2	6.0:0.6:13		20.4:3.6:15
Search Time		7.2:1.2:9	45.0:3.0:2	16.2:3.6:10
Headway	7.8:2.4:8	4.8:0.6:208	6:1.2.0:11	10.8:1.2:97
Departure Time Early		9.6:1.2:36		8.4:3.0:13
Departure Time Late		10.8:1.2:40		8.4:2.4:13
Departure Time Both		12.0:3.0:29		
Late Arrival		26.4:3.6:24	43.8:21.0:3	16.2:3.6:10
Schedule Delay Early		10.8:4.2:4	19.8:12.0:2	22.8:4.2:41
Schedule Delay Late		31.8:4.2:15	12.0:5.4:2	33.6:4.8:42
Standard Deviation		16.2:3.6:25		6.0:1.2:19

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

Noticeable features of the results are that the RP valuations are almost always greater than their SP counterparts and that the Non-UK values generally exceed the UK values, although we have to be mindful of possible confounding effects from variables such as journey purpose, distance and mode which it is a purpose of the meta-analysis to overcome.

There is some uncertainty as to what extent values of IVT relate to free flow or congested traffic and the evidence would here suggest that there is more correspondence between the congested values and IVT, although modal effects may have a bearing. Access time values exceed walk time values which may be because the latter has an element of interchange, uncertainty and indeed financial cost associated. Valuations associated with lateness are relatively large whilst those for departure time

shifts and headway are relatively low. Walk and wait time values do not relate to IVT values as expected and there are clearly confounding factors at work here.

Although again there will be confounding effects, particularly with journey purpose and mode, we can report a particularly impressive distance effect for the valuation of IVT. Up to 10 kilometres the mean value is €7.2 per hour, with a 95% confidence interval of ±11% of the central estimate. Between 11 and 25km, it rises to €11.4 (±11%) and €15.0 (±12%) for 26-100km. At journeys between 101 and 250km, the mean value is €16.8 (±10%) and is highest at €30.0 (±15%) for journeys over 250km.

4.2 Time Valuations

Table 17 reports valuations expressed in equivalent units of IVT, except for congested time where the numeraire is the value of free flow time. As expected, the time valuations of walk time, access time, wait time and search time all exceed one, although noticeably the premia attached to these types of time are greater for the Non-UK values. From the subsequent table, a contributory factor here might be the greater reliance on RP evidence in Non-UK studies.

The valuations of headway and departure time shift are not greatly different between the two data sets and seem plausible, and this is even more the case for the congested time values. However, there are noticeably large differences between the UK and Non-UK valuations of the attributes relating to travel time variability.

Table 17: Valuations in Equivalent Units of IVT

Attribute	UK	Non-UK
Congested Time	1.54:0.061:29	1.58:0.092:46
Walk Time	1.62:0.045:272	1.93:0.099:68
Access time	1.57:0.074:102	1.95:0.136:42
Wait Time	1.68:0.095:77	1.93:0.090:59
Interchange Wait	1.72:0.109:11	1.93:0.157:15
Search Time	1.47:0.173:11	2.18:0.336:13
Headway	0.77:0.031:224	0.56:0.044:104
Departure Time Early	0.63:0.094:30	0.42:0.077:14
Departure Time Late	0.67:0.106:33	0.60:0.070:14
Departure Time Both	0.74:0.136:16	-
Late Arrival	5.76:0.696:17	2.69:0.307:20
Schedule Delay Early	1.20:0.461:4	0.78:0.065:50
Schedule Delay Late	2.20:0.254:15	1.55:0.121:51
Standard Deviation	1.22:0.142:26	0.48:0.072:19

Note: The figures are the mean ratio, the standard error of the mean and the number of observations.

The time valuations are split by data type in Table 18. We observe the multipliers to be larger for the RP data for the 'traditional' attributes of walk time, wait time and access time. There is the possibility that variations of these attributes in some SP exercises is unrealistic, and hence they are ignored and have a lower value. In addition, strategic bias might operate more on cost than these time variables and deflates the SP multipliers. In contrast, we might expect the contentious issue of late arrival to itself be an incentive to strategic bias and protest response whereupon its SP based values would be larger.

Table 18: Time Valuations by Data Type

Attribute	RP	SP
Congested Time	1.50:0.16:8	1.48:0.05:63
Walk Time	2.01:0.18:34	1.63:0.04:294
Access time	1.88:0.16:37	1.55:0.07:98
Wait Time	2.22:0.14:38	1.60:0.07:94
Interchange Wait	2.03:0.31:2	1.82:0.11:24
Search Time	3.06:0.93:3	1.51:0.12:18
Headway	0.59:0.11:24	0.73:0.03:285
Departure Time Early	-	0.57:0.07:44
Departure Time Late	-	0.65:0.08:47
Departure Time Both	-	0.74:0.14:16
Late Arrival	3.73:1.27:5	4.16:0.47:32
Schedule Delay Early	1.00:0.41:4	0.79:0.07:49
Schedule Delay Late	1.03:0.13:4	1.75:0.12:61
Standard Deviation	-	0.91:0.10:45

Note: The SP values are from choice or ranking data. The figures are the mean ratio, the standard error of the mean and the number of observations.

Given the impressive relationship between the monetary valuations of IVT and distance reported in section 4.1, Table 19 reports the time multipliers segmented by whether the valuations related to journeys that were urban, inter-urban or some mix of the two.

As might be expected, headway and late arrival valuations are lower for longer distance journeys, although this is not the case for schedule delay late and the standard deviation of travel time (reliability ratio). Whilst walk time and wait time have lower valuations for inter-urban travel, which could be because quite reasonably the money value of IVT increases more with journey distance than do the money values of walk and wait time, the relationship does not hold for interchange wait time and access time. The pattern of results needs more detailed investigation through meta-analysis.

Table 19: Time Valuations by Distance

Attribute	Urban	Inter-Urban	Mix
Congested Time	1.73:0.10:38	1.34:0.08:23	1.48:0.12:14
Walk Time	1.68:0.04:325	1.49:0.12:15	-
Access time	1.41:0.08:63	1.90:0.10:66	1.81:0.27:15
Wait Time	1.86:0.07:113	1.50:0.22:14	1.41:0.12:9
Interchange Wait	1.78:0.11:16	1.94:0.21:10	-
Search Time	1.85:0.22:23	1.85:0.0:1	-
Headway	0.83:0.04:194	0.55:0.04:104	0.50:0.05:30
Departure Time Early	0.58:0.12:23	0.64:0.13:12	0.44:0.02:9
Departure Time Late	0.69:0.13:25	0.74:0.09:13	0.41:0.03:9
Departure Time Both	0.84:0.0:1	0.54:0.07:12	1.50:0.50:3
Late Arrival	4.61:0.49:30	1.96:0.25:5	1.85:0.03:2
Schedule Delay Early	0.87:0.10:33	0.63:0.20:6	0.74:0.10:15
Schedule Delay Late	1.57:0.17:33	1.90:0.20:19	1.72:0.23:14
Standard Deviation	0.76:0.12:17	1.16:0.23:17	0.75:0.08:11

Note: The figures are the mean ratio, the standard error of the mean and the number of observations.

5. META-ANALYSIS

5.1 Modelling Approach

The form of model used to explain variations in monetary values (V) takes a multiplicative form:

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

where there are n continuous variables (X_i) and p categorical variables having q categories (Z_{jk}). We specify q-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 the estimation of the parameters by ordinary least squares.

$$\ln(VoT) = \ln(\tau) + \sum_{i=1}^{n} \alpha_i \ln(X_i) + \sum_{j=1}^{p} \sum_{k=1}^{q-1} \beta_{jk} Z_{jk} \quad (2)$$

We tested a linear-additive function in place of equation 1 but this provided a somewhat inferior fit to the data. Two types of variable were specified. Main effects relate to the independent effect of a particular variable, such as distance or mode, on a valuation. Interaction effects are essentially the product of two main effects, thereby permitting, say, the effect of distance to vary by mode.

We also specified dummy variables for each specific study. These can discern errors specific to particular studies as might arise from omitted relevant factors in our model, a poor quality study for data, design or analysis reasons, and the approximations involved in allowing for inflation and converting currencies.

The reported model, in Table 20, does not contain 'outlier' observations with standardised residuals outside the range ±2. Given the quite disparate nature of the numerous studies, and the additional error introduced in making cross-country comparisons, it is sensible to remove the 5% of observations which are associated with the highest residual error. Nonetheless, the impact of this on the coefficient estimates was not particularly large.

The model is estimated on 2960 monetary valuations expressed in € per minute in 2010 prices. The adjusted R^2 goodness of fit measure of 0.800 is very respectable given the disparate nature of the studies, the inherent inability of this type of approach to examine the detailed context of studies, and the sampling distribution surrounding any individual valuation. It is assumed that the variation in the values which cannot be explained by the key variables examined is randomly distributed across the sample. We discuss the results for each of the 15 broad categories of variables in turn.

Table 20: Meta-Model Results (2010 incomes and prices)

Variable	Coeff(t)	Effect	Variable	Coeff (t)	Effect
Constant	-9.686 (18.4)		**Mode Used**		
Attribute Specific			Bus	-0.307 (8.0)	-26%
Walk	0.341 (5.6)	+41%	Air	0.244 (2.8)	+28%
Wait	0.343 (4.6)	+41%	CarRail	0.310 (4.9)	+36%
Search	0.605 (5.9)	+83%	+CarDepTimeShift	-0.316 (2.4)	-27%
IntWait	0.440 (3.6)	+55%	**Mode Valued (IVT)**		
Access	0.429 (4.4)	+54%	Train	-0.061 (1.9)	-6%
FreeFlow	-0.425 (7.2)	-35%	Air	0.520 (5.8)	+68%
Congested	n.s.		CarBus	0.206 (3.1)	+23%
Headway	n.s.		RailAir	0.484 (2.1)	+62%
DepShiftEarly	-0.708 (5.2)	-51%	**Numeraire**		
DepShiftLate	-0.446 (3.3)	-36%	Toll	-0.291 (4.9)	-25%
DepShiftBoth	-0.767 (4.5)	-54%	Fuel	0.125 (3.3)	+13%
Late	1.174 (7.2)	+223%	**SP Presentation**		
StdDev	-0.453 (2.5)	-36%	Cards	-0.313 (3.8)	-27%
SDE	-0.247 (1.5)	-22%	CAPI	-0.333 (8.6)	-28%
SDL	0.512 (3.0)	+67%	Adaptive	-0.608 (2.7)	-46%
+IncludeStdDev	-0.326 (2.7)	-28%	**SP Replications**		
Income (euros)			RepeatChoices	-0.010 (3.0)	
GDP	0.721 (13.6)		**Choice Context**		
+ PostEuro	-0.040 (9.9)		Abstract Choice	-0.113 (3.4)	-11%
+ EB	0.072 (8.6)		**Study Aim**		
+ HF	0.056 (4.8)		Yes	0.123 (4.1)	+13%
+ CarUser	0.039 (9.7)		**Values per Study**		
Distance (Km)			Number	0.008 (4.8)	
Time	0.188 (18.9)		**Source**		
+ CarValued	-0.048 (4.2)		Unpublished	-0.082 (2.1)	-8%
OVT	0.203 (8.6)		**Data Type**		
Rely	0.176 (4.0)		RP	-0.123 (2.2)	-12%
InterUrban			**Country Specific**		
DepTime	1.350 (10.4)	+286%	Austria	-1.316 (6.0)	-73%
Headway	0.166 (2.8)	+18%	Italy	-0.314 (3.5)	-27%
Purpose			Netherlands	0.255 (3.0)	+29%
CommPeak	0.150 (6.2)	+16%	Spain	0.281 (3.7)	+32%
NoDist	0.167 (5.7)	+18%	Switzerland	0.194 (2.2)	+21%
+ EBSP	-0.182 (2.3)	-17%	UK	-0.408 (9.2)	-34%
+ EBForecasting	0.224 (4.0)	+25%			
+ EBOVT	-0.219 (2.2)	-20%	Adjusted R^2	0.800	
+ EBTrainUser	0.245 (3.9)	+28%	Observations	2960	

Note: Terms prefixed with + are incremental effects. t statistics in brackets. Value of time in this estimated model expressed in **€ per minute**. Repeat choices and the number of values per study entered equation 2 in absolute form, in contrast to logarithmic for income and distance, and hence the exponential of the product of the coefficient and the variable denotes the impact on the value of time.

5.2 Attribute Specific Constants

A dummy variable was specified for 15 of the 16 attributes, with IVT serving as the arbitrary base. The coefficient for congested time was not 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 somewhat lower value that other forms of IVT. The latter presumably reflects a preference for car travel time over other modes. This is an important finding, although contrasting with the UK evidence (Abrantes and Wardman, 2010), since there is some ambiguity as to whether studies that have valued generic car IVT have yielded a valuation that relates to free flow time, congested time or some combination.

Walking and waiting time have significant coefficient estimates, indicating that all else equal they are 41% more highly valued than the base category. Whilst this is somewhat less than the factor of two commonly applied to IVT to convert it into equivalent walk and wait time units, it should be pointed out that, given the finding for congested and free flow time, the 41% relates to congested time yet relative to free flow time the valuations of walk and wait time are over twice as large. Interchange wait time (*IntWait*) and access time have slightly larger premia attached to them than walk and wait time but seem reasonable.

The car parking space search time coefficient (*Search*) was highly significant and denotes a particular dislike of this type of time, at 83% larger than the base, reflecting the annoyance and frustration at not being able to find a parking space.

An attribute specific effect for headway was far from significant. However, the outworking of the other effects means, as we shall see, that its valuation is less than the value of time and generally somewhat so. Switching departure time is different to schedule delay since the former generally relates to planning at the origin whereas the latter typically relates to travel time variability in the context of preferred arrival times. We distinguish between earlier departures (*DepShiftEarly*), later departures (*DepShiftLate*) and instances where no distinction between the two was made in the analysis (*DepShiftBoth*). There are strong negative attribute specific effects apparent here, and travellers appear to be less bothered at departing earlier than later as might be expected. Whilst departure time changes are relatively low for urban trips, as we shall see they are somewhat more important for inter-urban travel.

Late arrival time is, as expected, relatively highly valued, with an impact coefficient 3.23 times larger than IVT. Given a similar distance effect for reliability related attributes, the large premium for late time relative to IVT will be maintained over different distances.

Schedule delay early (*SDE*) has a relatively low value, presumably because the inconvenience of arriving early are often slight whereas schedule delay late (*SDL*) incurs a much larger penalty. SDL is valued less highly than late arrival and this could be because the former involves a distribution of journey times and implied lateness rather than the explicit presentation in the latter case. In the

former case, the lateness is less apparent which could mean it is not fully appreciated. The standard deviation of travel time (*StdDev*) is valued around two thirds of IVT and this seems reasonable.

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

We tested whether business travel has different multipliers for non-IVT attributes than for other trips, on the grounds that time is time regardless of how it is spent on a business trip. No significant effects were obtained.

5.3 Income

The measure of income used is gross domestic product per capita in euros at 2010 prices. The base GDP elasticity obtained is 0.721, with a very precise 95% confidence interval of ±15% of the central estimate. In order to detect whether currency conversions were having any effect, we specified an incremental term for whether the time period covered that when the Euro had been introduced (*PostEuro*). A slight but highly statistically significant reduction is observed for this period, although this could be a trend effect independent of any currency issues. Distinguishing further the Euro period between those countries that had changed their currency and those that had not did not have any further impact.

We have discerned two incremental effects relating to business travel. The first (*EB*) simply denotes whether the valuation relates to business travel. This of itself would lead to an income elasticity some 10% larger than the base. The second is where the reported business value was based on the Hensher formula (HF) which includes the wage rate plus also the employee's estimated valuation of time savings. The latter is equivalent to an additional 8% of the base income elasticity.

The Hensher formula for business travel values, given that in our model this also includes the *EB* term, would imply an income elasticity of 0.809. Whilst less than unity, this is acceptable given that a portion of the valuation would include personal valuations which we observe do not increase in proportion to income.

Car users (*CarUser*) have a slightly larger income elasticity which might be because their disposable incomes have tended to grow at a faster rate than national income.

The income elasticities, varying between 0.68 and 0.85, are slightly less than the figure of 0.90 obtained for the UK by Abrantes and Wardman (2011) but are larger than the Shires and de Jong (2009) figures which ranged between 0.47 for business travel and 0.68 for commuting.

We examined incremental effects that allowed the GDP elasticity to vary by country for those countries that had supplied more than just a few observations. There were only four statistically

significant effects , relating to Switzerland (0.040), France (0.033), Spain (0.045) and the United Kingdom (-0.023). Given the small effects, for convenience in application purposes we decided not to retain these.

We note that business valuations are also influenced by whether the estimation method was SP, whereupon the value is more likely to represent a lower personal than company value, and whether the business value was obtained from a forecasting study, whereupon the valuation is likely to be larger to the extent that it more closely reflects company policy.

5.4 Overall Journey Distance

A highly significant and plausible distance elasticity of 0.188 (±11%) was estimated for the travel time related values of IVT, search, free flow and congested (*Time*), falling by 25% for car as a mode (*CarValued*). These positive distance elasticities, one of the most common findings in the value of time literature, reflect the increasing discomfort of longer distance journeys and the larger opportunity cost of time spent travelling. They compare to 0.161 (±27%) for UK based elasticities obtained by Abrantes and Wardman (2011), which actually increased to 0.205 for car IVT.

A very similar distance elasticity of 0.203 (±23%) was obtained for OVT, made up of walk time, wait time, access time and interchange wait time. As a result, there will be very little variation in the time valuations of the OVT variables by distance. The same goes for the reliability (*Rely*) distance effect of 0.176 (±50%) which covers late arrival, SDE, SDL and StdDev.

Specifying additional terms for whether the journey was simply inter-urban or not did not discern any significant effects. In contrast, there were no significant continuous distance effects for departure time shifts and headway. Nonetheless, significant effects could be recovered for whether the journeys were inter-urban, defined as being over 30 kilometres. The effect on headway valuations is +18%, so that as might be expected headway becomes relatively less important compared to time for longer journeys. However, we observe a very strong effect for departure time shifts for inter-urban trips and it is not clear why this is so.

The wage rate approach to business travel values implies that time is time regardless of how it is spent. The Hensher approach would slightly modify this. We tested a variety of incremental effects on the distance elasticity effect for business travel and none were significant. It would seem that the business travel valuation does indeed increase with distance and this might be because it is more senior and hence higher income business travellers who travel farther.

Whilst distance effects could reflect differential journey purposes by journey length, the values of time tend to be segmented by purpose. A more likely confounding effect that needs to be borne in mind is that those with higher incomes, and hence higher values of time, tend to travel farther. SP exercises for longer journeys will also tend to offer larger time savings and this might have an influence on estimated valuations.

5.5 Journey Purpose

The business effect is already taken up in the income term specified for that purpose and discussed above. Relative to a base category of leisure and off-peak travel, commuters and peak travellers (*CommPeak*) are found to have values 16% larger all else equal. Where there was no distinction made by purpose (*NoDist*), the value is, as expected, larger than for leisure travel base.

We examined a number of interactions. The business values were 17% lower where obtained from SP studies (*EBSP*). We believe that this is because in some SP studies respondents answer on their own account rather than on the company's. Similarly, where the purpose of the study was forecasting (*EBForecasting*), and where there would be more emphasis placed on a company than a personal value, the valuation is 25% larger. Business travellers by train (*EBTrainUser*) have values 28% larger which we take to be because this category is dominated by relatively high income 'briefcase' travellers.

Finally, we discerned a 20% lower valuation of OVT for business travellers (*EBOVT*) and we presume that this brings our business valuations more into line with company valuations to the extent that all travel time for business travellers is dead time regardless of the type of time.

5.6 Mode Used

We distinguish between mode used and mode valued. Mode used relates to the characteristics of the person, and chiefly income, and mode valued is related to the characteristics of the mode, such as comfort, environment and security.

Surprisingly few mode used effects were apparent for the very many combinations in our data set as set out in Table 7. As is to be expected given their generally lower incomes, bus users have values around 26% lower than other user groups except for a joint for car and rail user's category and also air users. The joint car and rail users category have values that are 36% larger, although it is not clear why, whilst for air the figure is 28%. A range of interactions was tested but the only significant effect found was that departure time shifts have a somewhat lower value for car users (+CarDepTimeShift).

Car users will have higher valuations as a result of the higher income elasticity recovered for them and reported above but closely offsetting this will be the lower distance elasticity for car as a mode.

5.7 Mode Valued (IVT)

With respect to the valuation of IVT by the mode to which it relates, the estimate for bus was, surprisingly, insignificantly different from the base of car travel. Train travel does seem to have a slightly lower (6%) valuation, presumably reflecting its greater comfort. What is most noticeable is the very high value attached to air travel, which is 68% larger and presumably reflects the less comfortable travelling conditions and perhaps also a fear factor by some. A large effect is also apparent when the value relates to both rail and air combined which is presumably reflecting the

same effect. Values estimated jointly for car and bus are 23% larger and as pointed out the distance elasticity is lower for car as a mode.

5.8 Numeraire

We distinguished between a wide range of numeraires, including combinations of different monetary instruments. Whilst it was perhaps surprising that valuations based on road pricing were not lower than average, as might be expected due to protests about having to pay to use road space, 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 whilst the latter increases values by 13%. These figures are similar to the UK evidence (Abrantes and Wardman, 2011) of 21% and 12% respectively. The toll effect presumably reflects protest responses against charging for the use of road space whilst the fuel cost effect will reflect the failure of some respondents to account fully for fuel cost in their decision making. That these effects bound the numeraires for other costs, such as public transport fares and parking, which are less objectionable and paid for at the point of use, is not surprising.

5.9 SP Presentation Format

There are six categories of presentation; pen and paper, cards, CAPI, internet, telephone and adaptive, where the latter is a special case of CAPI where the trade-offs offered are recursively amended in the light of previous responses.

There is no discernible difference in valuations according to whether the SP presentation was pen and paper, internet or telephone. However, cards and CAPI where 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.

The use of cards is a very clear means of presenting SP exercises whilst the CAPI approach has a number of attractions. Both can randomise the order that the SP scenarios are presented. Table 14 indicates that cards in particular and CAPI were used in the early periods, and the lower values in these periods could be argued to have impacted on their incremental effects. However, pen and paper dominates the early period so time based explanations do not hold. It may be that internet samples are atypical, leading to higher valuations because of differences in incomes and social class.

Fortunately, as far as using our model for predicting values of time is concerned, we do not have to select a preferred method of SP presentation since we prefer to base the recommended valuations upon RP evidence.

5.10 SP Replications

With respect to the number of comparisons in SP exercises (RepeatChoices), a significant, negative elasticity was obtained. It may be that as respondents become fatigued they choose to pay more attention to cost rather than time attributes. However, the effect is minor; increasing the number of comparisons from 8 to 16 would only reduce the estimated value of time by around 8%.

The other two dimensions of SP design, 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 value of time varied little across the various choice contexts set out in Table 11. The only significant effect related to abstract choice contexts and then the values were only 11% lower.

5.12 Study Aim

This relates solely to the SP exercise and is based on the hypothesis that where the purpose of the study is transparently to value the variable in question then there is an incentive to bias response. There is a degree of correlation here with the number of attributes, since the more attributes there are then the less transparent will be the purpose of the study. To some extent, this offsets the incentive to strategic bias on cost, discussed in section 5.15 below as the most contentious variable, by switching the emphasis of attention elsewhere.

Transparency is based on our subjective assessment of the purpose of the study and its likely perception. A significant effect was recovered, with valuations 13% higher where we specified that the aim of the study was to value the variable in question.

5.13 Values per Study

As the number of values of travel time per study increases, so the values increase. This may be associated with better quality national value of time studies, which tend to yield large numbers of values, or more recent studies with higher values yielding relatively large numbers of observations. Nonetheless, doubling the number of values from the mean of 8 per study would only result in values 7% larger.

5.14 Source

The source of the valuations is potentially important given we make considerable use of unpublished studies and it could be argued that their outputs are of lesser quality compared to those that are peer reviewed. In contrast though, it could be argued that there is a greater likelihood that plausible results supporting the conventional wisdom are accepted for publication. We distinguished between

the six sources set out in Table 3. We found that there was indeed a significant effect from valuations obtained from unpublished evidence but the 8% reduction is relatively minor and does not unduly concern us.

5.15 Data Type

A longstanding concern is the extent to which respondents' stated preferences reflect their actual preferences, given the artificial nature of SP and the fact that respondents are not committed to behaving in accordance with their stated preference. The notion of strategic bias, where respondents send a protest response or aim to influence policy makers by deliberately distorting their answers, is a potentially serious problem in SP applications, whilst other forms of non-commitment bias may exist.

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. At 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 and indicates lower values by 12% 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 30% lower. In addition to this can be added the mean number of SP choices of 10 which would reduce the values by 10% although offset by the SP study aim being transparent causing values to be 13% larger. On balance, though, we feel that there is here further evidence that SP valuations are too low.

5.16 Country Specific Effects

We thought it prudent to test whether there were any residual country specific effects on the grounds that the transferability across countries is here a critical issue. Across the 26 countries for which valuations were obtained, only six country specific coefficients were significant. Of these, only that for Austria would require very substantial amendment to the values that would be implied by the parameters in the rest of the meta model, and indeed it is this country of the six where there were very few studies.

It is not inconceivable that travellers in the UK and Italy, for a given level of income, have values of time 34% and 27% lower respectively, or that travellers in Switzerland, the Netherlands and Spain have values 21%, 29% and 32% larger respectively.

Given the dominance of UK values in our data set, we felt it particularly important to isolate any UK specific effects since otherwise any adoption of the study results in appraisal would essentially 'impose' UK values on the rest of Europe.

5.17 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 and all categories were found to be insignificant. These were estimation method, number of variables in an SP exercise, number of alternatives in an SP exercise, whether non-traders had been omitted from the sample, the size of the sample and whether the valuation was for residents of major metropolitan areas.

A number of interactions were also tested but were insignificant, some of which have already been mentioned. There were no interactions between the distance effect and whether the mode was bus, tram or metro, presumably because the amount of variation in journey distances is limited for these modes. Nor did the income elasticity vary with attribute and the journey purpose effects did not vary by mode. We might have expected more modal impacts on the attribute specific variables, such as car users being more averse to walking, waiting and headway, whilst there were some variations in the attribute specific effects by journey purpose but not a credible pattern.

5.18 Insights into Study Quality

A comment that is frequently made about meta-analysis is that often it does not control for differences in quality across studies. More than that, there may be a tendency for studies to report models that have key parameters that accord with the 'conventional wisdom'[5]. Whilst systematic misreporting to fit with the conventional wisdom will have a distorting effect, detecting it is at best controversial and more than likely impossible, although the fixed effects specified in our model might account for it. Of greater practical significance is the inevitability that there will be variations in the quality of data and of its analysis across studies. However, there are a number of reasons why this need not unduly concern us here.

Firstly, the precision of elasticity estimates can be taken to be, in some measure, a function of the quality of the data and analysis. Whilst variances of the estimated values of time 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. The 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 and associated t ratios. We have also pointed out the values themselves are not influenced by the sample size with little effect from the number of observations provided by each study.

Secondly, we have removed those observations where the standardised residual lies outside the range ±2. These could be taken to represent the 5% of observations of poorest quality. This is more objective than the contentious process of removing those value of time observations that on inspection seem not to fit with the rest of the data. Nonetheless, this process does not make a great deal of difference to the results.

[5] Akin to the suspicions that in the early literature there was under-reporting of non-work values of time that did not fit with the convention of being around 25% of the wage rate.

Thirdly, fixed effects unique to studies have been specified. These dummy variable terms 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 in the sense of choosing the same option throughout. 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 it is random effect, it will be contained within the error term and not bias our coefficient estimates.

Finally, we have pointed out that the elasticities vary little with their source, which might be taken as another proxy for quality. Indeed, this was also the case in our meta-analysis of UK values of time (Abrantes and Wardman, 2011).

6. APPLICATION OF THE META-MODEL

We here use our model to provide values of time for the various countries of relevance to EIB. Section 6.1 addresses valuations of IVT, which is the attribute of primary concern to EIB. Section 6.2 illustrates the valuations of the other attributes we have covered, essentially as multipliers to the value of IVT.

6.1 Implied Valuations of IVT

We here provide values of time implied by our models and compare them with the RAND Europe and S&deJ values. For comparison purposes, we have uplifted the RAND Europe values to 2010 prices and incomes, using the income effects inherent in their models. We have also done the same for the implied valuations of the models reported by S&deJ. We then provide the valuations implied by our model. In contrast to the RAND Europe and S&deJ values, where no distance effect was identified, we provide values for a range of distance bands given the relatively strong distance effect in our model. These distance bands are 5, 25, 100 and 250 kilometres for car, bus and train, and 250, 500 and 750 kilometres for air.

Our preferred formulation of the meta model for the value of IVT (VoIVT) implies the valuation function of equation 3.

$$VoIVT = e^{-10.060+0.150C+0.245EBTU-0.307BU+0.244AU-0.061TV+0.520AV} \times D^{0.188-0.048CV} GDP^{0.681+0.128EB+0.039CU} \quad (3)$$

This is expressed in **€ per minute**. The first term (-10.060) is made up of the weighted average constant across all studies of -9.977, the values per study term based on the average of 5 values per RP study, and the RP term of -0.123. We take the appropriate income effect to include the *PostEuro* term whilst business travel values are obtained using both the *EB* and *HF* terms. 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. The country specific effects are ignored, although they would prove useful in explaining values obtained from specific studies, and we take published evidence to be preferable.

In equation 3, C denotes commuting, EB is employer's business, TU, BU, AU and CU are train user, bus user, air user and car user respectively, TV, CV and AV are train valued, car valued and air valued respectively whilst D is distance in kilometres, GDP is gross domestic product per capita and EBTU denotes employer's business for train users.

The values for car, bus, train and air are reported in Tables 21, 22, 23 and 24 respectively and are expressed in **€ per hour**. What we can observe is the stronger income effects in the models reported here. The difference in valuations with income is larger than in the RAND Europe and S&deJ work.

For the car values of time, the S&deJ values are the highest for commuting and we would argue that these seem to be too high for the lower income countries. For the higher income countries there is a reasonable degree of correspondence between our results and RAND Europe. The RAND Europe and S&deJ values are more similar for car other and particularly car business. Indeed, the car other values are reasonably similar across the three sources. There is some disparity between our findings and the other two sets of figures for business travel. This might be resolved by inspection of the wage rate in each country (the S&deJ meta-analysis data base also included some travel time values from wage rate studies) but we note that some S&deJ values do seem rather large for the lower income countries.

Turning to the bus values, a similar relationship between the RAND Europe and S&deJ values is apparent as for car users. Again our values are generally lower, particularly than the S&deJ figures, and exhibit more variation with income, avoiding what appear to be some large RAND Europe and S&deJ values for the lower income countries. Again the degree of correspondence between the values is greater for other trips. Given that most bus journeys are for short distances, our figures do pose a serious challenge to the other two sets. Business travel is not a big market for bus, and again we observe some large values for the RAND Europe and S&deJ models with ours being somewhat lower.

The RAND Europe and S&deJ values correspond more for train than car and bus. Our values are typically somewhat less than the other two sets, particularly for shorter distances. We find the S&deJ figures to be on the high side, particularly for commuting and other trips.

The RAND Europe and S&deJ values are highly consistent for air business travel and indeed here is where our figures correspond most closely, although again with a larger spread with income and our model does produce some very high values. Moreover, for other air travellers there is generally a high degree of correspondence between our figures and the RAND Europe figures.

In summary, our figures do provide a challenge to the RAND Europe recommendations updated to 2010 prices and incomes whilst the S&deJ figures are generally farther away from ours. The current figures are based on a considerably larger data base than the RAND Europe study and S&deJ that includes studies over a long period of time and also the most recent studies. We would point to some large recommended RAND Europe and S&deJ values for lower income countries. The discrepancies between the different methods for business travel would be clarified by observation of average wage rates in each country, ideally split by mode, and we return to this issue below.

Table 21: Car Values of Time (Euros per hour 2010 incomes and prices)

Country	Car Commuter						Car Business						Car Other					
	RAND	S&deJ	5	25	100	250	RAND	S&deJ	5	25	100	250	RAND	S&deJ	5	25	100	250
Albania	4.56	-	1.21	1.51	1.84	2.09	12.26	-	2.91	3.64	4.42	5.03	3.84	-	1.04	1.30	1.58	1.80
Austria	10.09	13.74	7.36	9.22	11.20	12.73	33.85	36.27	24.41	30.57	37.12	42.20	7.09	10.52	6.34	7.94	9.64	10.96
Belgium	9.70	13.07	7.12	8.92	10.82	12.31	32.33	35.07	23.46	29.39	35.68	40.56	6.87	10.13	6.13	7.67	9.32	10.59
Bosnia	4.52	-	1.38	1.73	2.10	2.38	12.31	-	3.39	4.25	5.16	5.86	3.77	-	1.19	1.49	1.80	2.05
Bulgaria	6.05	-	1.79	2.24	2.72	3.09	16.44	-	4.60	5.77	7.00	7.96	5.04	-	1.54	1.93	2.34	2.66
Croatia	5.79	-	3.12	3.91	4.75	5.40	16.73	-	8.90	11.15	13.53	15.39	4.63	-	2.69	3.37	4.09	4.65
Cyprus	7.24	11.91	5.32	6.66	8.09	9.19	22.64	28.36	16.64	20.85	25.31	28.77	5.42	11.46	4.58	5.73	6.96	7.91
Czech Republic	6.22	12.24	3.83	4.80	5.83	6.62	18.58	22.69	11.31	14.16	17.20	19.55	4.85	8.83	3.30	4.13	5.01	5.70
Denmark	11.36	15.76	8.57	10.74	13.04	14.83	38.69	39.98	29.21	36.60	44.44	50.52	7.86	11.72	7.38	9.25	11.23	12.76
Estonia	6.51	10.82	3.22	4.03	4.90	5.57	19.20	21.36	9.22	11.55	14.02	15.94	5.12	8.19	2.77	3.47	4.22	4.79
Finland	9.83	13.40	7.28	9.12	11.07	12.59	33.04	35.32	24.09	30.17	36.64	41.65	6.92	10.25	6.26	7.85	9.53	10.83
France	9.17	15.70	6.67	8.36	10.15	11.54	30.40	33.90	21.75	27.24	33.08	37.61	6.52	14.03	5.74	7.20	8.74	9.93
Germany	9.42	12.66	6.76	8.47	10.28	11.69	31.39	34.07	22.07	27.65	33.57	38.16	6.68	9.84	5.82	7.29	8.85	10.06
Greece	7.60	10.97	5.02	6.29	7.64	8.69	23.91	27.07	15.57	19.50	23.68	26.92	5.68	10.83	4.32	5.42	6.58	7.48
Hungary	7.43	9.83	2.98	3.73	4.53	5.15	22.30	20.48	8.40	10.52	12.78	14.53	5.78	7.74	2.56	3.21	3.90	4.43
Ireland	9.13	13.12	7.59	9.51	11.54	13.12	30.32	34.69	25.30	31.69	38.48	43.75	6.49	10.06	6.53	8.18	9.94	11.30
Italy	7.83	13.60	5.98	7.50	9.10	10.35	25.07	30.95	19.13	23.96	29.09	33.08	5.75	12.64	5.15	6.45	7.83	8.91
Latvia	6.77	11.32	2.61	3.27	3.97	4.51	18.79	23.59	7.19	9.01	10.94	12.44	5.59	8.91	2.25	2.81	3.42	3.88
Lithuania	5.82	10.02	2.65	3.32	4.03	4.58	16.28	20.54	7.32	9.17	11.14	12.66	4.76	7.79	2.28	2.86	3.47	3.94
Luxembourg	16.35	23.07	13.54	16.96	20.60	23.42	57.76	52.41	50.04	62.69	76.12	86.54	10.89	15.79	11.66	14.60	17.73	20.16
Macedonia	4.67	-	1.39	1.74	2.11	2.40	12.88	-	3.42	4.29	5.21	5.92	3.86	-	1.20	1.50	1.82	2.07
Malta	6.44	9.91	4.09	5.12	6.22	7.07	19.42	25.15	12.22	15.30	18.58	21.13	4.96	10.00	3.52	4.41	5.35	6.09
Netherlands	9.99	13.00	7.56	9.47	11.50	13.07	33.56	34.72	25.18	31.55	38.31	43.55	7.03	10.05	6.51	8.15	9.90	11.25
Norway	14.58	-	11.55	14.47	17.57	19.97	50.56	-	41.50	51.98	63.12	71.76	9.79	-	9.94	12.45	15.12	17.19
Poland	6.23	10.95	2.88	3.61	4.38	4.98	18.59	21.12	8.09	10.13	12.30	13.99	4.87	8.13	2.48	3.11	3.77	4.29
Portugal	6.67	9.37	4.31	5.40	6.56	7.45	20.75	23.68	13.00	16.28	19.77	22.48	5.04	9.42	3.71	4.65	5.64	6.42
Romania	6.44	-	2.03	2.54	3.08	3.50	17.54	-	5.34	6.69	8.13	9.24	5.37	-	1.74	2.19	2.65	3.02
Russia	8.78	-	2.56	3.21	3.90	4.43	24.35	-	7.04	8.82	10.71	12.18	7.22	-	2.21	2.76	3.35	3.81
Serbia	7.41	-	1.57	1.96	2.38	2.71	19.62	-	3.94	4.94	6.00	6.82	6.30	-	1.35	1.69	2.05	2.33
Slovakia	6.33	9.54	3.49	4.38	5.31	6.04	18.70	19.40	10.15	12.71	15.43	17.55	5.00	7.38	3.01	3.77	4.57	5.20
Slovenia	7.95	15.03	4.50	5.64	6.85	7.79	25.30	26.27	13.68	17.14	20.81	23.66	5.88	10.37	3.88	4.86	5.90	6.70
Spain	7.92	12.43	5.55	6.95	8.44	9.60	25.30	29.29	17.50	21.92	26.62	30.26	5.83	11.86	4.78	5.98	7.27	8.26
Sweden	9.65	14.53	7.79	9.76	11.85	13.47	32.35	37.18	26.10	32.70	39.70	45.14	6.79	10.87	6.71	8.40	10.20	11.60
Switzerland	12.14	17.39	9.82	12.30	14.94	16.98	41.66	41.90	34.27	42.93	52.13	59.26	8.25	12.43	8.45	10.59	12.85	14.61
Turkey	7.38	-	2.50	3.13	3.80	4.32	20.34	-	6.84	8.57	10.41	11.83	6.12	-	2.15	2.70	3.27	3.72
UK	7.42	12.49	6.27	7.85	9.53	10.83	23.39	34.30	20.19	25.29	30.71	34.91	5.54	9.86	5.39	6.76	8.20	9.32

Table 22: Bus Values of Time (Euros per hour 2010 incomes and prices)

	Bus Commuter						Bus Business						Bus Others					
Country	**RAND**	**S&deJ**	**5**	**25**	**100**	**250**	**RAND**	**S&deJ**	**5**	**25**	**100**	**250**	**RAND**	**S&deJ**	**5**	**25**	**100**	**250**
Albania	2.26	-	0.70	0.95	1.23	1.47	10.24	-	1.69	2.29	2.97	3.53	3.15	-	0.60	0.82	1.06	1.26
Austria	8.68	11.37	3.88	5.25	6.81	8.09	30.81	29.10	12.86	17.40	22.59	26.83	6.56	7.42	3.34	4.52	5.86	6.97
Belgium	8.47	10.81	3.76	5.08	6.60	7.84	29.36	28.16	12.38	16.76	21.75	25.84	6.32	7.14	3.23	4.38	5.68	6.75
Bosnia	2.58	-	0.79	1.08	1.40	1.66	10.35	-	1.96	2.65	3.44	4.08	3.11	-	0.68	0.93	1.20	1.43
Bulgaria	3.45	-	1.02	1.38	1.78	2.12	13.81	-	2.62	3.55	4.60	5.47	4.16	-	0.87	1.18	1.54	1.82
Croatia	4.55	-	1.72	2.33	3.03	3.60	14.42	-	4.91	6.65	8.63	10.25	3.92	-	1.48	2.01	2.61	3.10
Cyprus	6.41	9.86	2.85	3.86	5.01	5.95	20.11	22.76	8.92	12.08	15.67	18.62	4.80	8.08	2.45	3.32	4.31	5.12
Czech Republic	4.94	10.13	2.09	2.83	3.67	4.36	16.22	18.20	6.17	8.35	10.84	12.88	4.19	6.23	1.80	2.44	3.16	3.75
Denmark	9.48	13.03	4.48	6.06	7.87	9.35	35.39	32.08	15.27	20.66	26.81	31.85	7.35	8.25	3.86	5.22	6.77	8.05
Estonia	5.44	8.94	1.77	2.40	3.12	3.70	16.71	17.15	5.08	6.88	8.92	10.60	4.38	5.76	1.53	2.07	2.68	3.19
Finland	8.43	11.08	3.84	5.19	6.74	8.01	30.08	28.35	12.70	17.19	22.30	26.50	6.40	7.23	3.30	4.47	5.80	6.89
France	8.12	12.98	3.54	4.78	6.21	7.38	27.56	27.21	11.52	15.59	20.23	24.04	5.98	9.88	3.04	4.12	5.34	6.35
Germany	8.31	10.48	3.58	4.84	6.28	7.46	28.50	27.33	11.68	15.81	20.52	24.38	6.14	6.94	3.08	4.17	5.41	6.42
Greece	6.96	9.07	2.70	3.66	4.75	5.64	21.27	21.73	8.37	11.33	14.71	17.47	5.04	7.64	2.33	3.15	4.09	4.85
Hungary	6.98	8.13	1.65	2.23	2.89	3.44	19.50	16.44	4.65	6.29	8.16	9.70	4.98	5.45	1.42	1.92	2.49	2.96
Ireland	8.32	10.85	3.99	5.40	7.01	8.33	27.50	27.84	13.31	18.01	23.38	27.77	5.95	7.09	3.44	4.65	6.03	7.17
Italy	7.31	11.25	3.19	4.32	5.60	6.65	22.46	24.83	10.19	13.79	17.90	21.27	5.17	8.91	2.74	3.71	4.82	5.73
Latvia	4.59	9.36	1.45	1.97	2.55	3.03	15.91	18.93	4.01	5.43	7.04	8.37	4.63	6.29	1.25	1.69	2.20	2.61
Lithuania	3.92	8.28	1.48	2.00	2.59	3.08	13.83	16.48	4.08	5.52	7.16	8.51	3.98	5.49	1.27	1.72	2.23	2.65
Luxembourg	11.39	19.08	6.90	9.34	12.13	14.41	53.42	42.05	25.51	34.53	44.81	53.23	10.48	11.12	5.94	8.04	10.44	12.40
Macedonia	3.10	-	0.80	1.08	1.41	1.67	10.87	-	1.97	2.67	3.47	4.12	3.20	-	0.69	0.93	1.21	1.44
Malta	5.63	8.20	2.22	3.01	3.91	4.64	17.02	20.19	6.65	8.99	11.67	13.87	4.31	7.05	1.92	2.59	3.36	4.00
Netherlands	8.58	10.75	3.98	5.38	6.99	8.30	30.55	27.86	13.25	17.93	23.27	27.65	6.50	7.08	3.42	4.63	6.01	7.14
Norway	4.28	-	5.94	8.04	10.43	12.39	46.59	-	21.34	28.88	37.48	44.52	9.34	-	5.11	6.92	8.98	10.67
Poland	5.25	9.04	1.60	2.16	2.81	3.33	16.23	16.95	4.48	6.07	7.88	9.36	4.19	5.73	1.38	1.86	2.42	2.87
Portugal	6.14	7.75	2.34	3.16	4.11	4.88	18.40	19.00	7.05	9.54	12.38	14.71	4.44	6.64	2.01	2.72	3.53	4.20
Romania	3.45	-	1.15	1.55	2.01	2.39	14.73	-	3.02	4.09	5.30	6.30	4.42	-	0.99	1.33	1.73	2.06
Russia	5.45	-	1.43	1.93	2.51	2.98	20.64	-	3.93	5.32	6.90	8.20	6.01	-	1.23	1.67	2.16	2.57
Serbia	3.61	-	0.90	1.21	1.58	1.87	16.29	-	2.26	3.06	3.97	4.71	5.13	-	0.77	1.05	1.36	1.61
Slovakia	5.22	7.88	1.92	2.59	3.37	4.00	16.26	15.57	5.57	7.53	9.78	11.62	4.27	5.20	1.65	2.23	2.90	3.44
Slovenia	7.34	12.43	2.44	3.30	4.28	5.08	22.61	21.08	7.40	10.02	13.01	15.45	5.26	7.31	2.10	2.84	3.68	4.38
Spain	7.25	10.28	2.97	4.02	5.21	6.20	22.64	23.51	9.36	12.67	16.45	19.54	5.22	8.36	2.56	3.46	4.49	5.33
Sweden	8.21	12.02	4.09	5.54	7.19	8.54	29.42	29.84	13.71	18.56	24.08	28.61	6.27	7.67	3.52	4.77	6.19	7.35
Switzerland	3.89	14.37	5.09	6.89	8.95	10.63	38.27	33.64	17.78	24.06	31.22	37.09	7.81	8.76	4.38	5.93	7.70	9.15
Turkey	5.05	-	1.40	1.89	2.45	2.91	17.18	-	3.82	5.17	6.72	7.98	5.06	-	1.20	1.63	2.11	2.51
UK	7.32	10.32	3.33	4.51	5.85	6.95	20.84	27.53	10.73	14.52	18.85	22.39	4.91	6.94	2.87	3.88	5.03	5.98

Table 23: Train Values of Time (Euros per hour 2010 incomes and prices)

	Train Commuter						Train Business						Train Other					
Country	**RAND**	**S&deJ**	**5**	**25**	**100**	**250**	**RAND**	**S&deJ**	**5**	**25**	**100**	**250**	**RAND**	**S&deJ**	**5**	**25**	**100**	**250**
Albania	3.95	-	0.90	1.22	1.58	1.87	14.29	-	2.76	3.74	4.85	5.76	3.50	-	0.77	1.05	1.36	1.61
Austria	10.94	13.74	4.96	6.71	8.71	10.35	32.13	36.27	21.01	28.44	36.90	43.84	7.62	10.52	4.27	5.78	7.50	8.91
Belgium	10.45	13.07	4.80	6.50	8.44	10.02	30.89	35.07	20.23	27.38	35.53	42.22	7.34	10.13	4.14	5.60	7.26	8.63
Bosnia	3.97	-	1.02	1.38	1.79	2.12	14.19	-	3.20	4.33	5.61	6.67	3.47	-	0.87	1.18	1.54	1.83
Bulgaria	5.29	-	1.30	1.76	2.28	2.71	18.97	-	4.28	5.79	7.52	8.93	4.64	-	1.12	1.51	1.96	2.33
Croatia	5.40	-	2.21	2.99	3.87	4.60	18.24	-	8.02	10.86	14.09	16.74	4.41	-	1.90	2.57	3.33	3.96
Cyprus	7.31	11.91	3.65	4.94	6.40	7.61	22.92	28.36	14.58	19.73	25.61	30.42	5.49	11.46	3.14	4.25	5.51	6.55
Czech Republic	6.00	12.24	2.67	3.62	4.70	5.58	19.65	22.69	10.09	13.65	17.71	21.04	4.73	8.83	2.30	3.11	4.04	4.80
Denmark	12.49	15.76	5.73	7.76	10.07	11.96	36.21	39.98	24.95	33.76	43.81	52.05	8.56	11.72	4.93	6.68	8.66	10.29
Estonia	6.20	10.82	2.27	3.07	3.99	4.74	20.52	21.36	8.30	11.23	14.58	17.32	4.96	8.19	1.95	2.64	3.43	4.08
Finland	10.68	13.40	4.91	6.64	8.62	10.24	31.34	35.32	20.75	28.08	36.44	43.29	7.43	10.25	4.22	5.72	7.42	8.81
France	9.82	15.70	4.52	6.12	7.94	9.43	29.17	33.90	18.82	25.47	33.06	39.27	6.93	14.03	3.89	5.27	6.83	8.12
Germany	10.14	12.66	4.58	6.19	8.04	9.55	30.01	34.07	19.09	25.84	33.53	39.83	7.12	9.84	3.94	5.33	6.92	8.22
Greece	7.71	10.97	3.46	4.68	6.07	7.21	24.10	27.07	13.68	18.52	24.03	28.55	5.78	10.83	2.97	4.03	5.22	6.21
Hungary	7.19	9.83	2.11	2.85	3.70	4.39	23.47	20.48	7.60	10.28	13.34	15.85	5.66	7.74	1.81	2.45	3.18	3.78
Ireland	9.79	13.12	5.11	6.91	8.97	10.65	29.07	34.69	21.75	29.43	38.19	45.37	6.90	10.06	4.39	5.95	7.72	9.17
Italy	8.09	13.60	4.08	5.52	7.16	8.51	24.86	30.95	16.65	22.54	29.25	34.75	5.94	12.64	3.51	4.75	6.17	7.32
Latvia	6.06	11.32	1.86	2.52	3.27	3.88	21.31	23.59	6.55	8.87	11.51	13.67	5.20	8.91	1.60	2.17	2.81	3.34
Lithuania	5.25	10.02	1.89	2.55	3.31	3.94	18.31	20.54	6.66	9.02	11.70	13.90	4.45	7.79	1.62	2.20	2.85	3.39
Luxembourg	18.67	23.07	8.83	11.95	15.51	18.42	52.32	52.41	41.69	56.42	73.22	86.98	12.30	15.79	7.60	10.29	13.35	15.86
Macedonia	4.15	-	1.02	1.39	1.80	2.14	14.66	-	3.23	4.37	5.67	6.73	3.58	-	0.88	1.19	1.55	1.84
Malta	6.26	9.91	2.85	3.85	5.00	5.94	20.33	25.15	10.86	14.70	19.07	22.66	4.90	10.00	2.45	3.31	4.30	5.11
Netherlands	10.84	13.00	5.09	6.88	8.93	10.61	31.85	34.72	21.65	29.30	38.03	45.18	7.55	10.05	4.38	5.93	7.69	9.13
Norway	16.73	-	7.60	10.28	13.34	15.85	46.36	-	34.87	47.18	61.23	72.74	10.84	-	6.54	8.85	11.48	13.64
Poland	6.01	10.95	2.04	2.77	3.59	4.26	19.68	21.12	7.33	9.92	12.87	15.29	4.75	8.13	1.76	2.38	3.09	3.67
Portugal	6.69	9.37	2.99	4.05	5.25	6.24	21.15	23.68	11.52	15.59	20.23	24.03	5.08	9.42	2.57	3.48	4.52	5.37
Romania	5.65	-	1.46	1.98	2.57	3.06	20.23	-	4.93	6.68	8.66	10.29	4.94	-	1.26	1.71	2.21	2.63
Russia	7.89	-	1.83	2.47	3.21	3.81	27.57	-	6.42	8.69	11.28	13.39	6.71	-	1.57	2.13	2.76	3.28
Serbia	6.32	-	1.15	1.55	2.02	2.39	23.19	-	3.69	5.00	6.48	7.70	5.69	-	0.99	1.34	1.73	2.06
Slovakia	6.04	9.54	2.45	3.32	4.31	5.11	20.01	19.40	9.10	12.31	15.98	18.98	4.83	7.38	2.11	2.86	3.71	4.40
Slovenia	8.17	15.03	3.12	4.22	5.47	6.50	25.22	26.27	12.10	16.37	21.25	25.24	6.02	10.37	2.68	3.63	4.71	5.60
Spain	8.18	12.43	3.80	5.14	6.67	7.92	25.14	29.29	15.30	20.71	26.87	31.92	6.00	11.86	3.27	4.42	5.74	6.82
Sweden	10.45	14.53	5.24	7.08	9.19	10.92	30.75	37.18	22.40	30.32	39.35	46.74	7.29	10.87	4.51	6.10	7.91	9.40
Switzerland	13.77	17.39	6.51	8.82	11.44	13.59	38.59	41.90	29.05	39.31	51.02	60.61	9.04	12.43	5.61	7.59	9.85	11.70
Turkey	6.55	-	1.79	2.42	3.14	3.73	23.20	-	6.25	8.45	10.97	13.03	5.65	-	1.54	2.08	2.70	3.21
UK	7.54	12.49	4.26	5.76	7.48	8.89	23.54	34.30	17.53	23.73	30.79	36.58	5.64	9.86	3.67	4.96	6.44	7.65

Table 24: Air Values of Time (Euros per hour 2010 incomes and prices)

	Air Business					Air Others				
Country	**RAND**	**S&deJ**	**250**	**500**	**750**	**RAND**	**S&deJ**	**250**	**500**	**750**
Albania	19.31	-	10.29	11.72	12.65	5.41	-	3.68	4.19	4.53
Austria	49.01	49.94	78.30	89.20	96.27	17.87	-	20.33	23.15	24.99
Belgium	46.93	48.31	75.40	85.89	92.70	16.98	-	19.69	22.43	24.21
Bosnia	19.30	-	11.91	13.57	14.64	5.50	-	4.17	4.74	5.12
Bulgaria	25.79	-	15.95	18.17	19.61	7.33	-	5.33	6.07	6.55
Croatia	25.61	-	29.90	34.06	36.76	7.88	-	9.04	10.30	11.11
Cyprus	33.63	39.07	54.34	61.90	66.80	11.38	-	14.94	17.02	18.37
Czech Republic	28.08	31.24	37.58	42.81	46.20	9.00	-	10.96	12.48	13.47
Denmark	55.71	55.05	92.96	105.90	114.29	20.62	-	23.48	26.75	28.87
Estonia	29.16	29.42	30.94	35.24	38.03	9.23	-	9.30	10.60	11.44
Finland	47.82	48.64	77.33	88.09	95.07	17.44	-	20.11	22.91	24.73
France	44.19	46.68	70.14	79.91	86.24	15.92	-	18.53	21.11	22.78
Germany	45.57	46.92	71.14	81.04	87.46	16.48	-	18.75	21.36	23.05
Greece	35.44	37.28	50.98	58.08	62.68	12.05	-	14.16	16.14	17.41
Hungary	33.64	28.21	28.30	32.24	34.80	10.84	-	8.63	9.83	10.61
Ireland	44.07	47.78	81.04	92.32	99.63	15.88	-	20.92	23.83	25.72
Italy	36.92	42.61	62.06	70.70	76.30	12.80	-	16.71	19.04	20.55
Latvia	29.26	32.48	24.41	27.81	30.01	8.53	-	7.62	8.68	9.37
Lithuania	25.26	28.30	24.83	28.29	30.53	7.44	-	7.73	8.81	9.50
Luxembourg	82.14	72.17	155.35	176.97	190.99	31.47	-	36.18	41.22	44.48
Macedonia	20.08	-	12.02	13.70	14.78	5.82	-	4.20	4.78	5.16
Malta	29.24	34.65	40.47	46.10	49.75	9.49	-	11.66	13.28	14.34
Netherlands	48.58	47.82	80.69	91.92	99.20	17.71	-	20.84	23.75	25.63
Norway	72.28	-	129.92	148.01	159.73	27.67	-	31.13	35.46	38.27
Poland	28.11	29.09	27.30	31.11	33.57	9.01	-	8.37	9.54	10.29
Portugal	30.90	32.61	42.93	48.90	52.77	10.38	-	12.25	13.96	15.07
Romania	27.50	-	18.38	20.94	22.60	7.82	-	6.00	6.84	7.38
Russia	37.89	-	23.92	27.25	29.41	11.11	-	7.49	8.53	9.21
Serbia	31.10	-	13.76	15.67	16.91	8.52	-	4.70	5.36	5.78
Slovakia	28.40	26.72	33.90	38.62	41.68	8.97	-	10.05	11.44	12.35
Slovenia	37.33	36.17	45.09	51.36	55.43	12.88	-	12.77	14.55	15.70
Spain	37.30	40.34	57.01	64.95	70.09	12.90	-	15.56	17.73	19.13
Sweden	46.86	51.20	83.49	95.11	102.64	17.05	-	21.45	24.44	26.37
Switzerland	59.80	57.71	108.25	123.32	133.08	22.64	-	26.70	30.41	32.82
Turkey	31.72	-	23.28	26.52	28.62	9.17	-	7.32	8.34	9.00
UK	34.65	47.24	65.34	74.43	80.33	11.80	-	17.45	19.88	21.46

6.2 Detailed Comparison of Meta-Analysis and EIB Results

We here make three assessments of the values of time implied by our model with other evidence and in so doing compare the performance of our values of time against the EIB values. The three assessments that we make are:

- A comparison of our values and the EIB values against official values of time, largely from countries where 'national' studies have been conducted. These are countries with the larger GDP per capita.

- A comparison of what our model would predict for the lower income Eastern European countries with the results that have been obtained for those countries. This is likely to be a context where there is relatively greatest need for outside valuations to underpin project appraisal but our data set contains relatively few values from the emerging economies.

- A comparison of the business values against labour costs, given the widespread practice of relating the value of travel time in the course of work to the wage rate.

6.2.1 Official Values of Time

For the values implied by the meta-model for each country, we used 'local parameters' for a fairer assessment of the performance of the model. We did not use the country specific coefficients but we did use, for example, SP related variables since the values are derived from such models. Where the official values relate to a specific study, we used the parameters for that study and otherwise we made an educated guess. Nonetheless, this does not greatly alter the implied values of time relative to our preferred formulation of equation 3.

Table 25 provides the EIB and meta-model values for Norway, Netherlands, Germany, Sweden, Denmark, Switzerland and the United Kingdom. Where official business values are reported they are based upon labour costs rather than the outputs of SP models. The Swiss official values are distance related and hence we report the value for the mean journey distance for the mode and purpose.

Given the value of time in our model is dependent upon distance, we have obtained average distances for each mode and purpose and used these in calculating the values of time. There are 72 comparisons we can make from Table 25 of the meta and EIB valuations against official valuations.

Inspection of the values in Table 25 reveals that there is a broad level of agreement overall between the meta and EIB values and that each generally provide a good account of official values. In 37 out of the 72 cases (51%), the meta values are closer to official values. However, the picture varies by journey purpose. For commuting, the meta values are closer to the official values in 16 (67%) of the 24 cases whilst in contrast the figure is 8 (36%) out of 22 for business travel. The honours are even for the 26 comparisons for other trips

Table 25: Official Values of Time Compared with EIB Values and Meta-Model Values

	Commute			Other			Business		
	Official	Meta	EIB	Official	Meta	EIB	Official	Meta	EIB
Norway	Original prices and incomes 2009. Figures supplied by Farideh Ramjerdi								
Car Short (<100)	11.39	22 = 13.69	14.58	9.75	22=11.78	9.79	48.10	22=41.01	50.56
Car Long (>100)	25.31	125=17.46	14.58	18.48	218=16.25	9.79	48.10	218=56.54	50.56
PT (Bus) Short (<100)	7.59	19=7.22	4.28	5.82	19=6.12	9.34	48.10	19=21.31	46.59
Rail Long (>100)	19.74	125=13.16	16.73	11.65	303=13.38	10.84	48.10	303=46.57	46.36
Bus Long (>100)	13.04	125=10.29	4.28	9.24	232=9.8	9.34	48.10	232=34.12	46.59
Air				22.79	1386=31.85	27.67	56.33	1386=110.8	72.28
Netherlands	Originally based on HCG (1998). http://www.rijkswaterstaat.nl/kenniscentrum/economische_evaluatie/kengetallen/								
Car	10.51	20=8.58	9.99	7.27	13=6.59	7.03	36.43	17=23.30	33.56
Train	10.58	45=7.06	10.84	6.52	45=6.07	7.55	22.40	45=19.16	31.85
Bus/Tram	9.85	17=4.59	8.58	6.22	13=3.70	6.50	17.16	15=12.28	30.55
Germany	Bundesministerium für Verkehr, Bau und Stadtentwickelung (2005) Die gesamtwirtschaftliche Bewertungsmethodik des Bundesverkehrswegeplan 2003, Bonn, Druckerei des BMVBW.								
Car	5.95	20=7.98	9.42	5.95	14=6.53	6.68	33.44	19=21.58	31.39
Train	5.95	40=6.46	10.14	5.95	39=5.53	7.12	23.88	80=20.05	30.01
Bus	5.95	10=3.89	8.31	5.95	15=3.56	6.14	25.72	41=13.62	28.50
Sweden	Original prices and incomes 2008. Trafikverket (2012) Samhällsekonomiska principer och kalkylvärden för transportsektorn: ASEK 5. Available at http://www.trafikverket.se/Foretag/Planera-och-utreda/Planerings--och-analysmetoder/Samhallsekonomisk-analys-och-trafikanalys/ASEK---arbetsgruppen-for-samhallsekonomiska-kalkyl--och-analysmetoder-inom-transportomradet/								
Car Long (>100)	12.12	125=12.92	9.65	12.12	200=11.87	6.79	30.41	200=38.52	32.35
Bus Long (>100)	3.97	125=7.86	8.21	3.97	229=7.47	6.27	30.41	229=24.24	29.42
Train Long (>100)	7.62	125=10.05	10.45	7.62	273=10.02	7.29	25.80	273=32.53	30.75

Air Long (>100)				18.08	658=21.15	17.05	30.41	658=68.62	46.86
Car Short (<100)	10.14	12=9.30	9.65	6.37	12=8.01	6.79	30.41	12=25.98	32.35
Bus Short (<100)	5.54	13=5.13	8.21	2.93	13=4.35	6.27	30.41	13=14.13	29.42
Train Short (<100)	7.52	34=7.87	10.45	5.22	34=6.77	7.29	25.80	34=21.99	30.75
Denmark	Original prices and incomes 2004. Fosgerau et al. (2007)								
Car	11.87	47=12.27	11.36	11.87	47=10.56	7.86			
PT (Bus/Train)	11.87	39=6.84/8.75	9.48/12.49	11.87	39= 5.8/7.53	7.35/8.56			
Switzerland	Original prices and incomes 2003 (Swiss Association of Road and Transportation Experts (2009) for Commuting and Leisure, and Axhausen et al. (2006) for business.								
Car	31.73	10=12.29	12.14	23.96	10=10.58	8.25	37.10	18=38.84	41.66
PT (Bus)	13.47	5=5.74	3.89	6.59	3=4.42	7.81	27.26	10=18.59	38.27
PT (Train)	20.57	22=9.71	13.77	31.03	78=10.60	9.04	45.58	48=32.70	38.59
United Kingdom	Original prices and incomes 1997 (Mackie et al., 2003)								
Car	6.53	15=7.11	7.42	5.84	14=6.06	5.54			

Note: All official values uplifted to 2010 income levels with an income elasticity of unity.

Table26 reports the differences, in absolute terms, between the meta and official values and the EIB and official values, split by journey purpose. Overall, the EIB 'forecasts' of official values are somewhat more accurate and the mean discrepancies are almost significantly different. However, this masks different performance across purposes . For business travel, the EIB values are far more accurate. This is presumably because the RAND model that underpins these values was based on explaining business valuations that were wage rate based, and official valuations adopt such an approach, whereas the meta model also contains business valuations from RP and SP sources.

For commuting and other trips, the meta model provides more accurate predictions of official values, although the improvement over the EIB values is slight and far from statistically significant.

Table 26: 'Predictive' Accuracy

	Commute	Business	Other	All
Meta	3.79:0.89:24	12.20:2.71:22	3.26:0.90:26	6.16:1.03:72
EIB	4.04:0.90:24	5.32:1.04:22	3.37:1.00:26	4.19:0.57:72

Note: Figures are mean, standard error and number of observations

6.2.2 Eastern European Values of Time

The values in Table 25 can be taken to represent the wealthier economies of Europe, and certainly those that have undertaken national value of time studies. However, considerable investment in transport projects is being undertaken in the emerging economies where there is far less value of time evidence and official guidance is sparse. It is important to test the comparative performance of the different models in this context, particularly since our meta-model and the current EIB methodology differ somewhat in income elasticities which is the key differentiator between the two sets of countries.

Table 27 contains the values in our data set for the emerging economies for countries. We have reported the estimated value, uplifted to 2010 incomes using an income elasticity of one, along with the EIB and meta values. The final column contains a term (WageVoT) which represents an estimate of the value of time based on labour costs. For business travel this term is set equal to the labour cost and for other purposes we set it to 33% of the labour cost as a reasonable approximation of the values of time for non-business and business travel. For the meta model, we enter the parameters that most closely represent each particular study and valuation.

We can readily observe that the estimated values almost always exceed WageVoT. Overall, the ratio of the estimated value and WageVot is 3.18 with a standard error of 0.32 for the 31 observations. This falls to 1.90 (0.24) for the 11 business valuations but is 3.89 (0.40) for the 20 non-business valuations. The valuations recovered for these countries appear to be too large.

It is therefore surprising that the EIB values exceed the estimated values, with a ratio of 1.76 across the 47 observations. This is quite alarming; indeed, the ratio of the EIB value and WageVoT is 2.77 (0.13) across the 29 available observations.

In contrast, the meta-analysis provides what we feel to be much more reasonable values of time. The ratio of the meta value and the estimated value is somewhat less than one, at a mean of 0.30 (0.03) for the 52 observations. This is a reassuring finding given that we suspect the estimated valuations to be too large. Indeed, the ratio of the meta values to WageVoT is 1.01 with a standard error of 0.06 for the 31 observations.

The absolute divergence between the meta values and WageVot is 1.12 (0.16). The corresponding figure for the EIB values is 6.59 (0.84). When focus just on non-business trips, on the grounds that business values can be based around the wage rate, as in the official values of wealthier countries, the divergence for the meta values falls to 0.54 (0.05) and is 3.18 for the EIB values.

The reason behind the large valuations could well be that they were generally obtained to support infrastructure investment for which higher values are more welcome.

Table 27: Eastern European Values

Country	Variable	Purpose	Mode	Km	Value 2010	Meta	EIB	WageVoT
Albania (2010)	IVT	No Dist	Car	25	2.59	1.08	4.20	-
	IVT	No Dist	Car	75	2.11	1.26	4.20	
Belarus (1995)	IVT	Leisure	Rail	200	2.25	1.92		-
Croatia (1996)	IVT	Business	Car	200	31.93	5.08	16.73	-
	IVT	Leisure	Car	200	16.35	3.11	4.63	
	IVT	Leisure	Car	200	10.06	3.11	4.63	
Latvia (2007)	Congested	No Dist	Car	50	4.99	2.60	-	1.88
	Free Flow	No Dist	Car	50	4.70	1.70	-	1.88
	Congested	Commute	Car	50	4.83	2.56	6.77	1.88
	Free Flow	Commute	Car	50	4.80	1.67	6.77	1.88
	Congested	Business	Car	50	6.03	3.54	18.79	5.70
	Free Flow	Business	Car	50	5.60	2.31	18.79	5.70
	Congested	Leisure	Car	50	5.30	2.20	5.59	1.88
	Free Flow	Leisure	Car	50	4.90	1.44	5.59	1.88
Moldova (1995)	IVT	Leisure	Rail	200	4.19	0.81	-	-
Poland (1998)	IVT	Leisure	Car	100	10.09	2.91	4.87	2.31
	IVT	Business	Car	100	12.97	4.72	18.59	7.00
	IVT	Leisure	Car	100	11.53	2.91	4.87	2.31
Poland (1996)	IVT	Business	Car	135	10.48	4.92	18.59	7.00
	IVT	Leisure	Car	135	5.90	3.04	4.87	2.31
	IVT	Leisure	Car	70	11.46	2.77	4.87	2.31

Poland (2004)	IVT	Leisure	Car	167	19.87	3.13	4.87	2.31
	IVT	Leisure	Car	167	16.18	3.13	4.87	2.31
	IVT	Business	Car	167	23.64	5.07	18.59	7.00
	IVT	Business	Car	167	22.14	5.07	18.59	7.00
	IVT	Leisure	Car	167	9.37	3.13	4.87	2.31
	IVT	Leisure	Car	167	11.35	3.13	4.87	2.31
Poland (1997)	IVT	Leisure	Car	65	5.81	2.74	4.87	2.31
	IVT	Commute	Car	30	8.66	2.86	6.23	2.31
Poland (1995)	IVT	Business	Car	90	8.58	4.65	18.59	7.00
	IVT	Leisure	Car	90	6.01	2.87	4.87	2.31
Poland (1999)	IVT	Business	Car	120	12.54	4.84	18.59	7.00
Poland (1999)	IVT	Business	Car	80	16.03	4.58	18.59	7.00
	IVT	Leisure	Car	80	14.62	2.82	4.87	2.31
Romania (2006)	IVT	Business	Car	10	6.14	2.16	17.54	4.20
	IVT	Business	Car	125	9.21	3.07	17.54	4.20
	IVT	Leisure	Car	10	2.19	1.38	5.37	1.39
	IVT	Leisure	Car	125	5.26	1.96	5.37	1.39
Russia (1995)	IVT	Leisure	Rail	500	5.05	3.41	6.71	-
	IVT	Leisure		1500	3.16	4.20	6.71	-
Serbia (2007)	Congested	Commute	Car	30	5.92	1.29	7.41	-
	Free Flow	Commute	Car	30	5.63	0.84	7.41	-
	Congested	Business	Car	200	5.06	2.21	19.62	-
	Free Flow	Business	Car	200	4.81	1.45	19.62	-
	Congested	Leisure	Car	200	4.64	1.44	6.30	-
	Free Flow	Leisure	Car	200	4.41	0.95	6.30	-
	Congested	Commute	Car	30	6.54	1.29	7.41	-
	Free Flow	Commute	Car	30	2.72	0.84	7.41	-
	Congested	Business	Car	200	2.32	2.21	19.62	-
	Free Flow	Business	Car	200	1.89	1.45	19.62	-
	Free Flow	Leisure	Car	200	2.28	0.95	6.30	-
Ukraine (1995)	IVT	Leisure	Rail	200	11.95	1.23	-	-

Note: All countries provide one study except for Poland where seven were identified. Labour costs from Eurostat and are Euro per hr.

6.2.3 Business Values and Labour Costs

Table 28 reproduces previous figures for business travel, both car and train, along with labour costs in the final column.

The ratio of the EIB business values to the labour costs are 1.85 (0.21) and 1.94 (0.25). Both these ratios are significantly different from one. In contrast, the ratios for the meta values, for the 25km

distance,[6] are 1.27 (0.06) and 1.21 (0.06) respectively. Although these too are significantly greater than unity, they are much closer than for the EIB figures.

Although the EIB business values tended to out-perform the meta business values for the countries we covered in the assessment against official values, this is not the case more generally with regard to business values replicating labour costs where the meta values provide a much closer approximation.

Table 28: Business Values and Labour Costs

Country	Car Business						Train Business						Wage
	RAND	S&deJ	5	25	100	250	RAND	S&deJ	5	25	100	250	
Albania	12.26	-	2.91	3.64	4.42	5.03	14.29	-	2.76	3.74	4.85	5.76	-
Austria	33.85	36.27	24.41	30.57	37.12	42.20	32.13	36.27	21.01	28.44	36.90	43.84	28.00
Belgium	32.33	35.07	23.46	29.39	35.68	40.56	30.89	35.07	20.23	27.38	35.53	42.22	38.20
Bosnia	12.31	-	3.39	4.25	5.16	5.86	14.19	-	3.20	4.33	5.61	6.67	-
Bulgaria	16.44	-	4.60	5.77	7.00	7.96	18.97	-	4.28	5.79	7.52	8.93	3.10
Croatia	16.73	-	8.90	11.15	13.53	15.39	18.24	-	8.02	10.86	14.09	16.74	-
Cyprus	22.64	28.36	16.64	20.85	25.31	28.77	22.92	28.36	14.58	19.73	25.61	30.42	16.20
Czech Republic	18.58	22.69	11.31	14.16	17.20	19.55	19.65	22.69	10.09	13.65	17.71	21.04	9.90
Denmark	38.69	39.98	29.21	36.60	44.44	50.52	36.21	39.98	24.95	33.76	43.81	52.05	37.60
Estonia	19.20	21.36	9.22	11.55	14.02	15.94	20.52	21.36	8.30	11.23	14.58	17.32	7.70
Finland	33.04	35.32	24.09	30.17	36.64	41.65	31.34	35.32	20.75	28.08	36.44	43.29	28.90
France	30.40	33.90	21.75	27.24	33.08	37.61	29.17	33.90	18.82	25.47	33.06	39.27	33.10
Germany	31.39	34.07	22.07	27.65	33.57	38.16	30.01	34.07	19.09	25.84	33.53	39.83	29.10
Greece	23.91	27.07	15.57	19.50	23.68	26.92	24.10	27.07	13.68	18.52	24.03	28.55	17.50
Hungary	22.30	20.48	8.40	10.52	12.78	14.53	23.47	20.48	7.60	10.28	13.34	15.85	7.30
Ireland	30.32	34.69	25.30	31.69	38.48	43.75	29.07	34.69	21.75	29.43	38.19	45.37	27.90
Italy	25.07	30.95	19.13	23.96	29.09	33.08	24.86	30.95	16.65	22.54	29.25	34.75	26.10
Latvia	18.79	23.59	7.19	9.01	10.94	12.44	21.31	23.59	6.55	8.87	11.51	13.67	5.70
Lithuania	16.28	20.54	7.32	9.17	11.14	12.66	18.31	20.54	6.66	9.02	11.70	13.90	5.30
Luxembourg	57.76	52.41	50.04	62.69	76.12	86.54	52.32	52.41	41.69	56.42	73.22	86.98	32.70
Macedonia	12.88	-	3.42	4.29	5.21	5.92	14.66	-	3.23	4.37	5.67	6.73	-
Malta	19.42	25.15	12.22	15.30	18.58	21.13	20.33	25.15	10.86	14.70	19.07	22.66	11.50
Netherlands	33.56	34.72	25.18	31.55	38.31	43.55	31.85	34.72	21.65	29.30	38.03	45.18	30.50
Norway	50.56	-	41.50	51.98	63.12	71.76	46.36	-	34.87	47.18	61.23	72.74	41.40
Poland	18.59	21.12	8.09	10.13	12.30	13.99	19.68	21.12	7.33	9.92	12.87	15.29	7.00
Portugal	20.75	23.68	13.00	16.28	19.77	22.48	21.15	23.68	11.52	15.59	20.23	24.03	12.00
Romania	17.54	-	5.34	6.69	8.13	9.24	20.23	-	4.93	6.68	8.66	10.29	4.2
Russia	24.35	-	7.04	8.82	10.71	12.18	27.57	-	6.42	8.69	11.28	13.39	-
Serbia	19.62	-	3.94	4.94	6.00	6.82	23.19	-	3.69	5.00	6.48	7.70	-
Slovakia	18.70	19.40	10.15	12.71	15.43	17.55	20.01	19.40	9.10	12.31	15.98	18.98	8.00
Slovenia	25.30	26.27	13.68	17.14	20.81	23.66	25.22	26.27	12.10	16.37	21.25	25.24	14.10
Spain	25.30	29.29	17.50	21.92	26.62	30.26	25.14	29.29	15.30	20.71	26.87	31.92	20.2
Sweden	32.35	37.18	26.10	32.70	39.70	45.14	30.75	37.18	22.40	30.32	39.35	46.74	36.00
Switzerland	41.66	41.90	34.27	42.93	52.13	59.26	38.59	41.90	29.05	39.31	51.02	60.61	-
Turkey	20.34	-	6.84	8.57	10.41	11.83	23.20	-	6.25	8.45	10.97	13.03	-
UK	23.39	34.30	20.19	25.29	30.71	34.91	23.54	34.30	17.53	23.73	30.79	36.58	20.00

[6] Table 25 does not imply large mean distances overall for business trips. The average trip length in Great Britain for business trips, which is not reported in Table 25, is around 30km

6.3 Implied Valuations of Non-IVT Attributes

Table 25 reports the implied valuations expressed in units of IVT. Since the distance elasticities for the time and OVT categories are similar, we observe little variation in the walk, wait, search, interchange wait, access and free flow values. Given the lower distance elasticity for the reliability variables, we observe more variation in the IVT equivalent values of late arrival, SDE, SDL and StdDev but it is not large. Headway and in particularly departure time shift values vary somewhat between urban and inter-urban journeys. Nor is there a great deal of variation by mode, only to the extent to which the value of car time and train time is different.

Whilst there is generally little variation in these multipliers by mode and distance, it should be borne in mind that official values, such as the common practice of weighting walk and wait time as twice IVT, specify no variation at all around the recommended figure.

Table 29: Valuations Relative to Car IVT

	CAR				BUS				TRAIN			
	2	25	100	250	2	25	100	250	2	25	100	250
Walk	1.48	1.70	1.83	1.92	1.43	1.44	1.44	1.45	1.56	1.57	1.58	1.58
Wait					1.43	1.44	1.45	1.45	1.56	1.58	1.58	1.59
Search	1.84	1.84	1.84	1.84								
IntWait					1.55	1.56	1.57	1.57	1.69	1.70	1.71	1.72
Access					1.57	1.58	1.59	1.59	1.71	1.73	1.73	1.74
Free Flow	0.65	0.65	0.65	0.65								
Headway					0.87	0.54	0.50	0.42	0.96	0.59	0.55	0.46
DepShiftEarly	0.44	0.30	0.98	0.86	0.42	0.26	0.77	0.65	0.46	0.28	0.85	0.71
DepShiftLate	0.57	0.39	1.27	1.12	0.55	0.34	1.01	0.84	0.66	0.37	1.10	0.92
Late	3.35	3.55	3.67	3.75	3.24	3.02	2.90	2.83	3.53	3.29	3.17	3.09
StdDev	0.67	0.71	0.73	0.75	0.65	0.60	0.58	0.56	0.70	0.66	0.63	0.62
SDE	0.81	0.86	0.89	0.91	0.78	0.73	0.70	0.68	0.86	0.80	0.77	0.75
SDL	1.71	1.81	1.87	1.91	1.65	1.54	1.48	1.44	1.80	1.68	1.61	1.57

7. CONCLUSIONS

This research has been conducted with a view to providing useful data for the economic appraisal of transport projects performed by the European Investment Bank.

It constitutes by some margin the largest meta-analysis, in terms of the number of valuation observations, yet conducted, based on 3109 monetary valuations from 389 studies covering 26 European countries between 1960 and 2011.

Whilst the main emphasis is on the value of IVT, and indeed this variable forms the majority of the data set, we have also covered valuations of walk time, wait time, parking space search time, waiting at interchange locations, access to public transport time, free flow time, congested time, headway, departure time shift, schedule delay early and late, the standard deviation of travel time and late arrival time.

A model has been developed to explain variations in values. This meta-model underpins our recommended values of time. It takes the form of equation 3 reported above:

$$VoIVT = e^{-10.060+0.150C+0.245EBTU-0.307BU+0.244AU-0.061TV+0.520AV} \times D^{0.188-0.048CV} GDP^{0.681+0.128EB+0.039CU} \quad (3)$$

This is expressed in **€ per minute** in 2010 incomes and prices. C denotes commuting, EB is employer's business, TU, BU, AU and CU are train user, bus user, air user and car user respectively, TV, CV and AV are train valued, car valued and air valued respectively whilst D is distance in kilometres, GDP is gross domestic product per capita (given in Appendix 3) and EBTU denotes employer's business for train users.

The valuations challenge those provided by the RAND Europe study conducted for EIB in 2004, generally providing smaller valuations but with a larger and more plausible spread by income and with the added feature of sensible variations according to distance.

The model also provides a number of important methodological insights, such as how valuations vary with data type, means of presentation, estimation method, choice context, the dimensions of Stated Preference exercises, the aim of the study, and the monetary numeraire in which the valuation is expressed, as well as establishing factors that had no effect, notable of which were estimation method, sample size and numerous interaction effects.

We also report a series of 'multipliers', which are valuations of attributes other than IVT expressed in IVT units, which are useful in supporting the appraisal of changes in a wide range of time attributes other than IVT. Indeed, we are able to distinguish between free flow and congested travel time

which is important for the appraisal of car IVT changes and removes the ambiguity surrounding what a car value of time actually represents.

We have conducted a number of 'tests' on the valuations of time implied by our meta model and as such we can recommend the use of the meta-analysis based valuations in project appraisal in the European context on the following grounds:

- The income elasticities in our model are more plausible than in the current EIB value of time models;

- We might expect to find a distance effect on the value of time; it is one of the most apparent findings of empirical studies and the distance elasticity here estimated seems reasonable. There is no distance effect in the EIB models ;

- We have compared our results and the EIB values against official recommendations for wealthier countries. The meta values perform slightly better for commuting and leisure trips than the EIB values in recovering official values;

- Whilst the EIB business values were largely calibrated to wage rate based values for wealthier countries, and this could be why they out-perform the meta-values in 'predicting' the official business values of time in such countries, it could then be argued that they are potentially less transferable to the emerging economies of Eastern Europe. Our analysis demonstrates that the business values from the meta-model provide a much closer approximation to labour costs across Europe than do the EIB values;

- With regard to the emerging economies of Eastern Europe and non-business values, we conclude that the values estimated by studies in such countries are too large when compared to the wage rate, and indeed the EIB values tend to exceed what we regard to be already high values. The meta-analysis based values not only seem more reasonable but they accord very well with values of non-business travel time that, at 33% of the wage rate, can be taken as representative of the empirical evidence and official practice.

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Appendix 1: Original Studies from which Valuations Extracted

Appendix 2: Exchange Rates Used

Mid June 2010 exchange rates have been used except where a currency became obsolete and then we converted that currency to the euro at the official rate that it replaced it.

Country	*1 euro equals*
Albania	Original in Euros
Austria	13.76 ATS
Belarus	Original in USD
Belgium	40.34 BEF
Croatia	7.23 NAV
Denmark	7.43 DKK
Finland	5.95 FIM
France	6.56 FRF
Germany	1.96 DEM
Greece	341 GRD
Irish Republic	0.79 IEP
Italy	1936 ITL
Latvia	0.71 LVL
Moldova	Original in USD
Netherlands	2.20 NLG
Norway	7.90 NOK
Poland	4 PLN
Portugal	200 PTE
Romania	4.25 RON
Russia	Original in USD
Serbia	100 RSD
Spain	166 ESP
Sweden	9.57 SEK
Switzerland	1.39 CHF
Ukraine	Original in USD
United Kingdom	0.88 GBP
United States	1.2 USD

Appendix 3: GDP per Capita (2010 Euros)

Country	GDP
Albania	3065
Austria	37674
Belgium	35954
Bosnia	3674
Bulgaria	5271
Croatia	11462
Cyprus	23983
Czech Republic	15204
Denmark	46576
Estonia	11954
Finland	37093
France	32883
Germany	33460
Greece	22166
Hungary	10710
Ireland	39309
Italy	28264
Latvia	8921
Lithuania	9111
Luxembourg	87865
Macedonia	3716
Malta	16659
Netherlands	39096
Poland	10244
Portugal	17921
Romania	6281
Serbia	4391
Slovak Republic	13384
Slovenia	19042
Spain	25451
Sweden	40780
Switzerland	56220
Turkey	8412
United Kingdom	30120

Source: World Bank Statistics