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BENEFITS TRANSFER AND THE ECONOMIC VALUATION OF ENVIRONMENTAL DAMAGE IN THE EUROPEAN UNION: WITH SPECIAL REFERENCE TO HEALTH

SUMMARY FINAL REPORT

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I. OBJECTIVES

The core of the research programme carried out in this project has sought to provide estimates of the costs to individuals of suffering episodes of ill-health resulting from exposure to environmental pollutants. Following economic theory our measure of this cost, is an **individual's willingness to pay (WTP) to avoid an episode of ill-health**. WTP has been elicited through the use of a large scale contingent valuation survey carried out in five countries in the EU (namely the Netherlands, Norway, Portugal, Spain and the UK).

Values from this research provide the raw material for the second major axis of the research programme; an investigation into the **reliability of Benefits Transfer**. If figures derived in one study can be used in the decision-making process in different countries within the EU and across different policy contexts, then this greatly reduces the requirements for expensive and time consuming primary data collection. Consequently, the second key objective of the research programme was to test the reliability of transferring values across national boundaries and across policy contexts.

The costs of morbidity impacts of environmental pollution are not confined to individuals' WTP to pay to avoid episodes of ill-health. A more complete characterisation of the costs of an episode of ill-health would also include the costs to the economy at large, accounting for lost economic productivity and health service resource costs; the so-called **Costs of Illness (COI)**. The research programme sought to provide indications of the scale of these costs. Further, epidemiological evidence suggests that air pollution will also have mortality impacts. One measure of the cost of mortality is the **Value of a Statistical Life (VOSL)**. Since the literature abounds with estimates of the VOSL statistical techniques have been employed to summarise this literature and provide a best estimate of the VOSL that might be more reliably used to value the mortality impacts of environmental pollution.

The fundamental motivation for providing reliable values for the costs of ill-health is to improve the quality of project assessment using cost-benefit analysis. Cost-benefit approaches to environmental policy focus on the gains and losses of *economic efficiency* as measured by willingness to pay. Efficiency is a critically important feature of policy since inefficiency effectively means wasting resources that could be used to achieve some other policy objective. But policy makers are rightly concerned with the 'equity' or 'fairness' of policies. Equity may relate to the distribution of policy impacts across different socio-economic groups, or across different regions, or across different generations. As such, a final objective of the project was to examine the **distribution of the costs of environmental pollution** across regions and socio-economic groups.

II. METHODOLOGY

Environmental pollution is damaging. Over recent years the link between exposure to environmental pollution and damage to individuals' health has been firmly established. Clearly, policies that reduce (increase) environmental pollution will result in improvements (deterioration) in the health of the population. One framework within which policy-makers can assess the relative benefits of such projects is **cost-benefit analysis**. To assess the health benefits (costs) of a policy that reduces (increases) environmental pollution within a cost-benefit framework, policy-makers require access to three key categories of information:

1. Epidemiological assessments of the relationships between levels of exposure to environmental pollutants and damage to human health (so-called dose-response functions).
2. The number of individuals exposed to pollutants before and after the proposed policy is adopted.
3. The measurement, in monetary terms, of (a) the costs to individuals and (b) the costs to the economy at large associated with the health impacts of pollution.

The core of the research programme carried out in this project has sought to provide reliable values for the third of these informational requirements and, hence, improve the quality of project assessment using cost-benefit analysis. The methodology, therefore, is fundamentally **economic**. However, to ensure that the values estimated in this project are compatible with the previous stages of the project evaluation process described above **epidemiological** and **primary healthcare specialists** have been involved in the selection and design of the health impacts of environmental pollution examined in the study. To our knowledge, this is the first time that epidemiological and medical thinking have been incorporated into a economic valuation study *with the specific intention of ensuring the compatibility of economic and epidemiological approaches.*

The economic valuation of these health outcomes draws on methodologies developed in recent years by environmental economists to value non-market goods. In particular, the project adopts the technique known as **contingent valuation -** a questionnaire-based interview approach. Though the contingent valuation methodology (CVM) has progressed a great deal over recent years and now commands recognition as an important valuation tool, it has been criticised by other disciplines, notably psychologists, for assuming that individuals have well

defined preferences for non-market goods, such as health, and that they can translate these preferences into economic values. Therefore, the project has assessed the validity of some of these criticisms developing a contingent valuation approach and a method of **regression analysis** that accounts for individual preference uncertainty and difficulties in expressing these in monetary terms.

Given that there are a great many projects that could potentially influence levels of environmental pollution and that these projects could impact on many different populations, it would be of great advantage if the values of avoided ill-health estimated in this research could be used in a variety of policy contexts and across different populations. The practice of applying benefit estimates from one piece of research to the evaluation of projects with different contexts impacting on different populations is known as **benefits transfer**. An investigation of the reliability of benefits transfer forms the second major methodological focus of this research.

The contingent valuation work has focussed on episodes of ill-health caused by exposure to environmental pollution; in medical terminology, acute morbidity. Further work carried out in this project has investigated the value that society puts on the avoidance of risks of mortality. The measure of this value that has been assessed is the Value of a Statistical Life (VOSL). The number and variety of estimates of the VOSL quoted in the literature has grown exponentially over recent years. To summarise this literature and provide a best estimate of the VOSL, a meta-analysis has been carried out. **Meta-analysis** is frequently referred to as the 'analysis of analyses'. It involves the statistical analysis of the summary findings of prior empirical studies for the purpose of integrating the various findings. The technique allows us to 'control' for aspects of design of individual studies and to derive best estimates of the VOSL that summarise the findings in the literature.

One further important methodology employed in this research is the opportunity for the **spatial analysis of data** afforded by the use of **geographical information systems (GIS)**. GIS allow socio-economic data on populations to be combined with data on the geographical distribution of environmental pollutants. Using this approach, it has been possible to investigate issues of equity with regard to the socio-economic distribution of environmental pollution.

III. MAIN RESULTS

The Value of Health

Five contingent valuation (CV) studies were carried out in Portugal, the Netherlands, Norway, Spain and the UK. Respondents were asked to consider descriptions of up to six different episodes of ill-health associated with exposure to environmental pollution and asked to express their WTP to avoid suffering each separate episode. The episode descriptions were composed by epidemiological and primary healthcare specialists to ensure compatibility with epidemiological studies (full descriptions of episodes are provided in Table 1 at the end of this section).

In each country at least two different versions of the CV survey were administered. The first version of the survey was identical in all countries. This version was *context free*, i.e. it sought respondents' WTP to avoid an episode of ill-health providing neither details of what might cause the episode (*the causal context*) nor how paying money would allow the respondent to avoid it (*the policy context*).

The WTP results from the context free CV surveys are given in Table 2. These suggest some consistent patterns:

(a) WTP is highest for the longer lasting episodes, as we would expect
(b) Spain and Norway have the highest WTP for all episodes
(c) UK and Netherlands have the lowest WTP
(d) Portugal shows more variation, having the highest WTP for 'eyes' and lowest WTP for 'cough'

The estimates were subject to tests for statistical significance, i.e. to see if the different valuations reflect more than random error. These tests suggest that Norway and Spain tend to have significantly higher WTP to avoid ill-health episodes and the UK has significantly lower WTP.

A predictive equation for individual WTP was estimated, taking into account as explanatory variables: income, education, sex, age, experience of hospital, known allergy diagnosis and known asthma/bronchitis diagnosis. In general, the results were consistent with expectations:

(a) WTP varied positively with income and marginal WTP declines as income rises
(b) WTP varies positively with education
(c) WTP varies positively with having children
(d) Having asthma or bronchitis is positively related to WTP if coughing is involved

Associations that are generally statistically significant but not easy to explain include:

(a) women have lower WTP than men (women are often thought to be exposed to more health literature and advice)
(b) WTP varies positively with age (in the value of statistical life literature, there is a presumption that WTP falls with age).

Benefits Transfer of the Value of Health

By minimising the confounding influences of causal and policy context, 'context free' WTP provides a 'core' value that might be more reliably used for the purposes of benefits transfer across population groups. Benefit transfer tests using the context free values were conducted and revealed that the average error involved in transferring estimates across national boundaries is 36% when no socio-economic adjustment is made, and 44% when socio-economic adjustment is made. In other words, any given estimate transferred to a policy site would over or understate the 'true' value by 36-44%. Interestingly, the error in the transfer increases when socio-economic factors are taken into account.

A second issue with the application of benefits transfer is whether value is influenced by context e.g. whether people are WTP more or less for a reduction in what is effectively the same health impact if the context is air pollution rather than, say, some other form of pollution or risk.

To test for contextual effects, a further CV study was conducted in each of the five countries, this time citing either air pollution or water pollution as the context. The 'without context' results were compared to the 'with context' results and tests of statistical significance applied. In Portugal the location of the 'with' and 'without' CVs varied, as did the set of endpoints considered. In all cases, bar two from Portugal, there was no statistically significant difference between the with and without context answers. Context does not therefore affect WTP. In the two cases from Portugal, the 'with context' WTP was lower than the without context WTP.

The absence of contextual effects is encouraging for policy purposes since, subject to the errors in site-to-site transfer, it suggests that values can be transferred across contexts where the source of the problem changes. (How far this extends to very different risk contexts, e.g. radiation risks, has not, however, been tested here).

A more detailed study on context was conducted for the UK. Here the 'with' and 'without' context cases were supplemented by a third survey in which the 'with context' scenario contained potential policy measures to reduce air pollution. Thus, the context is expanded to include an added dimension. In this case context did affect WTP, with WTP being significantly higher in the 'with policy' case. In essence, then, there is some evidence here for supposing that WTP will vary for a policy. Since only one study was conducted for this effect, we cannot say if WTP 'with policy' varies between countries. But we can say that policy affects WTP compared to a policy-free context.

Issues in the Design and Analysis of Contingent Valuation Surveys

Contingent valuation remains controversial, although it seems fair to say that the degree of controversy has been markedly reduced as researchers develop responses to the potential biases and uncertainties in the method. Among the debates, an important one concerns the way in which WTP values are elicited. This amounts to an issue of how to formulate the question that asks for WTP. An *open-ended* approach takes the form of 'what are you WTP?'. An alternative *dichotomous choice* approach asks 'Are you WTP £X?'.

Three CV studies in Oslo were used to elicit WTP for the health endpoints Cough, Bed and Hospital. Questionnaires were designed to test the difference between open-ended and dichotomous choice elicitation formats. The main results were:

(a) WTP was generally higher under the dichotomous choice format than under the open ended format. This finding confirms that found in the rest of the literature.
(b) Respondents appear to use a higher certainty threshold under open ended questions than under dichotomous choice formats, i.e. respondents were more certain that they would pay the sum they stated under the open ended method;
(c) When told to use a specified certainty threshold (95% certain) all WTP values are adjusted downwards, but dichotomous choice answers are adjusted more than open ended answers.
(d) After adjusting for the specified uncertainty threshold, there is no significant difference between open ended and dichotomous choice responses.

These findings are of some importance since they suggest that, by taking careful account of uncertainty, the choice of elicitation format is not at all as important as the existing literature suggests.

An second issue widely debated in the contingent valuation literature is whether WTP answers are sensitive to the order in which questions are asked. Thus, if a respondent gives WTP for endpoint A, does this affect the answer for endpoint B? If so, asking for B first would produce a different WTP than if B is asked second, and so

on. Varying the order of questions was found to have no significant effect on WTP. Again, this is reassuring for policy implementation of benefits transfer.

Meta Analysis of the Value of a Statistical Life

All available European cost-benefit studies of pollution control tend to show that a major, and often the major, component of the benefits of control is avoided premature mortality. One possible measure of the value of avoiding risks of mortality is provided by the 'value of a statistical life' (VOSL). The number and variety of estimates of the VOSL quoted in the literature has grown exponentially over recent years. The diversity in these estimates has been a source of concern for policy-makers.

Concentrating on estimates of the VOSL derived from studies investigating premia paid to workers in jobs that entail risks of mortality, a meta-analysis of previous studies was undertaken. Meta-analytical techniques can be used to address the issue of *publication bias*. If publication bias (i.e. the tendency for researchers and journals only to report significant results) exists, then estimates of the VOSL published in the literature must be considered unsound. A test for the existence of publication bias was carried out using the data set of 63 estimates of the VOSL compiled from the wage-risk literature. Reassuringly, based on this test, no evidence of publication bias was detected in this sample of published estimates.

For each of the VOSL estimates, information was collected on both the characteristics of the study data (e.g. sample size, mean income, baseline risk of fatality, source of fatality risk data), and the details of the data analysis (e.g. functional form of the regression equation, whether account was taken of the worker's exposure to non-fatal risk, the statistical accuracy of the estimated VOSL). This data was used in a 'super regression' to see whether variation in estimates of the VOSL could be explained. The results were encouraging. Using eleven broad characteristics of each study's data, design and analysis, around 50% of the variation in the disparate estimates of the VOSL can be explained. For example, the model suggests that studies from samples with higher mean income return consistently greater estimates of the VOSL. Similarly, researchers that account for the fact that workers in risky jobs are likely to be less risk-averse than the general population, also return higher estimates of the VOSL.

We can use the results of the meta-analysis to derive 'best' estimates of the VOSL that control for sample characteristics and estimation biases and that summarise the findings in the literature. The research reveals that the best 'controlled' estimate of the VOSL is *£3.8 million* (in UK £1996).

Cost of Illness

The costs of morbidity go further than just individuals' willingness to pay to avoid episodes of ill-health. A fuller characterisation should account for all economic consequences, primarily;

- The cost of lost production caused by ill-health, and
- The cost in health care resources expended on treating episodes of ill-health

A basic analysis of these costs was undertaken. An approximation of the productivity cost resulting from a days absence from work, is provided by an aggregated measure of earnings across European Union employment sectors. Estimates of productivity costs calculated in this way are provided in Table 3. Similarly, health care resource costs were approximated with reference to annual revenue expenditure data on hospital facilities in each country, with appropriate adjustments for capital investments. These were available for Belgium, France, Germany, Italy, The Netherlands, Spain and the UK and are presented in local currencies in Table 4.

The Distributive Impacts of Environmental Pollution

Economic valuation is typically integrated into cost-benefit frameworks where the main concern is the overall economic efficiency of the results. But policy-makers need also be concerned with the incidence of costs and benefits on different stakeholders. One such division of stakeholders is between 'rich' and 'poor' citizens. Two studies were carried out to see if health risks from exposure to environmental pollution were unduly borne by poorer people.

In terms of air pollution, it was found that the incidence varied by administrative unit, with the poor suffering relatively more at the local level, but with the rich suffering more at the regional level. In terms of waste disposal sites, no bias against the poor was found.

The location specific nature of these studies makes it difficult to generalise, but there is a suggestion that policy needs to give careful consideration to the spatial impacts. 'Blanket' national policies that affect all regions may have marked distributional impacts due to the varying burdens of risk across regions. More decentralised, locally targeted policies may be better suited to achieve equitable outcomes.

Table 1: Ill-Health Episode Descriptions

Episode Name	Epidemiological End Point	Description
EYES	*Mild Symptom Day*	*One Day with mildly red, watering, itchy eyes. A Runny nose with sneezing spells. Patient is not restricted in their normal activities.*
COUGH	*Minor Restricted Activity Day*	*One day with persistent phlegmy cough, some tightness in the chest, and some breathing difficulties. Patient cannot engage in strenuous activity, but can work and do ordinary daily activities*
STOMACH	*Work-Loss Day*	***One Day of p**ersistent nausea and headache, with occasional vomiting. Some stomach pain and cramp. Diarrhoea at least twice during the day. Patient is unable to go to work or leave the home, but domestic chores are possible.*
BED	*Respiratory Bed Day*	*Three days with flu-like symptoms including persistent phlegmy cough with occasional coughing fits, fever, headache and tiredness. Symptoms are serious enough that patient must stay home in bed for the three days*
CASUALTY	*Emergency Room Visit for COPD and Asthma*	*A visit to a hospital casualty department, for oxygen and medicines to assist breathing problems caused by respiratory distress. Symptoms include a persistent phlegmy cough with occasional coughing fits, gasping breathing even when at rest, fever, headache and tiredness. Patient spends 4 hours in casualty followed by 5 days at home in bed*
HOSPITAL	*Hospital Admission for, COPD, pneumonia, respiratory disease and asthma*	*Admission to a hospital for treatment of respiratory distress. Symptoms include persistent phlegmy cough, with occasional coughing fits, gasping breath, fever, headache and tiredness. Patient stays in the hospital receiving treatment for three days, followed by 5 days home in bed*

Note: COPD = Chronic Obstructive Pulmonary Disease

Table 2: Context free WTP for avoidance of episodes of ill-health (£UK per episode)

	Pooled	Netherlands	Norway	Portugal	Spain	UK
Hospital	306	283	301	300	426	164
Casualty	158	128	239	185	146	131
Bed	97	71	119	88	113	83
Cough	27	28	36	28	39	20
Eyes	35	40	31	70	53	14
Stomach	35			61		26

Note: Parametric estimates only, rounded to nearest £

Table 3: Estimated per diem productivity costs from absenteeism in the European Union (ECU; 1997 prices)

COUNTRY	Per diem productivity cost
Belgium	
Germany	68.46 ECU
Greece	18.06 ECU
Spain	46.03 ECU
France	
Ireland	48.64 ECU
Italy	53.56 ECU
Luxembourg	121.11 ECU
Netherlands	61.34 ECU
Austria	
Portugal	23.30 ECU
Finland	
Sweden	54.07 ECU
United Kingdom	53.35 ECU
European Union Average	54.97 ECU

Table 4: Health service costs (Local currencies)

Country	Emergency Room – cost per visit	Hospitalisation – cost per inpatient day
Belgium	_	BF 8000 (1995 prices)
France	FF 150 (1996 prices)	FF 2020 (1994 prices)
Germany	DM 37.8 (1996 prices)	DM 515.47 (1995 prices)
Italy	L 31075 (1994 prices)	_
Netherlands	_	G 706 (1995 prices)
Spain	P 14174 (1995 prices)	_
United Kingdom	£ 52.24 (1997 prices)	£187 (1996 prices)

IV. SCIENTIFIC INTEREST AND NOVELTY

The studies underlying this report are the first comprehensive studies of willingness to pay (WTP) to avoid ill-health episodes in Europe where the health endpoints are potentially linked to environmental causes. The past practice of 'importing' such values from American studies is potentially misleading (the Norwegian study in the current programme carried out a direct comparison with US studies and found that transferred US estimates were 15-66% higher than the Norwegian estimates). Thus, for the first, time, we have WTP estimates from five EU countries relating to specified health end-points.

These WTP values have direct relevance to benefits transfer within the individual countries. The extent to which these values can be transferred across countries is, however, more suspect, with an error of about one-third for simple transfers of mean values. Nonetheless, this error does not render transfer impossible. While a great deal more work needs to be done, the research suggests that transfer can take place within these error bounds.

Further, the studies reveal that, in this case, the introduction of causal context (i.e. information on the environmental pollutant causing the ill-health episode) does not affect WTP. This is reassuring. However, further work is needed on the addition of policy contexts (i.e. a description of the measures of policy for which individuals are asked their WTP), since the UK study indicates that this may significantly increase WTP.

For CV practitioners the project has resulted in a number of methodological advances. First, it has presented an elicitation method that allows respondents to express their uncertainty over the exact amount they are willing to pay. Second, a class of models have been developed that can be used to analyse data containing uncertain responses. These models allow CV researchers to assess how respondent imprecision in stating their WTP increases or decreases in response to changes in the qualities of the good being valued or the characteristics of respondents, as well as answering the usual questions concerning how WTP itself is influenced by these factors.

Further, the elicitation procedures used in this research have been compared more generally with other elicitation procedures commonly applied in CV surveys. This research suggests that different elicitation procedures result in respondents stating significantly different WTP values. However, it also reveals that respondents answer the different elicitation questions using different certainty thresholds. For example, in response to an open-ended question of the form 'What are you WTP?' a respondent may be 90% certain they would pay the amount they state. On the other hand, in response to a *dichotomous choice* question asking 'Are you WTP £X?' a respondent replying 'Yes' may be only 50% certain that they would actually pay £X. Indeed, the main finding is that the form of the elicitation question is not of major significance provided explicit attention is paid to the degree of uncertainty in respondents' answers.

Concerning the other research conducted as part of this project, the work on wage-risk estimates of the VOSL is the most thorough and comprehensive meta-analysis of its kind to appear in the literature. Also, while work on the social incidence of environmental risks is fairly commonplace in the USA and Canada, little or no work on the subject has been done in the EU. The, research in the UK investigating whether exposure to environmental pollutants results in risks which are unduly borne by poorer people, provides an important step forward in the analysis of the distributive impacts of environmental policy.

V. POLICY RELEVANCE

Health damages are increasingly recognised as a major source of welfare loss in many economies. It has been estimated that 7,000 UK fatalities might have been caused by particulate emissions in 1994, with a cost of £11.1billion. Even a comparatively low concentration pollutant like airborne lead might be responsible for damage of £70million in 1992 due to its effects on urban male mortality in England and Wales. These are large numbers in comparison with other environmental damage estimates, and go some way to explaining why public health is now placed right at the top of environmental policy concerns.

As a result, there is an increasing demand from policy-makers for benefit estimates which are transferable across a wide range of policy scenarios and programmes. These estimates feed into exercises such as the ExternE social cost study, whereby health damage estimates are used to calculate externality adders associated with fuel generation, and welfare losses for inputs into extended social accounting calculations. Unfortunately, exercises such as these in Europe are currently hampered by the absence of a complete and consistent database of health damage values. This is particularly true for human morbidity.

The core research in this project, therefore, provides the first comprehensive study of willingness to pay to avoid ill-health episodes in Europe where the health endpoints are potentially linked to environmental causes. Values have been provided for five separate EU nations; Portugal, the Netherlands, Norway, Spain and the UK.

The attraction of being able to apply these values to a variety of projects and programmes, so-called benefits transfer, is obvious. Benefits transfer will generally be far cheaper to carry out than mounting new valuation studies at each new policy site. Given the growing use of cost-benefit approaches to policy and project issues in Europe, this potential cost saving is important. The problems that arise are essentially due to the difficulty of knowing whether the transferred value is in fact 'correct', i.e. if the value that is transferred corresponds to the value that would emerge from a primary valuation study at the policy site. If the error is large, benefits transfer will produce biases in policy evaluation.

The research, therefore, has sought to assess the confidence with which policy-makers can apply these values to the assessment of policies and programmes in a variety of contexts. The studies reveal that, in general, the introduction of causal context (i.e. information on the environmental pollutant causing the ill-health episode) does not affect WTP. This is reassuring for policy-makers since it implies that the values presented here for each country can be applied with reasonable safety to the evaluation of projects within that country that differ in terms of the pollutant responsible for the ill-health episode. However, further work is needed on the addition of policy contexts (i.e. a description of the measures of policy for which individuals are asked their WTP), since the UK study indicates that this may significantly increase WTP.

The research has also investigated the extent to which these values can be transferred across countries. This type of benefits transfer, however, appears more suspect, with an error of about one-third for simple transfers of mean values. Nonetheless, this error does not render transfer impossible. While a great deal more work needs to be done, the research suggests that transfer can take place within these error bounds.

VI. LIST OF PUBLICATIONS

In Preparation

Day, B.H., W.R. Dubourg, F. Machado, S. Mourato, S. Navrud, R. Ready, F. Spaninks, and M.X.V. Rodríguez, "Non-contextual values for the avoidance of episodes of ill-health: Tests for the stability of benefits transfer across national boundaries"

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Day, B.H., (1999) "A meta-analysis of wage-risk estimates of the value of statistical life" *CSERGE Working Paper*, Centre for Social and Economic Research on the Global Environment, University College London/University of East Anglia, London/Norwich.

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