

12 September 2007

**The Benefits of Water Framework Directive
Programmes of Measures in England & Wales
APPENDICES M - N**

A Draft Final Report to DEFRA re CRP Project 4b/c/d

NERA
Economic Consulting

The Accent logo consists of a grey, curved, brushstroke-like shape above the word "Accent" in a bold, black, sans-serif font.

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Appendix M. Supplementary Analyses Tables

M.1. Payment Card Contingent Valuation Supplementary Tables

This section presents supplementary analysis of the PC CV responses. It includes tables showing sample mean and median PC CV willingness-to-pay responses by a range of variables in the dataset and a summary of the results from supplementary econometric analyses.

M.1.1. Descriptive Analysis of PC CV WTP Amounts

M.1.1.1. Sensitivity of PC CV WTP to Sample Formation

Table M.1 presents descriptive statistics on the WTP distribution for the four samples defined in the main report to examine the influence of alternative exclusion approaches.

Table M.1
Comparison of Summary Statistics on PC CV WTP Across Analysis Samples

Sample Name	N	Payment Card CV Willingness To Pay Statistics (£/hh/yr)						
		mean	sd	min	p25	p50	p75	max
<i>pref</i>	1389	49.50	52.99	0	15	30	60	300
<i>trim1</i>	1462	51.50	64.93	0	10	30	60	500
<i>trim3</i>	1299	48.68	45.96	0	20	30	60	200

Source: NERA

Table M.1 shows that the PC CV WTP mean is around £50 and the median is £30 for each sample.

M.1.1.2. Sensitivity of Payment Card CV WTP to Disposable Income Determinants

Table M.2 presents PC CV WTP amounts by income group.

Table M.2
Payment Card CV WTP by Total Weekly Household Income

Total Weekly Household Income	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Low (<£300)	38.6	20	419
Medium	58.6	50	463
High (>£1,000)	72.3	50	127
Missing Income Data	42.7	25.5	380

Source: NERA

As expected, payment card CV WTP increases with total weekly household income.

Table M.3
Payment Card CV WTP by Household Composition

Household Composition	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Adults without children			
One adult	46.7	25.0	365
Two adults	48.0	30.0	498
Three or more	53.5	40.0	150
Adults with children			
One adult			
One child	38.9	20.0	38
Two children	33.2	20.0	22
Three or more	62.0	20.0	9
Two adults			
One child	52.2	45.0	107
Two children	60.1	40.0	84
Three or more	40.7	40.0	41
Three or more adults			
One child	68.7	50.0	45
Two children	39.9	27.5	16
Three or more	72.7	30.0	11
N			1,386

Source: NERA

Table M.4
Payment Card CV WTP by Presence of Children in Household

Children	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Households without children	48.4	30	1013
Households with children	52.5	30	376

Source: NERA

Table M.5
Payment Card CV WTP for Single Parents and Others

Single Parents	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
No	50.0	30	1320
Yes	40.1	20	69

Source: NERA

Payment card CV WTP is approximately equal for those with children as for those without children on average in the sample. Single parent households have a lower amount than others, but the sample sizes are quite small for this group.

Table M.6
Payment Card CV WTP by Receipt of State Financial Support

Any Member of Household Receiving State Financial Support?	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
No	57.4	50	547
Yes	44.4	25	842

Source: NERA

Households receiving state financial support of some kind have a significantly lower payment card CV WTP on average, in comparison with all other households.

Table M.7
Payment Card CV WTP by Respondent's Employment Status (Full Version)

Employment Status	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Working full-time (31+ hours)	58.2	45	442
Working part-time (1-30 hours)	47.9	30	205
Self employed	61.3	50	60
Working and full time student	65.8	35	12
Not working - seeking work	36.9	25	63
Not working - full time student	71.4	55	14
Not working - retired	44.5	25	387
Not working - looking after home/children	43.7	30	90
Not working - permanently sick/disabled	37.7	20	64
Not working - other	36.9	20	50
Don't know	5.0	5	1
Refused	0.0	0	1

Source: NERA

Table M.8
Payment Card CV WTP by Respondent's Employment Status (Abbreviated Version)

Employment Status	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Working	55.5	40.0	707
Not working	42.4	25.0	654
Students	68.8	45.0	26
Other	2.5	2.5	2

Source: NERA

As expected, respondents that are working have a higher payment card CV WTP on average than those that are not working. Students have a higher still payment card CV WTP on average, but the sample size is small for this group.

Table M.9
Payment Card CV WTP by Respondent's Socio Economic Classification

Socio Economic Class	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Large Emp - Manag.	44.9	30.0	22
Higher professional occup.	63.1	50.0	128
Lower manag.	64.2	50.0	245
Intermediate occup.	53.8	37.5	170
Small employers - own account	47.6	37.5	90
Low supervisory / technical	46.5	30.0	138
Semi-routine	43.9	30.0	122
Routine occup.	43.9	25.0	200
Never worked / LT unemp.	32.1	20.0	129
Not classified	40.3	20.0	145

Source: NERA

The higher socio-economic classes tend to have higher payment card CV WTP amounts on average.

M.1.1.3. Sensitivity of CV WTP to Use of the Water Environment

Table M.10
Payment Card CV WTP by Household's Use of the Water Environment

Any Household use	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Contact activities			
Non user	42.6	25	772
User	58.2	50	617
Fishing			
Non user	48.2	30	1160
User	56.2	35	229
Other activities			
Non user	39.4	20	264
User	51.9	30	1125
Any use (Contact, fishing or other)			
Non user	36.3	20	215
User	51.9	30	1,174

Source: NERA

As expected, users of the water environment, whether for contact activities, fishing, or other activities, all tend to have a higher payment card CV WTP on average than non-users.

M.1.1.4. Sensitivity of Payment Card CV WTP to Environmental Attitudes

Table M.11 to Table M.13 present descriptive results on PC CV WTP by the environmental attitude measures from the survey questionnaire.

Table M.11
Payment Card CV WTP by Membership to an Environmental Organisation

Anyone in Household Member of an Environmental Organisation?	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
No	44.7	26	1,015
Yes	62.5	50	374

Source: NERA

Table M.12
Payment Card CV WTP by Opinion on National Spending on Water Pollution Control

	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Continue improvements regardless of cost	53.1	35	641
Continue improvements if not excessive cost	50.0	30	547
Already paying the right amount	33.4	20	95
Concentrate on holding down costs	47.6	20	59
Already paying too much	28.7	20	41
Don't Know	32.5	30	6

Source: NERA

Table M.13
Payment Card CV WTP by Opinion on Water Company Spending on Pollution Control

	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Too much	16.8	20	25
About right	47.1	30	455
Too little	52.5	30	732
Don't Know	47.9	30	177

Source: NERA

Environmental attitudes appear to work well as predictors of payment card CV WTP for all question types. Those that are members of environmental organisations, consider that environmental improvements should continue regardless of cost or if the cost is not excessive, or, believe that water company spending on pollution control is too little, have higher WTP on average than other respondents.

M.1.1.5. Variation in Payment Card CV WTP Amounts by Geographic Area

Table M.14
Payment Card CV WTP by RBD

RBD	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Anglian	55.8	50	100
Dee	61.3	30	69
Humber	38.1	25	286
North West	46.1	30	143
Northumbria	56.8	30	50
Severn	62.7	50	136
Solway Tweed	45.6	20	54
South East	45.9	30	75
South West	58.6	40	59
Thames	50.8	30	363
Western Wales	42.4	25	54

Source: NERA

Respondents in the Humber RBD provided the lowest payment card CV WTP amounts on average; those in the Severn and Dee RBDs gave the highest amounts. The small sample sizes for some RBDs and the associated lack of representativeness of the population means that the numbers should be considered as indicative estimates at best.

Table M.15
Payment Card CV WTP by Country

Country	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
England	49.1	30	1,267
Wales	53.3	30	122

Source: NERA

There is little difference in the payment card CV WTP amounts given by English and Welsh residents.

Table M.16
Payment Card CV WTP by Rural / Urban Area

Rural / Urban?	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Rural	50.5	30	302
Urban	49.2	30	1,087

Source: NERA

There is little difference between urban and rural areas in respect of mean and median payment card CV WTP amounts.

M.1.1.6. Sensitivity of Payment Card CV WTP to Respondent Characteristics or Reaction to the Instrument

Table M.17
Payment Card CV WTP by Respondent's Sex

Sex	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Male	56.3	40	591
Female	44.4	25	798

Source: NERA

Males have a significantly higher mean and median payment card CV WTP than females. Given that the sample contains a larger number of females than males, this suggests that WTP estimates for the population will need to be weighted by sex.

Table M.18
Payment Card CV WTP by Respondent's Age

Age	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
18 - 29	53.0	30	199
30 - 64	50.5	30	899
65 +	43.9	25	290

Source: NERA

Older respondents have a somewhat lower mean and median payment card CV WTP than younger respondents on average in the sample.

Table M.19
Payment Card CV WTP by Respondent's Level of Education

Level of Education	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Primary	30.50	20	234
O levels, GCSE or CSE (1+ passes), NVQ Level 1 or foundation level GNVQ	45.10	25	388
5+ O, CSE grade 1's or GCSE A-C; School certificate; 1+ A or As; NVQ level 2 or intermediate GNVQ	45.40	30	177
2+ A levels; 4+ As; Higher School Certificate; NVQ Level 3; or Advanced GNVQ	59.20	50	161
First Degree, Higher degree, NVQ Level 4/5; HNC; HND; Qualified teacher status; Qualified medical doctor, dentist; nurse; midwife; health visitor	66.50	50	376
Other / Don't know	28.50	20	38
Refused	29.00	20	15

Source: NERA

Respondent's level of education has a significant effect on payment card CV WTP amounts, with the more educated giving larger values on average.

Table M.20
Payment Card CV WTP by Respondent's Understanding of the Questionnaire

	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Understood completely	54.5	40	844
Understood a great deal	45.7	30	355
Understood somewhat	33.7	20	131
Understood a little	35.1	20	36
Did not understand very much	15.5	10	11
Did not understand at all	57.1	20	7
Other	20.0	20	2
Missing	73.3	80.0	3

Source: NERA

Respondents who understood the questionnaire completely, or a great deal, gave higher values than other respondents.

Table M.21
Payment Card CV WTP by Respondent's Effort in Answering the Questionnaire

Respondent effort	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Gave questions careful consideration	53.2	35	1,031
Gave questions some consideration	38.6	20	320
Gave the question very little consideration	32.9	20	29
Other	61.7	25	6
Missing	73.3	80.0	3

Source: NERA

Respondents who gave the questionnaire careful consideration gave higher values than other respondents.

Table M.22
Payment Card CV WTP by Respondent's Level of Fatigue

	Mean WTP	Median WTP	N
Maintained concentration throughout	51.4	30	1,212
Lessened concentration in later stages	36.2	20	165
Other	32.8	20	9
Missing	73.3	80.0	3

Source: NERA

Respondents who maintained concentration throughout gave higher values than other respondents.

Table M.23
Payment Card CV WTP by Respondent's Reaction to the Local Water Environment Quality Map

Local Map vs Expected Status	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Great deal better	50.4	30.0	52
Somewhat better	57.8	32.5	142
As expected	46.8	30.0	408
Somewhat worse	49.5	30.0	428
Great deal worse	49.8	30.0	347
Don't know	28.8	22.5	12

Source: NERA

Table M.24
Payment Card CV WTP by Respondent's Reaction to the National Water Environment Quality Map

National Map vs Expected Status	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Great deal better	54.0	20.0	17
Somewhat better	41.4	30.0	93
As expected	49.0	30.0	483
Somewhat worse	50.4	30.0	490
Great deal worse	51.3	40.0	291
Don't know	48.0	30.0	15

Source: NERA

There appears to be no effect on payment card CV WTP with respect to differences between the water environment quality map and respondents expectations.

M.1.1.7. Sensitivities of CV WTP to SP Instrument Design Features

Table M.25
Payment Card CV WTP by Ordering of CE and CV Questions

Order of CE and CV Questions	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
CE then CV	56.1	40	708
CV then CE	42.7	20	681

Source: NERA

Respondents who received the payment card CV question first gave lower payment card CV WTP values than respondents who had first answered the CE questions.

Table M.26
Payment Card CV WTP by No Deterioration Cost Amount

Cost of Maintaining Current Water Environment Quality	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
£5	49.7	30	470
£10	46.9	30	447
£20	51.8	30	472

Source: NERA

The size of the no deterioration cost amount appears to have no consistent effect on payment card CV WTP values.

Table M.27
Payment Card CV WTP by Waterbody Type Example Used

Waterbody Type Example Used	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
Lake	49.5	30.0	346
Rural river	47.8	27.5	358
Transitional / Coastal	51.2	30.0	340
Urban river	49.6	30.0	345

Source: NERA

The water body type example used in the survey show material appears to have little or no effect on payment card CV WTP values.

Table M.28 presents PC CV WTP amounts by the degree of environmental improvement contained in the scenario put to respondents.

Table M.28
Payment Card CV WTP by Environmental Improvement Scenario

Environmental Improvement Scenario	Mean WTP (£/hh/yr)	Median WTP (£/hh/yr)	Sample Size (Freq)
75% good status in 2015	48.6	30	706
95% good status in 2015	50.4	30	683

Source: NERA

Table M.28 suggests that respondents' PC CV WTP amounts are not sensitive to the amount of improvement offered to them in the PC CV scenario. However, because there several versions of the survey, and with any type of field randomization of the versions it is inevitable that one obtains different numbers of completed interviews for each version, it is necessary to look for sensitivity using a formal statistical model that incorporates the experimental design. The multivariate analysis included in this report has shown that willingness to pay responses did display the expected sensitivity to scope of environmental improvement offered.

M.1.2. Econometric Analysis of PC CV WTP Amounts

In this sub-section we report on our econometric analysis of payment card CV WTP amounts. This analysis seeks to 'explain' WTP by fitting regression models.

In building a model to explain the payment card willingness to pay, we identify eight different groups of variables which can have a significant impact on willingness to pay:

- § Environmental changes (level of high quality / low quality, at the national and local level);
- § Disposable income (income, adjusted for household composition);
- § Use of the environment (contact activities, fishing, etc...);
- § Attitudes towards the environment (opinion on pollution control, membership to an environmental club, spending priorities, reactions to the maps, most important wfd benefit...);
- § Other demographics, e.g. sex, age, education, sec;
- § Geography - RBD, Country, urban/rural;
- § Survey instrument features: ordering of the questionnaire, water body type example;
- § Comprehension of questionnaire: e.g. understanding, concentration, fatigue.

Our strategy is to first estimate a model using the variables which appear to have the most impact when looking at univariate descriptive statistics, and then test different specifications for each of the eight groups identified above.

Our first step, however, is to choose the best specification between a “linear” specification, where our dependent variable is the final *wtp*, and a “log-linear” specification, where the dependent variable is $\ln(I + wtp)$.

M.1.2.1. Initial Model Specification: Linear Versus Log-Linear

Our first model explains the payment card willingness to pay (either as stated by respondents or transformed using the natural logarithm) as a function of:

- § The change in the level of High Quality for the local area (*delta_hl*);
- § Income as a continuous variable (as well as a dummy variable to capture an effect for respondents who did not answer to the income question);
- § Use/non use activities (contact activities, fishing, or other activities)
- § Attitude to pollution control and membership to an environmental club;
- § Sex and education (primary, level 1/2, level 3/5);
- § RBD;
- § Order of the questionnaire (*cv_first*); and
- § Level of understanding of the questionnaire.

To choose the best specification between a linear specification (dependent variable = final *wtp*), and a “log-linear” specification (dependent variable = $\ln(I + wtp)$), we compare results from our first model, using three different sample specifications. More precisely, we look at the R^2 and at the distribution of fitted willingness to pay.

As explanatory variables are different in the linear and the log-linear model, we construct an R^2 for the log-linear model which is directly comparable to the R^2 reported in the linear specification. The calculation of a comparable R^2 is needed because the dependent variable is different for the two models. The calculation was performed as follows:

1. Regress **Error! Objects cannot be created from editing field codes.** on different explanatory variables
2. Predict **Error! Objects cannot be created from editing field codes.** using the model in step 1: **Error! Objects cannot be created from editing field codes.**
3. Compute the residuals e_i
4. Generate the adjustment factor for the prediction of $(1+wtp)$: **Error! Objects cannot be created from editing field codes.**
5. Predict wtp: **Error! Objects cannot be created from editing field codes.**
6. Compute average wtp: wtp_bar
7. Compute comparable R^2 = **Error! Objects cannot be created from editing field codes.**

Table M.29 below presents our first model estimated in “linear” and “log-linear form”.

Table M.29
PC CV OLS Regression Results: Initial Model – Linear and Log-Linear
Specifications

	Linear Model	M1 - Log -linear - Sample: pref
<i>delta_hl</i>	8.400 (12.27)	0.232 (0.31)
<i>income_cont</i>	0.014 (0.00)**	0.000 (0.00)**
<i>income_miss</i>	1.056 (3.33)	0.064 (0.09)
<i>use</i>	5.964 (3.23)*	0.254 (0.10)**
<i>pollution control?</i>	9.363 (3.42)**	0.427 (0.11)**
<i>Member of club?</i>	7.343 (3.37)**	0.152 (0.07)**
<i>sex</i>	-10.908 (2.79)**	-0.185 (0.07)**
<i>edu_12</i>	9.889 (2.89)**	0.213 (0.10)**
<i>edu_35</i>	21.815 (3.73)**	0.532 (0.10)**
<i>rbd==Anglian</i>	16.062 (5.29)**	0.342 (0.14)**
<i>rbd==Dee</i>	18.526 (7.19)**	0.379 (0.15)**
<i>rbd==North West</i>	10.174 (4.57)**	0.210 (0.13)
<i>rbd==Northumbria</i>	21.729 (10.45)**	0.290 (0.22)
<i>rbd==Severn</i>	19.891 (5.50)**	0.344 (0.12)**
<i>rbd==Solway Tweed</i>	11.789 (8.62)	-0.046 (0.22)
<i>rbd==South East</i>	-2.343 (5.18)	0.079 (0.14)
<i>rbd==South West</i>	12.126 (7.81)	0.276 (0.16)*
<i>rbd==Thames</i>	5.318 (3.50)	0.067 (0.10)
<i>rbd==Western Wales</i>	5.297 (7.14)	-0.268 (0.26)
<i>cv_first</i>	-12.959 (2.68)**	-0.395 (0.07)**
<i>understood</i>	4.850 (3.46)	0.303 (0.12)**
<i>Constant</i>	10.343 (11.11)	1.961 (0.30)**
Observations	1389	1389
R^2	0.132	0.167
Comparable R^2		0.395

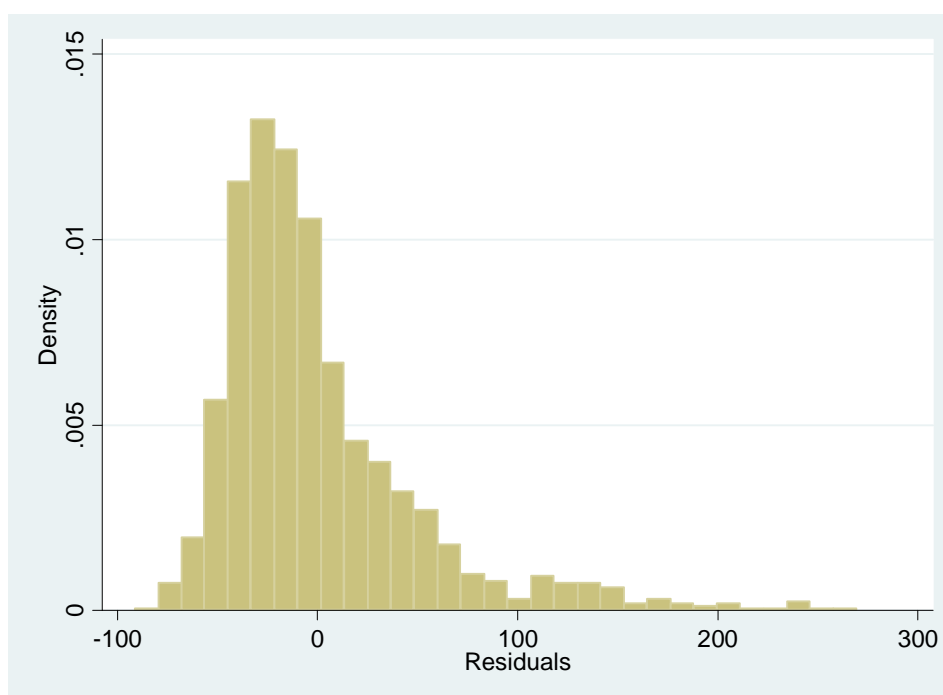
*Source: NERA; Standard errors in parentheses; * 2-sided $p < 0.10$, ** 2-sided $p < 0.05$; sample used is pref for both models; the dependent variable in the linear model is wtp_final; in the log linear model it is ln_wtp*
Note: in certain cases 1-sided p-values would be more appropriate, eg for delta_hl, given the alternative hypothesis is that the coefficient is greater than zero, rather than not equal to zero. A 1-sided p-value will be lower than a 2-sided p-value thus leading to a greater likelihood of rejecting the null hypothesis that the coefficient is equal to zero.

Table M.30
Distribution of Fitted WTP from Initial Model, and Sample WTP

Model	N	mean	sd	min	p25	p50	p75	max
Linear	1389	49.5	19.3	-0.1	36.1	48.8	62.0	116.2
Log-linear	1389	54.4	33.0	7.6	32.4	47.3	67.5	295.9
Sample WTP	1389	49.5	53.0	0	15	30	60	300

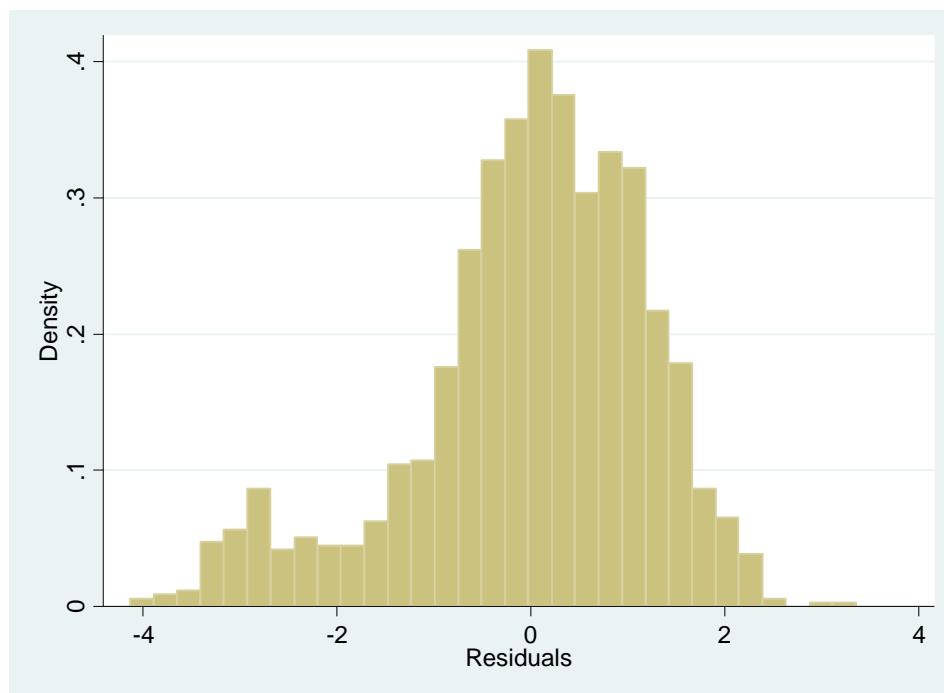
Source: NERA

Figure M.1
Distribution of Residuals from Linear Model



Source: NERA

Figure M.2
Distribution of Residuals from Log-Linear Model



Source: NERA

The log-linear specification fits the data significantly better than the linear specification as evidenced through a higher R^2 statistic. The residuals from the log-linear model depart from normality somewhat, with a cluster of residuals at the lower end of the distribution. These correspond to the large spike of responses at £0 WTP.

M.2. Aggregation Tables

Table M.31
PCCV WTP Aggregation to 95% Scenario

Variable	Coefficient	Population Value (Low Income)			Pop Value (Med Income)			Population Value (High Income)			Pop Value (All Incomes)		
		England	Wales	E&W	England	Wales	E&W	England	Wales	E&W	England	Wales	E&W
<i>ln_delta_hl</i>	0.822	0.586	0.476	0.576	0.586	0.476	0.576	0.586	0.476	0.576	0.586	0.476	0.576
<i>ln_inc</i>	0.26	5.324	5.324	5.324	6.225	6.225	6.225	7.601	7.601	7.601	6.479	6.366	6.474
<i>income_miss</i>	1.4	0	0	0	0	0	0	0	0	0	0	0	0
<i>children</i>	0.127	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305
<i>use</i>	0.257	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.839
<i>pol_control</i>	0.439	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855
<i>sex</i>	-0.187	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<i>edu_12</i>	0.155	0.36	0.353	0.359	0.36	0.353	0.359	0.36	0.353	0.359	0.36	0.353	0.359
<i>edu_35</i>	0.5	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349
<i>wales</i>	0.038	0	1	0.0553	0	1	0.0553	0	1	0.0553	0	1	0.0553
<i>cv_first</i>	-0.408	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<i>understood</i>	0.271	1	1	1	1	1	1	1	1	1	1	1	1
<i>Constant</i>	0.531	1	1	1	1	1	1	1	1	1	1	1	1
<i>SUM</i>													
<i>Exp(SUM) = median</i>		3.53	3.43	3.52	3.23	3.16	3.22	3.47	3.40	3.46	3.82	3.75	3.82
<i>Sample median</i>		34.20	30.94	33.90	25.33	23.60	25.14	32.01	29.83	31.77	45.78	42.66	45.44
<i>Sample median (cv_first)</i>		30	32.5	30	20	20	20	50	50	50	50	60	50
<i>Mean(exp(u))</i>	1.767	25.00	20.00	25.00	20.00	20.00	20.00	30.00	32.50	30.00	50.00	50.00	50.00
<i>Sample mean</i>		60.43	54.67	59.90	44.75	41.70	44.42	56.56	52.70	56.14	80.90	75.38	80.30
<i>Sample mean (cv_first)</i>		51.51	56.71	52.06	38.03	42.98	38.64	57.91	65.81	58.64	71.30	81.54	72.35

Source: NERA

Table M.32
DCCV Model Aggregation to 95% Scenario

Variable	Coefficient	Pop value (low income)			Pop value (med income)			Pop value (high income)			Pop value all incomes)		
		England	Wales	E&W	England	Wales	E&W	England	Wales	E&W	England	Wales	E&W
dc_bill ¹	-1.238												
ln_inc	0.398	5.324	5.324	5.324	6.225	6.225	6.225	7.601	7.601	7.601	6.479	6.366	6.474
income_miss	2.009	0	0	0	0	0	0	0	0	0	0	0	0
Continue improvements for pollution control?	0.501	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855	0.855
Member of club?	0.42	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270
edu_35	0.434	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349
cvfirst_dcposition_0_1	0.57	0	0	0	0	0	0	0	0	0	0	0	0
Maintained concentration	0.566	1	1	1	1	1	1	1	1	1	1	1	1
Constant	-1.656	1	1	1	1	1	1	1	1	1	1	1	1
Mean WTP		130.0	128.8	129.9	159.0	157.8	158.9	203.2	202.0	203.1	167.1	162.3	166.9
Median WTP (=mean)		130.0	128.8	129.9	159.0	157.8	158.9	203.2	202.0	203.1	167.1	162.3	166.9

Source: NERA

Table M.33
CE Fixed Coef Linear Model Aggregation to 95% Scenario

Variable	Coefficient	Pop value (low income)			Pop value (med income)			Pop value (high income)			Pop value all incomes)		
		England	Wales	E&W	England	Wales	E&W	England	Wales	E&W	England	Wales	E&W
hl8	0.85	0.865	0.738	0.854	0.865	0.738	0.854	0.865	0.738	0.854	0.865	0.738	0.854
ll8	-0.74	-0.601	-0.259	-0.571	-0.601	-0.259	-0.571	-0.601	-0.259	-0.571	-0.601	-0.259	-0.571
hn8	1.06	0.800	0.8	0.8	0.800	0.8	0.8	0.800	0.8	0.8	0.800	0.8	0.8
ln8	-0.84	-0.440	-0.44	-0.44	-0.440	-0.44	-0.44	-0.440	-0.44	-0.44	-0.440	-0.44	-0.44
hn20	0.73	0.800	0.8	0.8	0.800	0.8	0.8	0.800	0.8	0.8	0.800	0.8	0.8
bill	-1.62	1	1	1	1	1	1	1	1	1	1	1	1
inc_highmed_bill	0.31	0	0	0	1	1	1	1	1	1	0.160	0.120	0.158
male_bill	0.19	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
edu35_bill	0.39	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349
wales_bill	0.57	0	1	0.038	0	1	0.038	0	1	0.038	0	1	0.038
Mean WTP		215.1	316.5	216.1	275.8	501.0	278.2	275.8	501.0	278.2	223.0	331.2	224.0
Median WTP		215.1	316.5	216.1	275.8	501.0	278.2	275.8	501.0	278.2	223.0	331.2	224.0

Source: NERA

Table M.34
CE Non-Linear Model Aggregation to 95% Scenario

Variable	Coefficient	Pop value (low income)			Pop value (med income)			Pop value (high income)			Pop value all incomes)		
		England	Wales	E&W	England	Wales	E&W	England	Wales	E&W	England	Wales	E&W
ln_hl8	1.27	0.586	0.476	0.576	0.586	0.476	0.576	0.586	0.476	0.576	0.586	0.476	0.576
ln_ll8	-0.86	-0.470	-0.231	-0.452	-0.470	-0.231	-0.452	-0.470	-0.231	-0.452	-0.470	-0.231	-0.452
ln_hn8	1.56	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528
ln_ln8	-0.98	-0.365	-0.365	-0.365	-0.365	-0.365	-0.365	-0.365	-0.365	-0.365	-0.365	-0.365	-0.365
ln_hn20	1.05	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528	0.528
bill	-1.62	1	1	1	1	1	1	1	1	1	1	1	1
inc_highmed_bill	0.31	0	0	0	1	1	1	1	1	1	0.160	0.120	0.158
male_bill	0.19	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
edu35_bill	0.39	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349	0.351	0.317	0.349
wales_bill	0.57	0	1	0.038	0	1	0.038	0	1	0.038	0	1	0.038
Mean WTP		208.1	305.4	209.1	267.2	484.4	269.7	267.2	484.4	269.7	215.7	319.6	216.8
Median WTP		208.1	305.4	209.1	267.2	484.4	269.7	267.2	484.4	269.7	215.7	319.6	216.8

Source: NERA

Appendix N. Comparator Benefit Valuation Studies

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
Eftec (2002) "Valuation of Benefits to England and Wales of a Revised Bathing Water Quality Directive and Other Beach Characteristics Using Choice Experiment Methodology."	CE	809 respondents from England and Wales	Determine WTP for changes in water quality and other beach attributes likely to arise from a revised EC Bathing Water Directive			
Carson, R.T. and R.C. Mitchell (1993), "The Value of Clean Water: The Public's Willingness to Pay for Boatable, Fishable and Swimmable Quality Water," Water Resources Research 29(7) 2445-2454	CV	National probability sample using cluster sampling (cluster n = 61). Response rate of 79%. A total of 813 households, 70% of which yield reliable data.	Determine WTP for improvements to water quality in a variety of water body types.	Total (Boatable to Swimmable) \$242	Total (Boatable to Swimmable) \$24 to \$40 billion, mean of \$29.2 billion (1990 dollars)	
Huber, Joel and W. Kip Viscuzi (2006) Economics of Environmental Improvement, Report to the EPA, USA.	CE	A total of 4,257 respondents interviewed in six waves from October 2002 to October 2004. Use of Knowledge Networks panel. Average completion rate of 75%.	Estimate the benefits of improvements to inland surface water.	Each 1% improvement in national water quality had a mean value of \$39 and a median value of \$20.		Regional valuations were made on an iterative basis and national evaluations followed this format using referenda questions.
Bateman, et al (2006) "Does Phosphate Treatment for Prevention of Eutrophication Pass the Benefit Cost Test?", CERGE Working Paper EDM 06-13	CV	1,254 households in and around Norwich	Determine WTP to reduce the impact of eutrophication.	Users mean £75.41 and median £69.07	£169.89 million	

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
Andrews, K. et al, (1999) "Potential Costs and Benefits of Implementing the Proposed Water Resources Framework Directive," Report No: DETR 4477/5	NA	"Top-down" aggregate data using a methodology developed and reported in the Foundation for Water Research's manual (1996)	Construct a cost benefit analysis of the WFD.		Benefit assuming the smallest gap (that is least improvement) £1,643 million, largest gap £6,165.	
NVA 2003 Joint National Research	Likelihood of WTP	Customer research with a representative sample of 6,000 bill payers.	Develop research on the priorities for the water industry and what services and improvements would best suit customer needs.	Company preferred plans for improved services varied - minimums and maximums offered.	Majority of customers (46% probably and 14% definitely) were willing to pay for the company preferred plan.	
Eggert and Olsson (2006) - Heterogeneous preferences for marine amenities: A choice experiment applied to water quality	CE	800 individuals 18-65 years from the Swedish Register of Inhabitants. Swedish west coast Skagerak and Kattegatt.	Estimate the benefits of improving coastal water quality with respect to fishing possibilities, bathing water quality and biodiversity levels.	WTP mean values: Lower BioDiversity - SEK 1400 (\$209.14) Improve Fish Stock - SEK1200 (\$179.26) Water Quality - SEK 600 (\$89.63) Higher BioDiversity - SEK 600 (\$89.63)		High levels of environmental concern and that substantial values are at stake. The most urgent action is firstly to prevent further depletion of marine biodiversity and secondly to improve cod stocks. Improved water quality and improved marine biodiversity are also important.
Jones, Bateman, Wright (2003) - Estimating arrival numbers and values for informal recreational use of British Woodlands	Meta-analysis of CV, ITCols, ITCml, TC, and ZTC methods	Numerous studies, varied sample sizes	Estimate transferable monetary assessments of the value of woodland visits through a meta-analysis of previous valuation	1.24£/person/visit		Willis et al dominates meta analysis ZTC method substantially higher results

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
			studies.			
Hanley, Wright, Alvarez-Farizo (2005) - Estimating the economic value of improvements in river ecology using choice experiments: an application to the water framework directive	CE, Benefits tranfer experiment	210 responses from each. River Wear, in County Durham, England and River Clyde, in Central Scotland.	Estimate the value of improvements in three components of ecological status: healthy wilflife and plant populations, absence of litter/debris in the river, and river banks in good condition with only natural levels of erosion	benefits transfer experiment failed prices varied between two rivers RP Logit Approach, Ecology - Aesthetics - Banksides River Clyde -38.7, 28.57,42.99 respectively River Wear - 12.19,12.07,12.67 respectively Both Rivers - 20.17,16.91,21.53 respectively	No aggregate benefits transfer could be assessed	
Hanley, Bell, Alvarez-Farizo (2002) - Valuing the Benefits of Coastal water Quality Improvement Using Contingent and Real Behaviour				All figures in pounds		

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
Georgiou, Bateman, Cole, Hadley (2000)	CV, Contingent Ranking	675 sample of local residents in the Birmingham area (346 Type T, 329 Type B)		£3-5 per household per annum for a unit increase in RFF water quality scale Contingent Ranking produced higher results; Contingent Valuation may have been biased downwards as a result of the existence of incentives for respondents to understate their true WTP Distance Decay: 36 miles for large improvement, 17 miles for smallest Scope Insensitivity: Mixed Ordering Effect: Some, but not significant - ordering may be factor in scop sensitivity		23% unable to respond to open-ended CV while <2% unable to give a ranking response
Azevedo et al. (2003) - Iowa LakesValuation Project: Summary and Findings from Year 1	CE	8000 Iowa residents, 4423 were returned	Provide estimates of the value that Iowans place on their water resources.	Data on visits to water resources, Preference for improvements, No WTP values		
Egan et al. (2004) - Recreation Demand Using Physical Measures of Water Quality	CV	8000 Iowa residents, 4423 were returned	Incorporate rich set of physical water quality attributes, as well as site and household characteristics, into a model of recreational lake usage in Iowa	Average CV: 1) all 128 lakes improved 2) 9 zone lakes improved 3) 65 impaired lakes improved Per choice occasion \$4.01 \$0.76 \$0.09 Per Iowa household \$208.68 \$39.71 \$4.87	Average CV: 1) all 128 lakes improved 2) 9 zone lakes improved 3) 65 impaired lakes improved For all Iowa households \$240,649,000 \$45,788,092	

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
					\$5,612,219	
Adamowicz et al (1995) - Estimating the passive benefits of Britain's Inland Waterways	CV	758 households across GB	Measure the overall value of canals	Value of "maintenance" to canals: strategic responses removed - £6.78 mean all respondents - £6.66 mean		
Fisher et al (2002) - The Environmental Benefits of the Environmental Programme in the Periodic Review of the Water Industry (PR04)	see table printout					

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
McLlelland et al. (1992) - METHODS FOR MEASURING NON-USE VALUES: A CONTINGENT VALUATION STUDY OF GROUNDWATER CLEANUP	CV	National mailing of 5000 households	This study constitutes the third in a series of studies conducted for the USEPA exploring the use of the contingent valuation method (CVM) for valuing environmental benefits. The CVM is the only methodology now available for measuring non-use benefits which likely comprise a large portion of values for environmental commodities. The measurement of the total benefits (including use, altruistic, bequest and existence values) of cleaning up contaminated groundwater	Mean WTP - Full Sample, Regression Sample, Box-Cox - Monthly water bill increased every month for the next ten years (US Dollars). Complete Cleanup - 11.58, 11.70, 7.01 Containment - 5.96, 6.38, 3.95 Public Treatment - 7.98, 7.18, 4.02 National - no context 2.67, 2.98, 1.34 National - context - 2.03, 2.15, 1.13 Ten % Shortfall - 6.98, 7.38, 3.86 Seventy % Shortfall - 21.95, 22.99, 13.34		The initial value question in each version of the survey is the individual's willingness to pay for complete cleanup of a hypothetical groundwater contamination from a leaking landfill leading to a potential 50% shortage in domestic water supply

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
DEFRA (2004) - Valuation of health benefits associated with reductions in air pollution	CE	665 interviews (England, Scotland, Wales)	To generate empirical estimates of how much people in the UK are willing to pay for reductions in the health risks associated with air pollution	<p>Extra mths in Normal Health (1/3/6) - 60.15, 67.72, 80.87</p> <p>Extra mths in Poor Health (1/3/6) - 15.86, 11.53, 17.31</p> <p>Avoiding Hospital Admission - 36.49, 35.34, 35.15</p> <p>Avoiding Breathing Discomfort - 40.17, 31.31, 33.52</p> <p>£ per year per household Trimmed Means - 4 responses top/bottom removed from each subsample</p>	<p>Value of a person-year in normal health (1-3-6) - £27,630 - 9,430 - 6,040 - argument made that single day should be applied in policy</p> <p>Value of a person-year in poor health (1-6) - £14,280 - 7,280</p> <p>Value of preventing respiratory hospital admission - £1,310 - 7,110</p> <p>Value of preventing 2-3 days of breathing discomfort - £1,280 - 5,580</p>	

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
Willis et al. (2003) - The Social and Environmental Benefits of Forest in Great Britain	CV	Used previous study of 15,000 recreational visits to 42 forests in Scotland and Ireland. Conducted new survey of English and Welsh forests using landscape study of over 400 residents across England Scotland and Wales.	Provide estimates of each of these social and environmental benefits in terms of -marginal values, as an input into forest management, and -their total value across forests and woodlands in Great Britain, to assess the importance of woodlands to the British economy.	Marginal Benefits of Woodland: £1.66 to £2.75 for each recreational visit • £269 per annum per household, for those households with a woodland landscape view on the urban fringe • 35p per household per year for enhanced biodiversity in each 12,000 ha (1%) of commercial Sitka spruce forest; 84p per household/year for a 12,000 ha increase in Lowland New Broadleaved Native forest, and £1.13 per household/year for a similar increase in Ancient Semi Natural Woodland • £6.67 per tonne of carbon sequestered • £124,998 for each death avoided by 1 year due to PM10 and SO2 absorbed by trees, and £602 for an 11 day hospital stay avoided due to reduced respiratory illness • A cost of 13p to £1.24 per	Annual and capitalised social and environmental benefits of forests in GB (£ millions, 2002 prices) Environmental benefit Annual value Capitalised value Recreation 392.65 11,218 Landscape 150.22 4,292 Biodiversity 386.00 11,029 Carbon sequestration 93.66 * 2,676 Air pollution absorption 0.39 * 11 Total 1,022.92 29,226	* An approximation, since carbon sequestration, and probability of death and illness due to air pollution, varies over time. More carbon is sequestered in early rotations than in later rotations, resulting in an annuity stream that is inconsistent over multiple rotations. Similarly for air pollution, that results in an individual's life being shortened by a few days or weeks at the end of the individual's life at some point in the future.

Reference	Stated Preference Method	Sample	Context for Study	Results (Individual Level)	Results (Aggregate)	Notes
				m3 where water is lost to abstraction for potable uses, although for most areas the marginal cost is zero. The externality cost of woodland on water quality has been 'internalised' within forestry through the application of guidelines on woodland planting and conditions attached to forest certification.		
Li et al. (2004) - Using Choice Experiments to Value the Natura 2000 Nature Conservation Programs in Finland	CE, CV	4000 Finns, aged 18 to 70, randomly selected from the census register (2400 binary choice contingent valuation, 1600 with a choice experiment).	Estimate the values that the Finnish households would place on different preservation levels.	Preservation Area willingness - per person per year Mean WTP (willingness to pay for an increase) = 782 FIM (\$181.42) Mean WTA (willingness to accept for a decrease)= 3422 FIM (\$793.9)		

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