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Investigating the characteristics of expressed preferences for reducing the impacts of air pollution: A contingent valuation experiment

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**Ian J. Bateman^{1,2,3}, Stavros Georgiou²
Ian H. Langford⁴, Gregory L. Poe⁵
and Andreas Tsoumas⁶**

¹School of Environmental Sciences,
University of East Anglia, UK
(email: i.bateman@uea.ac.uk; tel: (44)(0) 1603 593125)

²Centre for Social and Economic Research
on the Global Environment,
University of East Anglia, UK
(email: s.georgiou@uea.ac.uk; tel: (44)(0) 1603 593743)

³Centre for Economic and Behavioural Analysis
of Risk and Decision,
University of East Anglia, UK

⁴Centre for Environmental Risk,
School of Environmental Sciences,
University of East Anglia, UK

⁵Department of Applied Economics and Management,
Cornell University, New York, USA

⁶Department of Environmental Studies,
The University of the Aegean, Lesvos, Greece

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Abstract

This paper presents the findings of research intended to investigate the nature of expressed preferences for reducing air pollution impacts. Specifically a contingent valuation (CV) experiment is designed to elicit individuals' values for reducing these impacts and examine how these may change when multiple schemes for reducing differing impacts are valued. Results indicate substantial substitution effects between a scheme delivering improvements to human health and one to reduce impacts upon plant life such that the value of a combined programme, delivering both types of benefit, is substantially less than the sum of values for the two separate schemes implemented in isolation of each other. A practical consequence of these findings is that estimates of the value of combined programmes may not readily be obtained by summing the values of their constituent parts.

Key words:

Air pollution, contingent valuation, anomalies, part-whole effect, experimental surveys

1. Introduction

Airborne pollutants impact upon a variety of receptors including humans, animals, plants, buildings and materials, etc. Individuals who are aware of and concerned by such impacts may hold values for reducing airborne pollutants. This paper presents the findings of an experiment designed to investigate the nature of expressed preferences for reducing air pollution impacts. Specifically we apply the contingent valuation (CV) method to the elicitation of individuals' values for reducing these impacts. The method is applied through an experimental design allowing the estimation of values for two separate schemes to reduce specific impacts and a further programme embracing both of these schemes. By varying participants' prior knowledge of what is to be valued such a design permits inspection of the effect upon expressed values of individuals being presented with single or multiple schemes and the interplay between the two. A further particular question addressed by this study is whether values for a number of schemes can be simply added together to provide acceptable estimates of the value of the combined scheme. To the extent that schemes are perceived as partial substitutes for each other, such simple addition will tend to overestimate the value of the combined scheme.

The CV method is a technique for assigning monetary values to individual preferences for changes in the provision of some good or set of goods (for a review of the CV method see Mitchell and Carson, 1989, and for recent debate see Bateman and Willis, 1999). The method typically operates through surveys of individuals in which respondents are presented with a hypothetical or contingent market for a good and asked to state either their willingness to pay (WTP) or willingness to accept (WTA) compensation for either a gain or loss of that good¹. CV has been extensively used to assess preferences for non-market goods such as those provided by the environment. Indeed it is the most widely applied of a developing set of stated preference (SP) valuation methods (for an introductory overview of SP and other valuation techniques see Bateman, 1999; for extended discussion see EFTEC, 2001).

A key objective of our research was to examine the extent to which values derived by CV were consistent with economic theory or exhibited certain anomalies reported in the literature. By anomalies we mean results that appear to be inconsistent with the expectations of economic theory as set out in many

¹ Hicks (1943) shows that the combination of elicitation methods and provision changes results in four potential measures of welfare change. Bateman *et al.*, (2000) report estimates of all four measures with respect to changes in traffic disamenity.

standard texts (see, for example, Varian, 1992). A number of arguments have been put forward to explain apparent anomalies in values derived by CV:

- Anomalies may be the consequence of methodological failings in the design or application of the CV method (Mitchell and Carson, 1989; Carson, 1997);
- Stated responses may not relate wholly to the good described by the investigator but in part to some general moral satisfaction derived from stating the intention of giving to a perceived good cause (Kahneman and Knetsch, 1992; Hausman, 1993; Desvousges *et al.*, 1996);
- Anomalies may evidence inadequacy in standard economic theory insofar as the theory is normative or prescriptive rather than descriptive of actual human behaviour (Bateman *et al.*, 1997a; 1997b).

The financial confines of the present research precluded investigation of the *origin* of any observed anomalies. To do so would have required a switch away from the hypothetical contingent market which underpins the CV method to the use of real-payment approaches such as those used in Bateman *et al.*, (1997a; 1997b). Given these restrictions, the present paper seeks only to examine whether anomalies are present in CV values, not explain their origin.

1.1 Emissions and impacts

In this study we focus principally upon the impacts of air pollutants rather than the emissions themselves. This seems reasonable given that we can expect that an individual's values will be driven by impacts rather than emissions². In order to motivate the empirical study two hypothetical schemes for reducing air pollution impacts were derived as follows:

- Scheme H: Reduction of the impacts of toxic vehicle emissions upon human health
- Scheme P: Reduction of the impacts of acidic power station emissions upon plant life

Further details of these schemes are given subsequently. In order to implement our research design these were supplemented by a further combined scheme as follows:

- Scheme A = Scheme H + Scheme P

² Arguably individuals may hold values for reducing emissions which have no discernible impact (e.g. colourless, odourless gasses which have no effect upon any receptor) if they object to the fact that these are non-natural. Work being conducted at CSERGE under the CEC EMERGE programme in part looks at one aspect of this issue.

The goods described by these three schemes provided the basic building blocks for constructing valuation scenarios. In Section 2 we briefly review theoretical expectations regarding CV values for public goods such as these. Specifically we consider four inter-related issues which have been the focus of recent research concerning arguably anomalous results derived from CV studies. These issues are:

- (i) Scope sensitivity;
- (ii) Part-whole / substitution effects;
- (iii) Ordering effect;
- (iv) Visible choice set effects.

In Section 3 we describe our experimental design for testing for the presence of such effects in values for the three impact reduction schemes mentioned above (full questionnaires for all design permutations are presented in Appendices to this report). Section 4 presents our experimental results. This opens by providing sampling details and sample socio-economic and demographic characteristics. Valuation results are then presented and a set of hypotheses regarding theoretical expectations (and hence anomalies) are formulated and tested. Finally, Section 5 summarises our findings and presents conclusions.

1.2 A note on the interpretation of findings: relative versus absolute values

The objective of the research was purely to investigate the *relative* nature of values for reducing air pollution impacts *within* the sample concerned and the hypothetical market employed. Resources were insufficient to investigate the *absolute* level of those values within either a wider sample or an incentive compatible structure. Given this *we do not defend the use of the values elicited in this study outside the context of this research*. It cannot be claimed that the values estimated in this study provide a reliable guide to those that individuals might in fact pay for real world impact reduction schemes. A defensible analysis of the absolute values associated with reducing air pollution impacts would require a substantial extension to this research entailing a different approach to the elicitation of values to improve the incentive properties of responses. However, the relationships between CV values for differing schemes can be defended as providing some indication of the expected relationships between actual values for the real-world equivalents of those schemes. It is these relationships between CV values which form the focus of this empirical exercise.

2. Theoretical Expectations and Anomalies

The basic tenet of welfare economics is that individuals maximise their utility by choosing what they prefer and preferring what they perceive as yielding maximum utility³ (Varian, 1992). The preferences underpinning these choices can be expressed as values which in turn may be assessed through measures such as WTP for a particular good. Economic theory says very little about the psychological processes which form preferences, indeed as Varian (1992) notes, “A utility function is often a very convenient way to describe preferences, but it should not be given any psychological interpretation” (p.95). However, theory does assume a form of rationality and consistency of preferences from which certain testable hypotheses may be derived. In this section we review in turn the four issues identified previously, in each case describing theoretical predictions and how anomalous responses may cause deviations between predicted and observed value relationships.

2.1 Scope sensitivity

Scope sensitivity describes the extent to which stated values are sensitive to changes in various dimensions of the good under investigation (Carson *et al.*, 2001). For example, it may be that values might rise with increases in the physical scale of an impact reduction scheme. However, while standard economic theory suggests that values should not fall as scope increases, it does not require that values have to rise with scope. As a simple example, individuals will only wish to purchase a certain quantity of milk per day after which additional milk has no marginal value. The same is true of some public goods. For instance, an individual may have a positive WTP for setting up a recreational woodland but, once that is provided, be unwilling to pay for a second such woodland.

The issue of whether scope sensitivity should be and is observed in a given application is essentially an open empirical question dependent upon the nature of the good and change in provision concerned. Nevertheless, since publication of the US NOAA Panel report on the validity of CV (Arrow *et al.*, 1993), scope sensitivity has been viewed (arguably with dubious justification) as a key indicator of study quality and has generated a substantial empirical and theoretical literature (Goodstein, 1995).

A number of factors may contribute to apparent scope insensitivity in CV values including:

³ This is a positive rather than normative theory in which the individual is the sole arbiter of what they feel maximises their own utility. So, for example, despite the associated health risks, smoking cigarettes can contribute to maximising a particular individual's utility.

(i) Choosing provision change increments which do not afford the statistical power to detect scope sensitivity (Arrow and Leamer, 1994; Rollins and Lyke, 1998);

(ii) Satiation, where individuals who may value a given increment of a good do not have significant values for subsequent additions of that good (Carson and Mitchell, 1995; Carson *et al.*, 1998);

(iii) Budget constraints, where individuals are unable to express preferences for a good which has increased in scope because they have insufficient funds⁴;

(iv) Design and application deficiencies, where poor study design means that respondents either do not understand the intended changes in scope or the valuation scenario lacks credibility;

(iv) Violations of theory (Hausman, 1993).

Bateman *et al.*, (2001) describe a number of tests including examinations of the consistency of scope sensitivity across valuations of nested goods, i.e. where the scope of one ‘inclusive’ good entirely comprises and exceeds that of another subset good. In the present paper we adopt a straightforward approach to scope sensitivity testing based upon the clear expectations provided by economic theory; specifically that values for an inclusive good should not be less than values for a subset good. Considering the three air pollution impact reduction schemes discussed previously this equates to theoretical expectations given in Equations (1) and (2) that:

$$\text{WTP (Scheme H)} \leq \text{WTP (Scheme A)} \quad (1)$$

and

$$\text{WTP (Scheme P)} \leq \text{WTP (Scheme A)} \quad (2)$$

Satisfaction of these tests is insufficient to prove the theoretical consistency of our contingent values. However, failure of these tests would be a strong indication of anomalous stated preferences.

⁴ A distinction has to be drawn here between theoretically consistent budget constraints, which for incremental changes in most goods are likely to be weak, and those suggested by alternative theories such as the notion of mental accounting proposed by Thaler (1985).

2.2 Part-whole / substitution effects

The ‘part-whole’⁵ phenomena occurs in the context of CV studies when it appears that the sum of the valuations placed by an individual on the parts of a good is larger than the valuation placed on the good as a whole (i.e. the sum of the part values exceeds that stated for the whole). A formal statement of the relevant standard economic theory is presented in Appendix A. In essence this theory does not allow for part-whole effects.

In the wake of the Exxon Valdez oil spill, part-whole effects emerged as principal focus of debate regarding the validity of the CV method. The argument runs through Kahneman & Knetsch (1992), Smith (1992), Harrison (1992), Carson and Mitchell (1993), Boyle *et al.*, (1994), as well as through the interchanges in Hausmann (1993) and between Hanemann (1994) and Diamond and Hausman (1994). The occurrence of part-whole effects within CV studies was (and still is) seen by critics as a major challenge to the validity of the CV method. However, Bateman *et al.*, (1997a) demonstrate that part-whole effects can be observed in consumers real-money purchases of private goods. This suggests that such effects may constitute a true anomaly and shortcoming of standard theory.

Considering our elicited values and remembering that Scheme A involves the joint implementation of Schemes H and P, then part-whole effects would be observed if Equations (3) holds:

$$[WTP(\text{Scheme H}) + WTP(\text{Scheme P})] > WTP(\text{Scheme A}) \quad (3)$$

For convenience we will refer to the sum $[WTP(\text{Scheme H}) + WTP(\text{Scheme P})]$ as the ‘calculated’ value of Scheme A and contrast this with the amount $WTP(\text{Scheme A})$ which we refer to as the ‘stated’ value of Scheme A. However, substitution effects mean that the presence of part-whole phenomena for *certain* goods need not necessarily constitute a theoretical anomaly (Carson *et al.*, 1998). For example, two ‘part’ goods might be valued at, say, £10 each when obtained separately. If these ‘parts’ are regarded as substitutes for each other then the value of a ‘whole’ bundle consisting of both goods might be less than £20⁶. In our application we have chosen goods which individuals may or may

⁵ The terms ‘part-whole’ and ‘embedding’ are employed in the cognitive psychology literature dealing with the perception of visual parts and wholes, where evidence suggests that one hemisphere of the brain is responsible for perception of wholes, while another deals with the parts of an object (Robertson and Lamb, 1991; Tversky and Hemenway, 1984).

⁶ Throughout, our focus is on goods being partial substitutes, and the consequent issue of superadditivity of parts relative to the whole. This reflects the general theoretical demonstration that bundles of public goods tends to be substitute favouring (Carson *et al.*, 1998) and the general finding of superadditivity in contingent valuation experiments

not consider as substitutes for each other. It may or may not be that the reduction of air pollution impacts upon plants (Scheme P) is not a substitute, or partial substitute, for relieving air pollution impacts upon human health (Scheme H). Therefore, within the confines of the present research, we cannot distinguish between the part-whole phenomena (a theoretical anomaly) and a substitution effect (a finding which is entirely consistent with theory). However, this project is constrained to an empirical investigation of whether part-whole/substitution effects are observed rather than in disentangling the precise cause of such an effect.

Assuming that individuals see the provision of schemes as independent of each other (an issue we discuss at the end of Section 2), one of two outcomes are possible:

- (i) If part-whole/substitution effects are not observed then a valuation obtained from a study of reducing air pollution impacts upon human health can be added to a valuation obtained from a study of reducing air pollution impacts upon plants to obtain an estimate of the value of a scheme to reduce air pollution impacts upon both human health and plants.

Therefore in the absence of part-whole/substitution effects:
 $[WTP(\text{Scheme H}) + WTP(\text{Scheme P})] = WTP(\text{Scheme A})$
i.e. the calculated value for Scheme A equals its stated value.

- (ii) If part-whole/substitution effects are observed then adding a valuation obtained from a study of reducing air pollution impacts upon human health to that from a valuation obtained from a study of reducing air pollution impacts upon plants will over-estimate the value of a scheme to both human health and plants.

Therefore in the presence of part-whole/substitution effects:
 $[WTP(\text{Scheme H}) + WTP(\text{Scheme P})] > WTP(\text{Scheme A})$
i.e. the calculated value for Scheme A exceeds its stated value.

2.3 Ordering effects, list direction, and list length

One of the earliest findings of empirical CV research is that when respondents are presented with a list of goods and asked to provide values for each of those goods, then the stated value for any given good is dependent upon its position such that the nearer to the start of the list that the good is positioned, the higher is the stated value it is accorded (Randall, Hoehn and Tolley, 1981; Hoehn and

(Mitchell and Carson, 1989). It is, however, theoretically possible that goods are viewed as complements. In such an instance, the sum of the parts would add up to less than the value of the whole.

Randall, 1982; Hoehn, 1983; Tolley *et al.*, 1983). In a recent reassessment of this issue, Bateman *et al.*, (2001) show that whether or not such results are anomalous depends in part upon the type of list in which goods are presented.

In an *inclusive list* goods are presented as additions to (or subtractions from) any good(s) presented previously in that list. In this manner, adopting the nomenclature of Kahneman and Knetsch (1992) as extended by Carson and Mitchell (1995), a broader good, A, is thought of as being composed of nested good B plus its complement B*. Similarly B is composed of nested good C and its complement C*. In an inclusive list of goods in which an individual has already expressed a value for good C, a subsequently elicited value for good B will actually refer to C*, the increment between ex ante holdings of good C and ex post holdings of good B. This implies that, since the value stated by a respondent for any given good is dependent upon their current endowment of private and public goods, it is readily seen that, for example, the value for good B as the first good presented to an individual will be different from the value stated when the good appears after good C⁷. Such *sequencing effects* are an expected prediction of economic theory (Carson and Mitchell, 1995; Randall and Hoehn, 1996). Indeed it is this effect that is purportedly most damaging to the practical application of CV, “because willingness to pay for the same good can vary over a wide range depending on whether the good is assessed on its own or embedded as part of a more inclusive package” (Kahneman and Knetsch, 1992, p.57). However, a number of authors (e.g., Smith, 1992; Harrison, 1992; Carson and Mitchell, 1995; Carson, Flores and Hanemann, 1998) have sought to show, with varying degrees of mathematical sophistication, that such context dependence is to be expected in inclusive lists.

In an *exclusive list*, which is the kind of list that choice theory typically addresses, goods are presented as alternatives to any other goods given in that list. This list format also holds the level of other goods constant across valuation tasks. Here the expressed value for a good valued at any position in such a list always refers to the same unit of that good irrespective of its position in that list.

⁷ While the discussion in the text focuses upon nested goods, Carson, Flores and Hanemann (1998) show that such effects also apply to non-nested private and public goods by the fact that having purchased a good changes the reference level of goods and services in a persons utility function. Because of potential substitution and complementarity effects this may change the value that one places upon other goods. Using a trivial private goods example, think of tea and milk (which are regarded by most English people as being complements!). An individual's value for tea may depend upon whether they have previously been asked to value and purchase milk at their maximum willingness to pay and hence have the same initial utility level but possess more goods and less money. The value that this otherwise identical individual would place upon tea is different than if that person were asked to value tea over and above any nominal income effects associated with the prior purchase of milk. Carson, Flores and Hanemann (1998) show that this analysis also applies to public goods.

For example, a respondent may initially be asked to value good C, after which the endowment which serves as a reference point for the utility function is returned to its original position (i.e., good C is no longer held) and, say, good B is valued. Here, according to standard theory, the expressed value for good B is independent of its position in the list due to the fact that the same good is being valued (i.e., in this example, the stated value for B does not refer to the value of C* as per the inclusive list case given above) and the reference income, prices, level of private and public goods and utility level across valuation questions remains constant. Provided that the CV respondent adjusts their perceived holdings of goods back to the initial status quo between valuation tasks, any residual variation associated with presentation is therefore an anomaly (possibly of cognitive psychological origin) and can be termed an *ordering effect*. Empirical evidence of the presence of such effects in CV studies is mixed (Boyle, Welsh and Bishop, 1993).

Again assuming that individuals see the provision of schemes as independent of each other (see discussion at the end of Section 2), ordering effects would be observed if the value of goods presented in an exclusive list varied according to their position in that list. We can further characterise lists in terms of their ‘direction’, i.e. whether they progress from ‘smaller’ to ‘larger’ goods, which we term a ‘bottom-up’ list, or from ‘larger’ to ‘smaller’ to yield a ‘top-down’ list. The terms ‘small’ and ‘large’ are, strictly speaking, subjectively determined by the individual. However, typically for nested goods list direction can be determined through inspection of how goods are nested. In our experiment we have clear nesting of Schemes H and P within Scheme A. However, the relationship of Schemes H and P to each other are not, a-priori, obvious (although an anthropocentric world view might suggest that relieving impacts upon humans is more valuable than relieving impacts upon plants). Therefore, without strong priors regarding expected values list direction is only obvious ex-post for non-nested goods. Nevertheless we shall make use of this list direction terminology in discussing our results.

A final permutation concerning list definition concerns the length of lists. Given the three schemes we have defined previously, list length can be varied by presenting different sub-samples of respondents with either one, two or all three of the schemes concerned. Evidence exists that varying raising awareness of the constituent parts of a good may increase stated values for that good; a phenomena known as event-splitting (Starmer and Sugden, 1993; Humphrey, 1995; 1996). In our experiment we vary list length between two or three goods, always including Schemes H and A and either including or excluding scheme P. By always presenting Scheme A (which embraces Schemes H and P) as the final valuation object we attempt to see whether prior inclusion of Scheme P results in an event-splitting effect, raising the value of Scheme A.

As conjectured in Bateman *et al.*, (2001), list length may also have an effect on stated values if warm glow (individual value associated with the act of giving rather than the value of the good (Andreoni, 1990) or other-regarding behaviour (Ferraro *et al.*, 2002) is somehow partitioned across all the valuation tasks that an individual understands that they will be asked to complete. These authors state “Another conjecture...is that warm glow may somehow be allocated across the extent of the initial visible choice set. Here the entire good causes account is allocated across the initial valuation response in stepwise disclosure designs but is spread across the wider set of goods available from the outset in advanced disclosure formats.” (footnote 12, p. 25).

2.4 Visible choice set effects

Bateman *et al.*, (2001) define a new dimension through which CV study design may influence scope sensitivity; the *visible choice set*. Reflecting recent theoretical developments by Cubitt and Sugden (forthcoming), they define the visible choice set as that set of goods which, at any given point in a valuation exercise, the respondent perceives as being the full extent of purchase options which will be made available in the course of that exercise. The important point to note here is that in some study designs the extent of the visible choice set is varied throughout the course of the experiment. This may occur in bottom-up, top-down, inclusive and/or exclusive list study designs. For example, in a bottom-up, exclusive list, prior to any values being elicited respondents might be told that they are going to be presented with three goods, C, B and A and asked to value each in turn; an approach which Bateman *et al.*, (2001) term an *advance disclosure* visible choice set. A similar framework could be adopted for top-down designs. Conversely, under what is in all other respects the same design, respondents may be presented initially with only good C and a value elicited on the basis of that visible choice set alone; then they are told about good B (i.e., the visible choice set changes relative to that held at the initial valuation) and a further valuation elicited; finally they are presented with good A (i.e., the visible choice set is further changed) and a value elicited. Similarly, but perhaps less dramatically, a top-down approach could be perceived as altering the realm of the possible choice set by unfolding new opportunities for valuing subsets of the more inclusive goods. Bateman *et al.*, (2001) characterise such approaches as exhibiting a *stepwise disclosure* visible choice set, with valuation tasks being interspersed between each expansion of the choice set. This contrasts with such valuation tasks being undertaken after full revelation of the full choice set as per the advance disclosure approach. Note that in the stepwise approach each valuation task is undertaken in ignorance of the

subsequent expansion of the choice set. As such the additional choices can be seen as unanticipated ‘surprises’ to the respondent⁸.

Considering our elicited values, visible choice set effects would be observed if values for the same good differed according to whether they were obtained from stepwise and advance disclosure treatments. So, for example, if WTP (Scheme P) obtained from a stepwise disclosure treatment differed from WTP (Scheme P) obtained from an advance disclosure treatment then we observe visible choice set induced effects.

Evidence for the occurrence of such effects is presented in Bateman *et al.*, (2001) who analyse visible choice set and list direction effects within a nested set of improvements to an open-access lake in Norfolk, UK. Here three schemes were presented in an exclusive list format. A split sample design was used to present goods within both advance and stepwise disclosure visible choice sets. These samples were further subdivided into bottom-up and top-down list direction subsamples (which, due to the nested characteristics of goods, could be determined ex-ante; e.g. a bottom-up list direction presents the scheme with the smallest impact first and that with the largest impact last). The resulting four subsamples were denoted as follows:

ABU = Advance disclosure of choice set; bottom-up list direction
 ATD = Advance disclosure of choice set; top-down list direction
 SBU = Stepwise disclosure of choice set; bottom-up list direction
 STD = Stepwise disclosure of choice set; top-down list direction

⁸ At issue is the degree to which changes in the visible choice set are unanticipated. We posit that in most scope and list tests conducted to date, individuals have substantially uninformed priors concerning potential subsequent expansions in the visible choice set prior to any given valuation task. We suggest that this lack of prescience stems from at least two sources. First, as raised by Bishop and Welsh (1992) in the context of the valuation of little known but endangered species, information gathering is costly, and one way to ration scarce information gathering resources is to ignore information that is not relevant to the current choice set. Since contingent valuation exercises typically address a novel issue it is naïve to expect respondents to anticipate the realm of possible alternative scenarios that could potentially be offered. Second, the choices and the lists to be presented are controlled exclusively by the interviewer, who is, by the nature of the exchange, endowed with the “ability to construct arbitrary sequences of trading opportunities, to condition these opportunities on events and to spring unforeseen opportunities on their potential victims” (Cubitt and Sugden, draft manuscript p.5). These factors lead us to believe that it is not unreasonable to assume that in most stepwise progressions respondents do not anticipate subsequent valuation questions once the initial valuation task has been completed. Unfortunately, the existing literature does not provide enough information to allow us to test this formally, although evidence to support this contention is provided in Bateman *et al.*, (2001).

Table 1 presents median WTP amounts for the three schemes obtained from each of the above treatments.

Table 1: Median WTP (£) for Three Nested Lake Improvement Schemes

Sample	Smallest scheme	Intermediate scheme	Largest scheme
ABU	8.00	15.00	20.50
ATD	8.40	15.00	25.00
SBU	30.00	32.75	40.00
STD	5.00	15.00	27.50

Source: Bateman *et al.*, (2001).

The results detailed in Table 1 show a clear message. Within each treatment increases in the scope of goods are synonymous with rises in WTP, a result which is in accordance with theoretical expectations (although theory merely states that values should not decline with increasing scope). However, while treatments ABU, ATD and STD yield insignificant differences in WTP values, these do differ significantly from those derived from the SBU treatment. It seems that a treatment presenting respondents with the lowest value good first and where they are at that time unaware of a wider choice set, yields higher values both for that initial good and for those presented subsequently. This interaction of visible choice set and ordering effects is explicitly tested for in the experimental design used in the present analysis.

Whether or not such effects constitute theoretical anomalies is a debateable point. For private goods, economic-theoretic expectations are clear with respect to willingness to pay and disclosure type; choice theory states that preferences are independent of the choice set and therefore we should expect no difference in stated values elicited from either a stepwise or advance disclosure presentation of an exclusive (or inclusive) list. Yet, for public goods, choice theory predicts that strategic incentives *may* affect stated values where the visible choice set contains more than one such good. This may apply even when those goods considered are exclusive, such that only one good will eventually be provided, if the stated values for one good are not considered to be independent of the other goods in the choice set. These strategies may change according to both the number and composition of goods in a choice set. Therefore the strategy space may differ through the course of a stepwise exclusive list while it remains constant within an advance disclosure treatment.

This does not mean that strategic incentives do not apply to advance disclosure formats, merely that these incentives are constant. Strategic behavior arguments are considered in our subsequent explorations of the empirical results obtained in this research. In the interim, because strategies could be complex and vary across individuals, we will proceed with the assumption that respondents treat the choices offered in the exclusive lists employed to be independent. This allows us to test the hypothesis that willingness to pay responses will be invariant to visible choice set type.

3. Study Design

3.1 Scenarios: air pollution impact reduction schemes

A study design was defined to examine whether the various anomalies and effects under investigation were present within a CV study focussing upon values for the reduction of air pollution impacts. The various anomalies were assessed through a split sample design with each sample being presented with a somewhat different questionnaire (full details of all questionnaires are presented in Appendix B).

As noted in Section 1.2, the objective of the research was purely to investigate the *relative* nature of values for reducing air pollution impacts. Resources were insufficient to investigate the absolute level of those values within an incentive compatible structure. Given these constraints we adopted a simple open-ended response format for eliciting WTP answers. It is recognised that the open-ended format is liable to strategic behaviour by respondents (Carson *et al.*, 2000) with under-representation of true WTP being a frequently cited strategy⁹. However, in a split sample context, such as adopted in this study, the open-ended approach is acceptable for detecting *differences* in WTP responses between treatments (see for example, Bateman and Langford, 1997). The open-ended method is also highly statistically efficient in that each respondent is asked to state their maximum WTP which in turn dramatically reduces sample size requirements relative to say the more incentive compatible dichotomous choice approach (Hanemann and Kanninen, 1999) thus facilitating a sufficient sample size within the confines of the available research budget.

Given our focus upon differences in WTP between treatments, rather than a concern for the validity or defensibility of absolute WTP values, efforts were made to simplify the cognitive task faced by respondents. Providing the level of information is kept constant across treatments, any significant difference between samples (other than those due to sample characteristics) may indicate the presence of anomalies. Given this we were able to justify reliance upon respondents' prior levels of information, assuming that this is randomly distributed across samples. This was clarified to respondents in the opening statement of all questionnaires which also introduced the subject of air pollution impacts and read as follows:

"This research concerns peoples views about air pollution. We deliberately do not provide you with lots of new information and statistics about the current level or impacts of air pollution as we

want to avoid unduly influencing your answers with information that most people do not have."

Respondents were then appraised of the valuation tasks before them by informing them that they would be presented with details regarding one or more air quality improvement schemes and that they would be asked to value the implementation of these schemes. Respondents facing advance disclosure visible choice sets were told from the outset the number of air quality improvement schemes (two or three) that they would be presented with during the entire course of the experiment. However, respondents facing the stepwise information treatment were only told of the first scheme that they would face. The following statement is taken from an advance information treatment (details of all treatments are given in Appendix B):

"We are going to tell you about three alternative air quality improvement schemes. Once we have told you about all three then we will consider each in turn and ask you what the maximum amount you would be willing to pay per year for each scheme to be implemented in practice. We are not going to go into technical details about how schemes will be implemented or about how money would be collected as there are a variety of possible options and this is not what we are interested in. Do not worry about these technical details, just think about how much you are willing to pay for each scheme.

As each of the three schemes is an alternative to the current situation we start by briefly considering, in very simple terms, what this current situation is."

As can be seen, the above statement also introduced the information regarding the current situation which was phrased as the following simple statement (this and subsequent air quality improvement schemes are presented in approximately the same format as shown to respondents):

"Here briefly is the current situation:

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

⁹ Although over-statement is an equally plausible strategy (see Bateman *et al.*, forthcoming).

Respondents were then presented with various combinations of scheme details and valuation tasks. The various combinations employed over the split sample design are detailed in Section 3.2. We detail these as follows. In this section we provide details for all of the schemes (remembering that our event-splitting test meant that some respondents were only presented with certain of these schemes).

Details for Scheme H were as follows:

Scheme H: Toxic vehicle emissions and human health

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects no longer occurred.

For those respondents presented with Scheme P details were as follows:

Scheme P: Acidic power station emissions and effects on plant life

- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of power plant emissions which affect plant life to the level where these effects no longer occurred.

Details for Scheme A were as follows (again taken from an advance disclosure treatment):

"We could implement the following alternative which is simply a combination of both of the above alternatives. "

Scheme A: Scheme H and Scheme P

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Toxic vehicle emissions and acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of emissions to the level where their effects no longer occurred.

In every case (all samples) schemes were presented in exclusive list formats, i.e. as alternatives to each other (consequently ordering effects, to do with the positioning of a scheme within a list, are not expected).

3.2 Split sample design and corresponding tests

Investigation of the various anomalies discussed previously dictated the various treatments which together define the study design. Considering these anomalies in turn we can see the various design requirements they impose:

- (i) Scope Sensitivity: In this study we only conduct simple scope tests examining whether stated values are non-declining as the scope of a good increases. In terms of study design this is provided by contrasting values for Scheme H or Scheme P with values for Scheme A (which comprises both Schemes H and P). Theoretical expectations are that values for Scheme A should not be lower than those for either Scheme H or Scheme P. Such a test can be afforded by any sample which faces questions valuing Scheme A and at least one of the other Schemes.
- (ii) Part-whole/substitution effects: A formal test for part-whole/substitution effects requires that respondents be asked to provide individual values for Schemes H, P and A and so such samples

were collected. If the calculated value for Scheme A (obtained by summing the values stated for Scheme H and those for Scheme P) exceeds stated values for Scheme A then we have evidence of either an anomalous part-whole effect or a theoretically consistent substitution effect.

- (iii) Ordering effects: Given that all schemes are presented within exclusive lists as alternatives to each other, then (accepting that strategic incentives may vary between disclosure groups) the value of each scheme should be independent of its position within a list. To test this in some treatments Scheme H was presented before Scheme P while in others this ordering was reversed. A further event-splitting test is provided by examining the value of Scheme A in lists of either two or three schemes.
- (iv) Visible choice set effects: These were examined by presenting some respondents with advance information regarding all the schemes they would be valuing while other treatments presented respondents with stepwise information detailing just one scheme at a time and eliciting values before presenting a subsequent scheme.

Combining all the above tests led us to devise a study design consisting of five subsamples of respondents, described in points (i) to (v) below:

- (i) Here a stepwise information approach was adopted. Respondents were presented with Scheme H and asked to value it. Respondents were then presented with Scheme A and asked to value that. Comparison of these values provides a simple scope test. We will give this sample the label **SHA** indicating a stepwise (**S**) information format eliciting values for Schemes **H** and **A**.
- (ii) Here a stepwise information approach was again adopted. Respondents were presented with Scheme H and asked to value it. This process was then repeated for Scheme P and finally for Scheme A. Comparison of these values provides a further simple scope test. Furthermore, the derived values for Scheme H, P and A allow us to conduct a part-whole test for a stepwise treatment. Comparison with sample SHA allows us to see if there is an ordering effect with regard to the value of Scheme A (or if the explicit valuation of all the constituent parts of Scheme A affects the stated value for that scheme). We label this sample **SHPA** indicating a stepwise (**S**) information format eliciting values for Schemes **H**, **P** and **A**.

- (iii) Here an advance information approach was adopted. Respondents were presented with Scheme H and Scheme A before being asked to value both in turn. Comparison of these values provides a further simple scope test. Comparison with sample SHA allows us to see if there is a visible choice set effect with regard to the value of Schemes H and A. We label this sample **AHA** indicating an advance (**A**) information format eliciting values for Schemes **H** and **A**.
- (iv) Here an advance information approach was again adopted. Respondents were presented with Schemes H, P and A before being asked to value each in turn. Comparison of these values provides a further simple scope test. Furthermore, the derived values for Scheme H, P and A allow us to conduct a part-whole test for an advance information treatment. Comparison with sample SHPA allows us to see if there is a visible choice set effect with regard to the values of Schemes H, P and A. We label this sample **AHPA** indicating an advance (**A**) information format eliciting values for Schemes **H**, **P** and **A**.
- (v) Here a stepwise information approach was adopted. Respondents were presented with Scheme P and asked to value it. Respondents were then presented with Scheme H and asked to value that. This sample does not yield a meaningful simple scope test as the relative values for these two schemes are subject to individual preferences. However, comparison of these values with those for the same schemes elicited from samples SHPA and SHA provide tests of ordering effects for these values. We label this sample the label **SPH** indicating a stepwise (**S**) information format eliciting values for Schemes **P** and **H**.

Table 2 summarises the split sample design discussed above. The first column identifies each sample using the labels defined above. Numbers in parentheses are sample sizes from our main survey. The second column confirms the disclosure type and the middle column shows the ordering of information provision and valuation tasks for each scheme considered by a sample. Here **bold** type indicates the choice set visible to participants prior to the initial valuation task, confirming the difference between stepwise and advance disclosure formats. *Italic* type shows the subsequent expansion of the visible choice set just prior to the second valuation task for participants in stepwise treatments. Finally, normal type indicates the further expansion of the visible choice set experienced by participants in the SHPA treatment just prior to their third and last valuation task. The fourth column provides labels for the various

values directly stated by respondents in each treatment. These labels indicate both the sample from which that value was obtained and, in subscripts, the scheme valued. So, for example, the value stated by respondents in sample SHA for Scheme H is denoted SHA_H .

Note that in each treatment respondents are asked to state their willingness to pay for Scheme H and at least one of the other two schemes. This means that in every case we can obtain an estimate of value for all three separate schemes either by observing them directly or by calculating them from the other two stated values. For example, in sample SHA respondents state values for both Scheme H and Scheme A. By subtracting the former from the latter we can therefore obtain a calculated value for Scheme P. Furthermore, we can obtain calculated values for schemes for which we also have directly stated values. For example, in sample SHPA we have stated values for all three schemes. However, by adding together the values for Schemes H and P we can obtain a calculated value for Scheme A assuming no substitution or part-whole effects. Some of these inferred values have been calculated and are detailed in the last column of Table 2. These calculated values are labelled in a manner similar to that for the other values but have a subscript c (for calculated) immediately preceding the letter denoting the Scheme in question. Therefore while $SHPA_A$ indicates the stated value for Scheme A derived from the SHPA sample, the inferred value of Scheme A calculated by summing the stated values for Schemes H and P from the same sample is denoted $SHPA_{cA}$.

Note that the presence of substitution effects means that the stated and calculated values for the same scheme may not be identical, even within the same sample. Indeed divergence can be taken as suggesting that either part-whole or substitution effects are significant.

Table 2: Experimental design and subsample structure

Group	Disclosure type	Design (ordering of information provision and valuation questions)	Stated values	Inferred values
SHA (n=40)	Stepwise	Info on good 1 (health)	SHA_H	$SHA_{cP} = (SHA_A - SHA_H)$
		WTP good 1 (health)		
		<i>Info on good All</i>	SHA_A	
		<i>WTP good All</i>		
SHPA (n=40)	Stepwise	Info on good 1 (health)	$SHPA_H$	$SHPA_{cA} = (SHPA_H + SHPA_P)$
		WTP good 1 (health)		
		<i>Info on good 2 (Plants)</i>	$SHPA_P$	
		<i>WTP good 2 (Plants)</i>		
		Info on good All	$SHPA_A$	
		WTP good All		
AHA (n=40)	Advance	Info on good 1 (health)	AHA_H	$AHA_{cP} = (AHA_A - AHA_H)$
		Info on good All		
		WTP good 1 (health)	AHA_A	
		WTP good All		
AHPA (n=28)	Advance	Info on good 1 (health)	$AHPA_H$	$AHPA_{cA} = (AHPA_H + AHPA_P)$
		Info on good 2 (plants)		
		Info on good All	$AHPA_P$	
		WTP good 1 (health)		
		WTP good 2 (plants)	$AHPA_A$	
		WTP good All		
SPH (n=40)	Stepwise	Info on good 2 (plants)	SPH_P	$SPH_{cA} = (SPH_P + SPH_H)$
		WTP good 2 (plants)		
		<i>Info on good 1 (health)</i>	SPH_H	
		<i>WTP good 1 (health)</i>		

Information in the 'Design' column is formatted as follows:

Bold type indicates the initial choice set visible to respondents when they gave their first valuation response. For advance disclosure treatments only this also applies for second and (where applicable) third valuation responses.

Italic type indicates the subsequent choice set visible to stepwise disclosure respondents when they gave their second valuation response. (where applicable).

Normal type (non-bold, non-italic) indicates the subsequent choice set visible to stepwise disclosure respondents when they gave their third valuation response (where applicable).

4. Results

Data were collected through one-to-one, in-person surveys of students at their residential addresses at the University of East Anglia, addresses being selected at random. A total sample of 238 respondents was collected of which 50 were used in a pilot survey refining the wording of questionnaires. As wording was substantially simplified between the pilot survey and the main survey, those presented with the pilot questionnaire are excluded from our main analysis.

4.1 Sub-sample demographic characteristics

All respondents were asked a number of socio-economic and demographic questions. These were used to examine possible differences between sub-samples which may complicate our subsequent analyses. Summary statistics for key variables within and across samples are presented in Table 3.

Considering respondents expected income over the next 12 months, while sample AHPA appears to have a somewhat higher income than other samples these differences proved to be just insignificant at $\alpha = 5\%$. Similarly no significant differences were found either in terms of the number of non-UK respondents in each sample (who arguably would be less likely to receive the long term benefits of any air pollution impact reduction scheme) or with respect to gender. Considering respondent age, while the descriptive statistics shown in Table 3 shows that mean age for all samples was within the range 20 to 24 years, nevertheless significant differences were found here again it is sample AHPA which appears the most different to other samples. Taking into account that this is also the sample with the smallest number of respondents, it seems likely that there are a few older (and probably richer) respondents within this sub-sample. Although these are not substantial differences they are worth keeping in mind when we consider our subsequent valuation results.

4.2 WTP for air pollution impact reduction schemes by sub-sample

Descriptive statistics for the various stated and calculated WTP measures obtained from each sub-sample are detailed in Table 4. Examining these we can see that WTP values for Scheme H (all of which are here shown as stated values only) are relatively stable between sub-samples with mean measures ranging from about £72-£85 and median values being between £50-£70 (notice that the highest values are obtained from sub-sample SPH which is the only one where Scheme H is not presented first).

Stated values for Scheme P are also relatively stable with means ranging from £44-£54 and medians varying from £30-£47 (the latter value again being obtained from sub-sample SPH). However, these values differ substantially

Table 3: Socio-economic and demographic profile of samples

Group	Gross expected income in the next 12 months (£)			Number of non-UK respondents	Gender		Age last birthday			Previously studied economics?		Total sample size
	Mean	s.e.	Median		Male	female	mean	s.e.	median	No	Yes	
SHA	6138	676	5000	3	16	24	20.1	.40	19.0	30	10	40
SHPA	6411	732	4500	2	16	24	20.3	.24	20.0	33	7	40
AHA	7171	956	5000	2	20	20	21.7	.33	21.5	31	9	40
AHPA	9059	1007	6650	0	14	14	23.3	.73	23.0	21	6	28
SPH	6581	895	4000	1	19	21	20.8	.49	20.0	32	8	40
All samples	6977	393	5000	8	85	103	21.1	.20	20.0	147 ¹	40 ¹	188
Significance of differences	0.054			0.446	0.189		0.000			0.945		

Note: ¹ One missing value.

from the calculated values for Scheme P (found by subtracting stated values for Scheme H from those for Scheme A). These range from mean values of £18-£28 and medians of £5-£10¹⁰. This large excess of stated over calculated values suggest either strong part-whole problems or that Schemes H and P are at least partial substitutes for each other. This latter explanation seems entirely plausible and so we cannot conclude that there is firm evidence of anomalies here and assume that this is the case in the remainder of our discussion.

Stated values for Scheme A are also relatively similar across treatments with means ranging from £100-£113 and medians varying from £70-£100. Calculated values for Scheme A are consistently above their stated equivalents with means from £117-£131 and medians from £90-£120. Again this would be expected if we were either witnessing part-whole phenomena or if Schemes H and P were to some degree substitutes for each other (in this latter case the calculated sum of individuals values for Schemes H and P should exceed their stated joint value as expressed for Scheme A; this pattern conforms to what we find in the results). This latter explanation again seems highly plausible and so we have no reason to assume that these results necessarily constitute theoretical anomalies.

The overall impression given by the results presented in Table 4 is of relatively stable values for each individual scheme, but of substitution effects existing between Schemes H and P resulting in their values as individual goods exceeding their value as the joint good provided by Scheme A.

These results have some important messages for regulatory policy assessment. First, they suggest that values for air pollution impact reduction schemes may be significant (given the lack of incentive compatibility in our open ended elicitation format this can only be a tentative judgement, but the results do suggest that such values may exist). Second, the findings suggest that these values may be reasonably robust (although we investigate this issue further below). Thirdly, and perhaps most importantly, these findings suggest that values obtained for individual air pollution impact reduction schemes cannot be simply added across schemes to obtain estimates of the value of wider schemes embracing all of those individual schemes. Our results suggest that such an approach ignores the substitution effects which may exist between schemes and

¹⁰ Note that the lower end of the distribution of calculated values for Scheme P includes a number of negative values derived from cases where WTP for Scheme H exceeds that for Scheme A. This is a cause for some concern as such results typically arise where respondents feel that the more embracing good (here Scheme A) lacks credibility or is unlikely to be implemented. Other possible explanations for such responses are considered in Bateman *et al.*, (2001).

therefore risks the likelihood that the value of wider schemes, estimated by such a route, would be over-estimated.

Finally inspection of the distributional information contained in Table 4 suggests that, as often observed in CV studies, distributions of WTP responses are positively skewed. The final column of the table reports a formal test for normality indicating that, in every case apart from one of the calculated measures, normality is rejected at $p < 0.1$. This indicates that parametric tests relying upon such normality assumptions may be unreliable. Given this we employ non-parametric techniques for testing relationships between the measures collected (a comparison with parametric results is given in Appendix C which shows that the latter are highly susceptible to outlier responses).

4.3 Tests of scope sensitivity and value consistency

As discussed previously, a-priori we have no theoretical expectations of the relative values associated with Schemes H and P, either could be valued higher or they could be valued equally. However, given that each is nested with the large good provided by Scheme A we have a clear expectation that WTP for the latter should not be less than that for either of the former.

An illustration of the degree of scope sensitivity observed between Scheme H and A is given in Figure 1 which shows mean stated and calculated WTP values for each good and for each treatment (stated values being used in preference to calculated values where both are available from one treatment). As can be seen the degree of scope sensitivity appears to be similar across treatments. Figure 2 which repeats this analysis for Schemes P and A although here it should be noted that for treatments SHA and AHA values for Scheme P are calculated rather than stated. Nevertheless, the degree of scope sensitivity again seems similar across treatments.

In order to test the significance of these differences and to examine differences between WTP measures for Schemes both within and across treatments a series of non-parametric tests were conducted full details of which are provided in Appendix C. A summary of findings is presented in Table 5.

The numbers given in the cells of Table 5 indicate the number of tests which show either a significant (sig) or non-significant (ns) difference between the WTP values concerned.

Table 4: Descriptive WTP statistics by sub-sample and Scheme

Measure	Count	Mean	s.e. mean	Std Deviation	Minimum	Percentile 05	Percentile 25	Median	Percentile 75	Maximum	p non-normal ¹
SHA _H	40	79.50	11.81	72.79	5.00	9.75	20.00	52.00	105.00	300.00	.015
SHA _P	40	27.63	11.15	68.71	-30.00	-11.00	0.00	5.00	25.75	400.00	.010
SHA _A	40	107.13	17.72	109.21	5.00	9.75	32.50	70.00	150.00	500.00	.015
SHPA _H	40	84.61	17.39	107.20	5.00	5.00	30.00	55.00	100.00	500.00	.010
SHPA _P	40	54.16	15.89	97.95	4.00	4.95	10.00	30.00	50.00	500.00	.010
SHPA _A	40	113.29	25.42	156.68	5.00	9.75	40.00	77.50	112.50	900.00	.010
SHPA _{CA}	40	138.76	32.96	203.17	9.00	9.95	55.00	90.00	150.00	1000.00	.010
AHA _H	40	81.41	11.05	68.98	10.00	10.00	30.00	50.00	100.00	300.00	.010
AHA _P	40	18.31	3.66	22.89	-10.00	0.00	0.00	10.00	25.00	100.00	.010
AHA _A	40	99.72	11.48	71.71	10.00	10.00	50.00	100.00	110.00	300.00	.081
AHPA _H	28	72.18	11.96	63.31	0.00	0.00	16.25	50.00	127.50	200.00	.020
AHPA _P	28	44.50	6.81	36.02	0.00	0.00	12.50	45.00	73.75	120.00	.035
AHPA _A	28	104.18	15.95	84.42	0.00	0.00	21.25	90.00	195.00	280.00	.010
AHPA _{CA}	28	116.68	17.37	91.89	0.00	0.00	32.50	100.00	200.00	290.00	.054
SPH _P	40	49.85	4.64	29.32	5.00	10.25	30.00	47.50	58.75	120.00	.010
SPH _H	40	81.53	7.70	48.72	5.00	15.25	50.00	70.00	100.00	240.00	.073
SPH _{CA}	40	131.38	11.77	74.46	10.00	25.75	80.00	120.00	161.25	360.00	.348

Note: ¹ Shapiro-Wilk test of normality. Here p denotes the probability that the difference between a normal distribution and that of the observed WTP values is due to random chance.

Shaded cells are tests between comparable WTP sums for identical schemes elicited from different treatments. Here theoretical expectations are that all treatments should yield similar values¹¹. All of the 23 such tests reported show no significant difference in values (i.e. $p > 0.05$) suggesting strong valuation consistency across treatments.

Considering comparisons between different value measures (non-shaded cells), here numbers in brackets are within-sample (internal) tests, while numbers outside brackets are between-sample (external) tests. All of the former internal tests hold treatment constant and show consistently significant differences between measures. This confirms that the apparent scope sensitivity indicated in Figures 1 and 2 is indeed statistically significant and that, within any given treatment, values for Scheme H are significant larger than those for Scheme P and significantly smaller than those for Scheme A. This supports the anthropocentric prior that individuals value reduction of air pollution impacts upon human health more than the reduction of impacts upon plants.

The external tests, shown by the figures outside brackets in unshaded cells, are considerably less consistent and indicate that treatment differences across samples do have significant impacts upon WTP values. It is to an analysis of these treatment differences that we now turn.

¹¹ Assuming that Schemes are seen as independent.

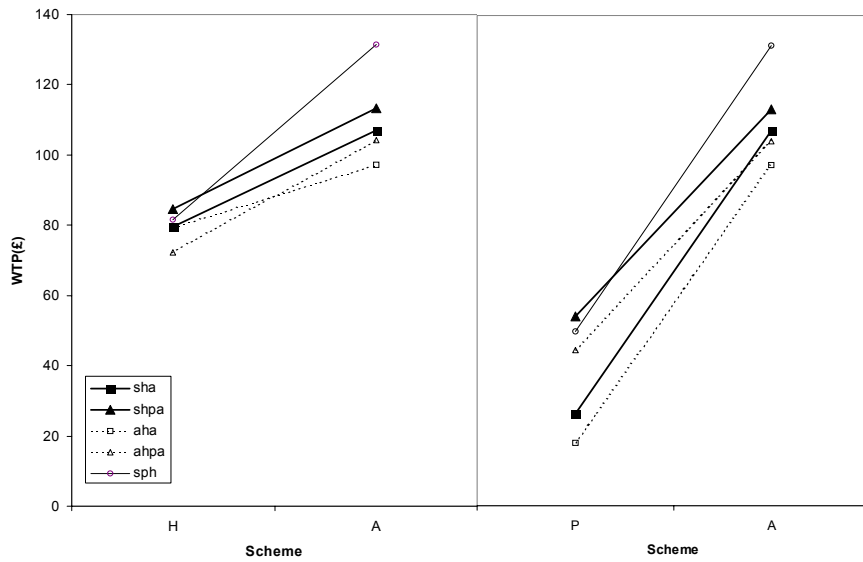


Figure 1:
Mean WTP values for Schemes H & A by treatment

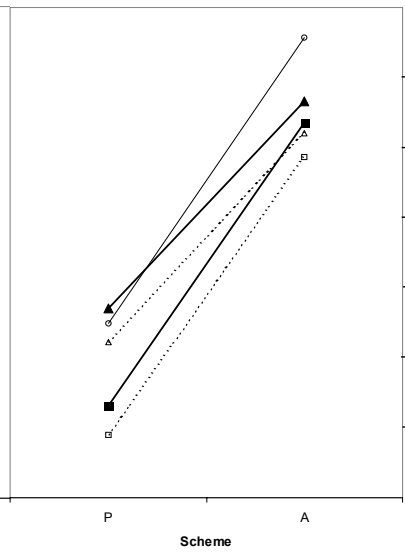


Figure 2:
Mean WTP values for Schemes P & A by treatment

Table 5: Significance of differences in WTP values for Schemes¹

WTP for Scheme →		H		P		CP		A		cA	
		Sig	Ns	sig	Ns	sig	Ns	Sig	ns	sig	ns
WTP for Scheme →	H	0	10								
	P	7(3)	6	0	3						
	CP	9(2)	0	7	0	0	1				
	A	1(4)	15	10(2)	0	6(2)	0	0	6		
	CA	3(3)	8	6(3)	0	6	0	2(2)	8	0	3

Notes:

1. Numbers in cells indicate the number of tests which show either a significant (sig) or non-significant (ns) difference between the WTP values concerned
 sig = $p \leq 0.05$ ns = $p > 0.05$

4.4 Tests of treatment effects

We have five distinct treatments each of which yields stated and/or calculated values for each of the three schemes under consideration. This experimental design permits inspection of the impact of the following dimensions upon these values:

- (i) Whether values vary across treatments. If significant treatment differences are detected the analytical focus then turn to consider the origin of those effects as expressed through the following tests;
- (ii) Whether values are stated or calculated – permitting us to examine whether part-whole / substitution effects are significant;
- (iii) Whether values differ according to their being elicited from stepwise or advance disclosure visible choice sets;
- (iv) Whether the interaction of disclosure and ordering type embodied in the SPH treatment results in significant effects (of particular interest given our empirical finding that values for Scheme P are significantly lower than those for Scheme H such that the SPH treatment is seen to be a partially nested equivalent of the SBU treatment which yielded such marked effects in the Bateman *et al.*, (2001) study reviewed in Table 1 of this paper) and;
- (v) Whether values for Scheme A exhibit signs of event-splitting effects¹².

In order to test the overall effect outlined in (i) above the variables TYPE_H, TYPE_P and TYPE_A were defined to characterise the five distinct treatment types employed to elicit values for the three schemes investigated. In summary these variables were coded as follows (specific coding details for each variable are given in Appendix C):

- 1 = stated values from stepwise disclosure treatments with Scheme H valued first (SHA & SHPA)¹³
- 2 = calculated values from stepwise disclosure treatments with Scheme H valued first (SHPA)

¹² As a side analysis we also examine whether list length has any discernable effect upon values for other schemes. See footnote in our report on event splitting tests.

¹³ Non-parametric tests clearly fail to reject hypothesis of no significant difference between measures included within this category (for SHA_A v. SHPA_A p = 0.896; for SHA_H v. SHPA_H p = 0.888)

- 3 = stated values from advance disclosure treatments with Scheme H valued first (AHA & AHPA)¹⁴
- 4 = calculated values from advance disclosure treatments with Scheme H valued first (AHPA)
- 5 = stated values (Schemes P and H) or calculated value (Scheme A) from stepwise disclosure treatments with Scheme P valued first (SPH)

Mean and median WTP values for all three schemes across all five treatments are given in Table 6 (Appendix C provides further details regarding the distribution and variance of each value estimate) together with non-parametric tests of the null hypothesis that values for a given scheme do not vary across the levels of the TYPE variable (Appendix C also reports an outlier sensitivity analysis and, for comparison, parametric tests; results show that the latter are highly sensitive to outliers while non-parametric test are stable). Here shaded cells indicated calculated values while unshaded cells indicate those which were directly stated by respondents.

Inspecting Table 6 a number of clear messages can be seen. First, values for Scheme H are consistently higher than within treatment values for Scheme P and, as noted previously, there is clear evidence of scope sensitivity with Scheme A values consistently higher than those for other schemes. A second finding is that calculated values for both Scheme H and Scheme P are consistently and substantially below stated values. This result is generally reversed for Scheme A (calculated mean values always exceed stated means however median values are more variable; although the highest median is calculate and the lowest is stated, other medians are less easily categorised). Remembering that, for Scheme A, calculated values are obtained by adding together stated values for Scheme H and Scheme P, overall this pattern provides some evidence for a part-whole/substitution effect with the sum of parts exceeding the stated value of the whole.

The last row of Table 6 gives a formal test of the null hypothesis of the equality of values for given schemes across the levels of the TYPE variable. Equality is clearly rejected for both Scheme H and Scheme P. For Scheme A the test statistic falls just outside the conventional 5% significance level, although it is clearly significant at the 10% level¹⁵.

¹⁴ Non-parametric tests clearly fail to reject hypothesis of no significant difference between measures included within this category (for AHA_A v. AHPA_A p = 0.888; for AHA_H v. AHPA_H p = 0.473).

¹⁵ This result is also clearly significant if the three highest values stated by respondents are omitted (p = 0.033).

Table 6: Mean and median WTP (£) for three air pollution impact reduction schemes; by five treatments.

TYPE	Scheme H			Scheme P			Scheme A		
	N	Mean WTP (s.e.)	Median WTP	n	Mean WTP (s.e.)	Median WTP	n	Mean WTP (s.e.)	Median WTP
1	80	82.05 (10.44)	52.00	38	54.16 (15.89)	30.00	76	110.21 (15.39)	72.50
2	40	59.13 (13.91)	40.00	38	27.63 (11.15)	5.00	38	138.76 (32.96)	90.00
3	68	77.55 (8.10)	50.00	28	44.50 (6.81)	45.00	67	101.58 (9.37)	100.00
4	28	59.68 (10.67)	35.00	39	18.31 (3.66)	10.00	28	116.68 (17.37)	100.00
5	40	81.53 (7.70)	70.00	40	49.85 (4.64)	47.50	40	131.38 (11.77)	120.00
Total	256	74.74 (4.74)	50.00	183	38.59 (4.43)	25.00	249	116.37 (7.79)	95.00
Diff ¹	p = 0.026			p < 0.001			p = 0.057		

Note: ¹ Diff = Kruskal-Wallis test of the null hypothesis that values for a given scheme do not vary across the various levels of the TYPE variable. Definition of the TYPE variable is given in the text. Here n refers to the number of estimates, not to the number of respondents. Shaded cells indicated calculated values, unshaded cells denote stated values.

In order to investigate the determinants of the effects noted in Table 6 a set of potential explanatory variables were defined to parameterise the various dimensions of our study design. These variables are defined as follows:

CALC = 1 if the value under investigation was calculated (as defined previously); = 0 if the value was stated directly

STEP = 1 if the value under investigation was elicited from a stepwise disclosure choice set; = 0 if it was elicited from an advance disclosure choice set

SPH = 1 if the value under investigation was elicited from the design in which Scheme P was presented first (i.e. sample SPH); = 0 if the value was elicited from a design in which Scheme H was presented first.

EVENT_SPLIT = 1 for values of Scheme A elicited from designs where prior stated values for both Scheme H and Scheme P were elicited; = 0 for values of Scheme A elicited from designs where prior stated values for Scheme H only were elicited.

Table 7 presents details of the influence of each of the above variables upon WTP values for the three schemes. WTP values are given for each level of the above explanatory variables showing the influence of each. The first variable considered is CALC and results given show that when CALC = 0 (i.e. values are stated rather than calculated) mean WTP for Scheme H is £80.29, but that this falls to £59.36 for stated values. Corresponding median values decline from £60 to £40 and the non-parametric test statistic shows that this decline is clearly statistically significant (p=0.005). Results for Scheme P conform to the same pattern. However, as discussed previously, this implies the opposite change in values for Scheme A with calculated mean WTP being £106.17 for stated values compared to £130.14 for stated values (with an increase in medians from £80 to £100). Our test statistic shows that the part-whole/substitution effect suggested by these findings is clearly significant.

Results for the STEP variable show a reasonably consistent direction, with mean WTP values higher from stepwise than advance disclosure treatments. However, Examination of medians shows that this effect is not clear-cut and tests only indicate significance at the 10% level for Scheme P and no significance for either of the other schemes. However, returning to the results of Bateman *et al.*, (2001) given in Table 1 we can see that such a finding is not surprising as it was only in the stepwise bottom-up (SBU) treatment that results were clearly different from those of other treatments. As discussed previously, because we were not exclusively dealing with nested goods in the present experiment we could not specify from the outset which of our various stepwise disclosure treatments would most closely conform to the SBU approach. However, we now have clear evidence from previous tables that Scheme P is considered to be the lowest value of the goods presented to participants. Therefore, SBU design used in our previous study corresponds to the SPH treatment used here, with the lowest value good being valued first in a stepwise format where participants are unaware that they will be subsequently be presented with the higher value Scheme H good.

Table 7: Treatment effects

Explanatory Variable	Level	Scheme H				Scheme P				Scheme A			
		n	Mean WTP (s.e.)	Median	Sig. Diff. (p)	n	Mean WTP (s.e.)	Median	Sig. Diff. (p)	n	Mean WTP (s.e.)	Median	Sig. Diff. (p)
CALC	0	188	80.29 (5.49)	60.00	0.005	106	49.98 (6.18)	40.00	0.000	143	106.17 (9.26)	80.00	0.025
	1	68	59.36 (9.14)	40.00		77	22.91 (5.79)	10.00		106	130.14 (13.34)	100.00	
STEP	0	96	72.28 (6.55)	50.00	0.933	67	29.25 (3.87)	20.00	0.097	95	106.03 (8.34)	100.00	0.736
	1	160	76.26 (6.52)	51.00		116	43.98 (6.59)	30.00		154	122.75 (11.50)	92.50	
SPH	0	216	73.44 (5.45)	50.00	0.039	143	35.44 (5.50)	20.00	0.000	209	113.50 (9.01)	85.00	0.006
	1	40	81.53 (7.70)	70.00		40	49.85 (4.64)	47.50		40	131.38 (11.77)	120.00	
EVENT_SPLIT	0									77	103.38 (10.44)	90.00	0.243
	1									172	122.19 (10.26)	100.00	

Note:

1. Mann Whitney U test of the null hypothesis of no significant difference in values across the two levels of the variable in question

Table 7 shows that the impact of adopting the SPH design is to substantially raise the WTP statements for the initially valued good (Scheme P) relative to the comparatively low values accorded to this good under other treatments. Tests confirm the statistical significance of this result. This effect is carried over into the values for Scheme H elicited from treatment SPH which are again significantly higher than those for under other treatments (a result we comment upon further in conclusions to this paper). Unsurprisingly this means that the calculated values for Scheme A from treatment SPH are also significantly higher than those from other samples.

Finally Table 7 also reports results from our test of event splitting effects in values for Scheme A. Here, asking respondents to value both the constituent parts of Scheme A as opposed to only asking for a prior of Scheme H (and not eliciting prior values for Scheme P) results in an increase in mean WTP for Scheme A from £103.38 to £122.19 (with median values increasing from £90 to £100). However, while this directional shift is in accordance with event-splitting expectations, tests show that this effect is not statistically significant in this instance¹⁶.

Summarising Table 7 we can see that the CALC and SPH effects appear to be the major drivers of within scheme variation in values. However, these variables overlap significantly in that all of the values for Scheme A derived from treatment SPH are calculated rather than stated. To control for a final test was performed which permits us to examine the crucial question of whether values derived from single ‘part’ good valuation studies can be added to those for other ‘parts’ to correctly estimate values for embracing ‘whole’ goods. To test this we examine whether the sum of values for Scheme H and Scheme P, presented as the first good encountered by respondents in designs where they are unaware of any subsequent valuation possibilities, yield a calculated value for A which is similar to that obtained from stated values for Scheme A.

¹⁶ We also examined the possibility that the list length seen by respondents in the initial visible choice set may impact upon values for other schemes even after controlling for position within a list. Such tests cannot be performed upon stepwise treatments where initial list length is always constant at just one good. However, some, albeit weak, evidence for a list length effect can be gleaned by examining the stated values for Scheme H obtaining from advance disclosure treatments AHA and AHPA. Here Scheme H is always valued first and the only difference between the treatments is in terms of list length. From Table 4 we can see that mean stated WTP for Scheme H from treatment AHA (i.e. AHA_H) is £81.41 while the comparable value for Scheme H from treatment AHPA (i.e.) is £72.18. This suggests that values might decline as list length increases. However, these values are not significantly different yielding equal medians. Nevertheless, we believe that this might be a fertile area of future research.

Here we have two values for Scheme H which are both the first good valued by respondents and where those respondents faced stepwise designs and were unaware of the subsequent opportunities to value other goods (values SHA_H or $SHPA_H$). In contrast we have just one such value for Scheme P (value SPH_P). By adding the latter value for Scheme P with each in turn of the values for Scheme H we obtain estimates of calculated value for Scheme A based exclusively upon first response values from stepwise designs. This mimics the estimated value of Scheme A which would typically be obtained from combining values from most conventional CV studies of the constituent parts of this good. These values can be contrasted with those stated values for Scheme A derived from our design (values SHA_A , $SHPA_A$, AHA_A , $AHPA_A$). We can therefore derive the following variables detailing different measures of WTP for Scheme A.

STATED = stated values for Scheme A (SHA_A , $SHPA_A$, AHA_A , $AHPA_A$)

CALC1 = Calculated value for Scheme A derived by summing first response stepwise values $SHA_H + SPH_P$

CALC2 = Calculated value for Scheme A derived by summing first response stepwise values $SHPA_H + SPH_P$

Table 8 reports findings from comparisons of these measures.

Inspecting Table 8 we can see that calculated values obtained by summing first response values for the constituent parts of Scheme A substantially overestimates the stated values of the Scheme. Overestimates of mean WTP values range from 30-35% while overestimates of median values range from 33-66%. Non parametric tests confirm that in both cases these differences are highly significant ($p < 0.01$). Therefore, in this case single good (part) valuations, added together, result in very substantial and significant overestimates of combined good (whole) values.

Table 8: Comparing stated WTP for Scheme A with values calculated from stepwise first responses for Scheme H and Scheme P

Scheme A measure	Count	Mean (s.e.)	Median
STATED	148	98.83 (8.64)	75.00
CALC1	40	128.68 (11.45)	120.00
CALC2	40	133.39 (17.85)	100.00

Notes:

STATED = stated values for Scheme A ($SHAA$, $SHPAA$, $AHAA$, $AHPAA$)

CALC1 = Calculated value for Scheme A derived by summing first response stepwise values $SHAH + SPHP$

CALC2 = Calculated value for Scheme A derived by summing first response stepwise values $SHPAH + SPHP$

5. Summary and Conclusions

This study reports an analysis of certain characteristics of values for the reduction of air pollution impacts as estimated using the CV method. A split sample design has been used to investigate a number of issues and potential anomalies which have been highlighted in the CV and experimental economics literature. Values were elicited for three Schemes to reduce the impacts of air pollution upon:

- (i) human health (Scheme H)
- (ii) plants (Scheme P)
- (iii) human health and plants (Scheme A; which combined the effects of Scheme H and Scheme P)

Stated values were obtained for each of these schemes from across the various treatments which define our study design. In addition to these *calculated values* for Scheme A were obtained by summing stated values for Scheme H and for Scheme P. Calculated values for Scheme P were obtained by subtracting stated values for Scheme H from stated values for Scheme A. The calculated values implicitly assume an absence of part-whole/substitution effects between the values of Schemes H and P. For example, the calculated value of Scheme A implicitly assumes that Scheme H is in no respects a substitute for Scheme P (and vice versa). By comparing stated and calculated value for a given schemes we can test these assumptions.

Our experiments yielded a number of findings. There was considerable value consistency within stated values for each scheme suggesting that respondents were referring to some underlying (although not necessarily theoretically consistent) preferences or valuation process. Furthermore, no anomalies were found regarding sensitivity to the scope of schemes, instead general evidence of significant scope sensitivity was observed.

However, the use of stepwise designs which present participants with low value goods first (i.e. our SPH treatment) appears to generate significantly different values than do other approaches. Specifically, when a good which is valued at a relatively low level in other treatments is presented at the beginning of a stepwise list its value is elevated. This finding could be interpreted as either a theoretically consistent substitution effect (Carson *et al.*, 1998) or as the impact of a theoretically inconsistent ‘moral satisfaction of giving’ to a good cause being attached to first responses (Kahneman and Knetsch, 1992). Disentangling the different potential drivers of an identical effect is problematic and would require a considerable ‘verbal protocol’ extension to our design (Schkade and

Payne, 1992). However, the consequent effect upon Scheme H values in the SPH treatment cannot be explained by economic theory which would expect that the movement from first position in all other treatments to second position in the SPH list would result in a reduction in stated values arising from substitution effects. Instead, as shown in Table 7, values for Scheme H from the SPH treatment are significantly higher than those in other treatments. While this is inconsistent with economic theory it does conform to psychological expectations based on an ‘anchoring and adjustment’ heuristic wherein the high values stated previously for Scheme P feed through into elevated values for Scheme H stated subsequently.

While the latter finding is of most concern from a theoretical and methodological perspective, perhaps the most important practical finding concerned the clear evidence found of significant part-whole/substitution effects. In particular, we found that summing the values obtained from several single good valuation exercises (i.e. corresponding to first responses in our stepwise disclosure designs) to calculate estimates for wider goods risks the likelihood of significantly overestimating the value of the latter wider goods. Policymakers need to be aware of the potential for such relationships when assessing valuation evidence as part of efforts to design appropriate economic instruments for regulatory purposes.

In summary therefore, our findings raise a number of theoretical and methodological and applications issues which need to be borne in mind when undertaking valuation work regarding air pollution externalities. Indeed we might expect that a number of these concerns may well apply to many public good valuation exercises. However, in conclusion we should remember that this was a relatively simple exercise dictated by resource constraints which precluded the use of incentive compatible designs. Therefore its findings should be treated with caution. In particular the absolute values for WTP measures should be disregarded. Nevertheless the fundamental nature of the concerns raised suggest that these issues are worthy of further investigation within a more controlled and incentive compatible framework.

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Appendix A: Theoretical Model of Part-Whole Effects

Suppose an individual has an endowment of a group of goods, x (so that x is a vector) and spends y on all other goods. Let x' , x'' represent two other levels of endowment, with $x \leq x' \leq x''$, so that $(x''-x')$ and $(x'-x)$ are the 'first' and 'second' parts respectively. Willingness to pay for the first part is defined by:

$$U(x,y) = U(x',y-wtp^1),$$

where U is a utility function representing the individual's preferences. Willingness to pay for the second part, given that the consumer has the first part is:

$$U(x,y) = U(x'',y-wtp^1-wtp^2)$$

Finally, willingness to pay for the whole is,

$$U(x,y) = U(x'',y-wtp^3),$$

Note that in field trials it is often not possible to adjust for income effects, so that wtp^2 would be approximated by,¹⁷

$$U(x',y) = U(x'',y-wtp^2).$$

PHB proper exists if the elicited values for wtp_i , $i=1,2,3$, are such that,

$$wtp^1 + wtp^2 > wtp^3$$

¹⁷ If demand for x is normal, then this leads to an overestimate of wtp^2 which may yield the conclusion that part-whole bias exists when it does not.

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Appendix B: Questionnaires

In this Appendix we reproduce the questionnaires used in each of three samples used in this study (questionnaires have been somewhat reformatted in size to fit this report). Each questionnaire is denoted with the sample to which it appertains using the group number and coding system developed for Table 2 and are presented in the following order:

- (i) Group 1: SHA
- (ii) Group 2: SHPA
- (iii) Group 3: AHA
- (iv) Group 4: AHPA
- (v) Group 5: SPH

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[Type: Group 1: SHA]

This research concerns peoples views about air pollution. We deliberately do not provide you with lots of new information and statistics about the current level or impacts of air pollution as we want to avoid unduly influencing your answers with information that most people do not have.

We are going to tell you about **an air quality improvement scheme**. Once we have told you about this scheme we will consider it and ask you the maximum amount you would be willing to pay per year in order to be implemented in practice. We are not going to go into technical details about how this scheme will be implemented or about how money would be collected as there are a variety of possible options and this is not what we are interested in. Do not worry about these technical details, just think about how much you are willing to pay.

This scheme is an alternative to the current situation and we start by briefly considering, in very simple terms, what this current situation is.

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Please consider a move from the Current Situation described below to that under Scheme H.

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme H: Toxic vehicle emissions and human health

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects no longer occurred.

Think about how much the implementation of Scheme H is worth to you.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme H such that the air quality is improved from its current level to the level described in Scheme H.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

Maximum amount per year: (£)

--	--	--

 (p)

--	--

In the space below please briefly describe the factors that influenced your answer:

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After this point scheme H NO LONGER OPERATES
Consider now a move from the Current Situation to that under Scheme A.

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme A: Scheme H and Scheme P

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Toxic vehicle emissions and acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of emissions to the level where their effects no longer occurred.

Think about how much the implementation of Scheme A is worth to you.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme A such that the air quality is improved from its current level to the level described in Scheme A.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

Maximum amount per year: (£)

--	--	--

 (p)

--	--

In the space below please briefly describe the factors that influenced your answer:

--	--	--	--

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The next 15 questions deal with your feelings about a range of issues. There are no right or wrong answers. Please write at the end of each line which number on the scale given below indicates how much you agree or disagree with it. Please try to answer every statement even if you don't have a strong opinion about it. I would like your immediate response, so please do not spend too much time on any one question.

Statement	Strongly agree	Some-what agree	Un-sure	Some-what disagree	Strongly disagree
I fully understood what was asked of me in this questionnaire.					
I found this questionnaire difficult to answer honestly.					
The environmental issues described in this questionnaire are of interest to me					
The scenarios presented in the questionnaire seemed realistic to me.					
I feel that monetary values are an acceptable way of representing people's values of environmental assets.					
Nature should not be valued in economic terms.					
A comfortable life for my family and myself is important to me.					
I am interested in the spiritual side of life.					
Morals and ethics should be used to solve environmental conflicts.					
I believe there is some ultimate power overseeing my life.					
I believe that it is entirely up to me to make a success of my life.					
I am solely responsible for my own thoughts and actions.					
I have complete freedom in my life to choose how I want to live.					
Life is fundamentally random and meaningless.					
My life only has meaning if I choose to give it meaning.					

When you have responded to each statement, please continue to the next page

INFORMATION ABOUT YOU

What degree course are you on? (e.g. MSc EIA) _____

What year of study are you in? _____

Are you permanent residence in UK? YES NO (Delete one)

Sex: Male Female (Delete whichever does not apply)

Ethnicity group: _____

Age last birthday: _____ years

Have you studied economics before? YES NO (Delete one)

If "yes", to what level? (Tick highest level to which studied)

- GCSE
- A level
- Bachelor's degree
- Master's degree
- Ph.D.

What is your expected income from all sources, before tax, in the next 12 months? (Include loans, parental contributions, earnings, gifts, etc.)?

£ _____

END OF QUESTIONS; THANK YOU FOR YOUR HELP!

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[Type: Group 2: SHPA]

This research concerns peoples views about air pollution. We deliberately do not provide you with lots of new information and statistics about the current level or impacts of air pollution as we want to avoid unduly influencing your answers with information that most people do not have.

We are going to tell you about **an air quality improvement scheme**. Once we have told you about this scheme we will consider it and ask you the maximum amount you would be willing to pay per year in order to be implemented in practice. We are not going to go into technical details about how this scheme will be implemented or about how money would be collected as there are a variety of possible options and this is not what we are interested in. Do not worry about these technical details, just think about how much you are willing to pay.

This scheme is an alternative to the current situation and we start by briefly considering, in very simple terms, what this current situation is.

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Please consider a move from the Current Situation described below to that under Scheme H.

Here is briefly the current situation:

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

And here is the alternative scheme H:

Scheme H: Toxic vehicle emissions and human health

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects no longer occurred.

Think about how much the implementation of Scheme H is worth to you.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme H such that the air quality is improved from its current level to the level described in Scheme H.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

Maximum amount per year: (£)

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 (p)

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In the space below please briefly describe the factors that influenced your answer:

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After this point scheme H NO LONGER OPERATES

Consider now a move from the Current Situation to that under Scheme P.

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme P: Acidic power station emissions and effects on plant life

- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of power plant emissions which affect plant life to the level where these effects no longer occurred.

Think about how much the implementation of Scheme P is worth to you.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme P such that the air quality is improved from its current level to the level described in Scheme P.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

Maximum amount per year: (£)

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 (p)

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In the space below please briefly describe the factors that influenced your answer:

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After this point scheme P NO LONGER OPERATES

Consider now a move from the Current Situation to that under Scheme A.

Note that scheme A is simply Scheme H and Scheme P.

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme A: Scheme H and Scheme P

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Toxic vehicle emissions and acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of emissions to the level where their effects no longer occurred.

Think about how much the implementation of Scheme H is worth to you.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme A such that the air quality is improved from its current level to the level described in Scheme A.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

Maximum amount per year: (£)

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 (p)

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In the space below please briefly describe the factors that influenced your answer:

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The next 15 questions deal with your feelings about a range of issues. There are no right or wrong answers. Please write at the end of each line which number on the scale given below indicates how much you agree or disagree with it. Please try to answer every statement even if you don't have a strong opinion about it. I would like your immediate response, so please do not spend too much time on any one question.

INFORMATION ABOUT YOU

What degree course are you on? (e.g. MSc EIA) _____

What year of study are you in? _____

Are you permanent residence in UK? YES NO (Delete one)

Sex: Male Female (Delete whichever does not apply)

Ethnicity group: _____

Age last birthday: _____ years

Have you studied economics before? YES NO (Delete one)

If "yes", to what level? (Tick highest level to which studied)

- GCSE
- A level
- Bachelor's degree
- Master's degree
- Ph.D.

What is your expected income from all sources, before tax, in the next 12 months? (Include loans, parental contributions, earnings, gifts, etc.)?

£ _____

Statement	Strongly agree	Somewhat agree	Unsure	Somewhat disagree	Strongly disagree
I fully understood what was asked of me in this questionnaire.					
I found this questionnaire difficult to answer honestly.					
The environmental issues described in this questionnaire are of interest to me					
The scenarios presented in the questionnaire seemed realistic to me.					
I feel that monetary values are an acceptable way of representing people's values of environmental assets.					
Nature should not be valued in economic terms.					
A comfortable life for my family and myself is important to me.					
I am interested in the spiritual side of life.					
Morals and ethics should be used to solve environmental conflicts.					
I believe there is some ultimate power overseeing my life.					
I believe that it is entirely up to me to make a success of my life.					
I am solely responsible for my own thoughts and actions.					
I have complete freedom in my life to choose how I want to live.					
Life is fundamentally random and meaningless.					
My life only has meaning if I choose to give it meaning.					

When you have responded to each statement, please continue to the next page

END OF QUESTIONS; THANK YOU FOR YOUR HELP!

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[Type: Group 3: AHA]

This research concerns peoples views about air pollution. We deliberately do not provide you with lots of new information and statistics about the current level or impacts of air pollution as we want to avoid unduly influencing your answers with information that most people do not have.

We are going to tell you about **two alternative air quality improvement schemes**. Once we have told you about both schemes, then we will consider each in turn and ask you what the maximum amount you would be willing to pay per year for each scheme to be implemented in practice. We are not going to go into technical details about how schemes will be implemented or about how money would be collected as there are a variety of possible options and this is not what we are interested in. Do not worry about these technical details, just think about how much you are willing to pay for each scheme.

As each of the two schemes is an alternative to the current situation we start by briefly considering, in very simple terms, what this current situation is.

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Here is briefly the current situation:

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

There are two alternative air quality improvement schemes: First, we could implement the following scheme:

Scheme H: Toxic vehicle emissions and human health

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects no longer occurred.

Secondly we could implement the following alternative.

Scheme A: Scheme H and Scheme P

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Toxic vehicle emissions and acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of emissions to the level where their effects no longer occurred.

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We are now going to consider each of the alternative improvement schemes in turn, and how much the implementation of each of these schemes is worth to you. We shall start with Scheme H and then move on to Scheme A. In each case, think about how much you would value a move from the Current Situation to that provided by each scheme.

First consider a move from the Current Situation to that under Scheme H. Here again is the Current Situation:

<u>Current Situation</u>
<ul style="list-style-type: none">Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

<u>Scheme H: Toxic vehicle emissions and human health</u>
<ul style="list-style-type: none">The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects <u>no longer</u> occurred.

Think about how much the implementation of Scheme H is worth to you. Feel free to compare the schemes before answering.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme H such that the air quality is improved from its current level to the level described in Scheme H.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

maximum amount per year: (£)

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 (p)

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In the space below please briefly describe the factors that influenced your answer:

Consider now a move from the Current Situation to that under Scheme A.

<u>Current Situation</u>
<ul style="list-style-type: none">Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

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<u>Scheme A: Scheme H and Scheme P</u>
<ul style="list-style-type: none">The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.Toxic vehicle emissions and acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of emissions to the level where their effects no longer occurred.

Think about how much the implementation of Scheme A is worth to you. Feel free to compare the schemes before answering.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme A such that the air quality is improved from its current level to the level described in Scheme A.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

Maximum amount per year: (£)

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 (p)

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In the space below please briefly describe the factors that influenced your answer:

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The next 15 questions deal with your feelings about a range of issues. There are no right or wrong answers. Please write at the end of each line which number on the scale given below indicates how much you agree or disagree with it. Please try to answer every statement even if you don't have a strong opinion about it. I would like your immediate response, so please do not spend too much time on any one question.

INFORMATION ABOUT YOU

What degree course are you on? (e.g. MSc EIA) _____

What year of study are you in? _____

Are you permanent residence in UK? YES NO (Delete one)

Sex: Male Female (Delete whichever does not apply)

Ethnicity group: _____

Age last birthday: _____ years

Have you studied economics before? YES NO (Delete one)

If "yes", to what level? (Tick highest level to which studied)

- GCSE
- A level
- Bachelor's degree
- Master's degree
- Ph.D.

What is your expected income from all sources, before tax, in the next 12 months? (Include loans, parental contributions, earnings, gifts, etc.)?

£ _____

Statement	Strongly agree	Somewhat agree	Unsure	Somewhat disagree	Strongly disagree
I fully understood what was asked of me in this questionnaire.					
I found this questionnaire difficult to answer honestly.					
The environmental issues described in this questionnaire are of interest to me					
The scenarios presented in the questionnaire seemed realistic to me.					
I feel that monetary values are an acceptable way of representing people's values of environmental assets.					
Nature should not be valued in economic terms.					
A comfortable life for my family and myself is important to me.					
I am interested in the spiritual side of life.					
Morals and ethics should be used to solve environmental conflicts.					
I believe there is some ultimate power overseeing my life.					
I believe that it is entirely up to me to make a success of my life.					
I am solely responsible for my own thoughts and actions.					
I have complete freedom in my life to choose how I want to live.					
Life is fundamentally random and meaningless.					
My life only has meaning if I choose to give it meaning.					

When you have responded to each statement, please continue to the next page

END OF QUESTIONS; THANK YOU FOR YOUR HELP!

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[Type: Group 4: AHPA]

This research concerns peoples views about air pollution. We deliberately do not provide you with lots of new information and statistics about the current level or impacts of air pollution as we want to avoid unduly influencing your answers with information that most people do not have.

We are going to tell you about **three alternative air quality improvement schemes**. Once we have told you about all three then we will consider each in turn and ask you what the maximum amount you would be willing to pay per year for each scheme to be implemented in practice. We are not going to go into technical details about how schemes will be implemented or about how money would be collected as there are a variety of possible options and this is not what we are interested in. Do not worry about these technical details, just think about how much you are willing to pay for each scheme.

As each of the three schemes is an alternative to the current situation we start by briefly considering, in very simple terms, what this current situation is.

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Here is briefly the current situation:

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

There are three **alternative** air quality improvement schemes: First, we could implement the following scheme:

Scheme H: Toxic vehicle emissions and human health

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects no longer occurred.

The second **alternative** is as follows:

Scheme P: Acidic power station emissions and effects on plant life

- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of power plant emissions which affect plant life to the level where these effects no longer occurred.

Finally we could implement the following **alternative** which is simply a combination of both of the above alternatives.

Scheme A: Scheme H and Scheme P

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Toxic vehicle emissions and acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of emissions to the level where their effects no longer occurred.

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We are now going to consider each of the alternative improvement schemes in turn, and how much the implementation of each of these schemes is worth to you. We shall start with Scheme H, then move on to Scheme P, and finally consider Scheme A. In each case, think about how much you would value a move from the Current Situation to that provided by each scheme.

First consider a move from the Current Situation to that under Scheme H. Here again is the Current Situation:

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme H: Toxic vehicle emissions and human health

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects no longer occurred.

Think about how much the implementation of Scheme H is worth to you. Feel free to compare the schemes before answering.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme H such that the air quality is improved from its current level to the level described in Scheme H.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

Maximum amount per year: (£) (p)

In the space below please briefly describe the factors that influenced your answer:

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Consider now a move from the Current Situation to that under Scheme P.

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme P: Acidic power station emissions and effects on plant life

- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of power plant emissions which affect plant life to the level where these effects no longer occurred.

Think about how much the implementation of Scheme P is worth to you. Feel free to compare the schemes before answering.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme P such that the air quality is improved from its current level to the level described in Scheme P.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

maximum amount per year: (£) (p)

In the space below please briefly describe the factors that influenced your answer:

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Consider now a move from the Current Situation to that under Scheme A.

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme A: Scheme H and Scheme P

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Toxic vehicle emissions and acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of emissions to the level where their effects no longer occurred.

Think about how much the implementation of Scheme A is worth to you. Feel free to compare the schemes before answering.

What is the maximum amount you would be prepared to pay per year in order to implement Scheme A such that the air quality is improved from its current level to the level described in Scheme A.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

maximum amount per year: (£) (p)

In the space below please briefly describe the factors that influenced your answer:

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The next 15 questions deal with your feelings about a range of issues. There are no right or wrong answers. Please write at the end of each line which number on the scale given below indicates how much you agree or disagree with it. Please try to answer every statement even if you don't have a strong opinion about it. I would like your immediate response, so please do not spend too much time on any one question.

Statement	Strongly agree	Somewhat agree	Unsure	Somewhat disagree	Strongly disagree
I fully understood what was asked of me in this questionnaire.					
I found this questionnaire difficult to answer honestly.					
The environmental issues described in this questionnaire are of interest to me					
The scenarios presented in the questionnaire seemed realistic to me.					
I feel that monetary values are an acceptable way of representing people's values of environmental assets.					
Nature should not be valued in economic terms.					
A comfortable life for my family and myself is important to me.					
I am interested in the spiritual side of life.					
Morals and ethics should be used to solve environmental conflicts.					
I believe there is some ultimate power overseeing my life.					
I believe that it is entirely up to me to make a success of my life.					
I am solely responsible for my own thoughts and actions.					
I have complete freedom in my life to choose how I want to live.					
Life is fundamentally random and meaningless.					
My life only has meaning if I choose to give it meaning.					

When you have responded to each statement, please continue to the next page

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INFORMATION ABOUT YOU

What degree course are you on? (e.g. MSc EIA) _____

What year of study are you in? _____

Are you permanent residence in UK? YES NO (Delete one)

Sex: Male Female (Delete whichever does not apply)

Ethnicity group: _____

Age last birthday: _____ years

Have you studied economics before? YES NO (Delete one)

If “yes”, to what level? (Tick highest level to which studied)

- GCSE
- A level
- Bachelor’s degree
- Master’s degree
- Ph.D.

What is your expected income from all sources, before tax, in the next 12 months?
(Include loans, parental contributions, earnings, gifts, etc.)?

£ _____

END OF QUESTIONS; THANK YOU FOR YOUR HELP!

[Type: Group 5: SPH]

This research concerns peoples views about air pollution. We deliberately do not provide you with lots of new information and statistics about the current level or impacts of air pollution as we want to avoid unduly influencing your answers with information that most people do not have.

We are going to tell you about an **air quality improvement scheme**. Once we have told you about this scheme we will consider it and ask you the maximum amount you would be willing to pay per year in order to be implemented in practice. We are not going to go into technical details about how this scheme will be implemented or about how money would be collected as there are a variety of possible options and this is not what we are interested in. Do not worry about these technical details, just think about how much you are willing to pay.

This scheme is an alternative to the current situation and we start by briefly considering, in very simple terms, what this current situation is.

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Consider a move from the Current Situation to that under Scheme P.

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

Scheme P: Acidic power station emissions and effects on plant life

- The main effect of the acidic emissions produced by power stations is upon plant life. For example power plant emissions are associated with acid rain which damages plants.
- Acidic power station emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to reduce those types of power plant emissions which affect plant life to the level where these effects no longer occurred.

Think about how much the implementation of Scheme P is worth to you.

What is the **maximum** amount you would be prepared to pay per year in order to implement Scheme P such that the air quality is improved from its current level to the level described in Scheme P.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

maximum amount per year: (£)

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 (p)

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In the space below please briefly describe the factors that influenced your answer:

After this point scheme **P NO LONGER OPERATES**

Please consider now a move from the Current Situation described below to that under Scheme H.

Here is briefly the current situation:

Current Situation

- Existing regulations ensure that air pollution stays at roughly its present level with some consequences for human health, water quality, plants and animals, buildings and materials etc.

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And here is the alternative scheme H:

Scheme H: Toxic vehicle emissions and human health

- The main impact of toxic vehicle emissions is in terms of damage to human health. For example, vehicle emissions are associated with worsening the condition of those suffering from heart and respiratory problems. They may also put children at risk of respiratory problems.
- The toxicity of vehicle emissions may be reduced in a number of ways but all of these cost money. Please consider the maximum amount you would be willing to pay per year to fund a scheme which reduced the toxicity of vehicle emissions to the level where these respiratory and health effects no longer occurred.

Think about how much the implementation of Scheme H is worth to you.

What is the **maximum** amount you would be prepared to pay per year in order to implement Scheme H such that the air quality is improved from its current level to the level described in Scheme H.

(WRITE YOUR ANSWER IN THE BOXES BELOW)

maximum amount per year: (£)

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 (p)

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In the space below please briefly describe the factors that influenced your answer:

The next 15 questions deal with your feelings about a range of issues. There are no right or wrong answers. Please write at the end of each line which number on the scale given below indicates how much you agree or disagree with it. Please try to answer every statement even if you don't have a strong opinion about it. I would like your immediate response, so please do not spend too much time on any one question.

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Statement	Strongly agree	Somewhat agree	Unsure	Somewhat disagree	Strongly disagree
I fully understood what was asked of me in this questionnaire.					
I found this questionnaire difficult to answer honestly.					
The environmental issues described in this questionnaire are of interest to me					
The scenarios presented in the questionnaire seemed realistic to me.					
I feel that monetary values are an acceptable way of representing people's values of environmental assets.					
Nature should not be valued in economic terms.					
A comfortable life for my family and myself is important to me.					
I am interested in the spiritual side of life.					
Morals and ethics should be used to solve environmental conflicts.					
I believe there is some ultimate power overseeing my life.					
I believe that it is entirely up to me to make a success of my life.					
I am solely responsible for my own thoughts and actions.					
I have complete freedom in my life to choose how I want to live.					
Life is fundamentally random and meaningless.					
My life only has meaning if I choose to give it meaning.					

When you have responded to each statement, please continue to the next page

INFORMATION ABOUT YOU

What degree course are you on? (e.g. MSc EIA) _____

What year of study are you in? _____

Are you permanent residence in UK? YES NO (Delete one)

Sex: Male Female (Delete whichever does not apply)

Ethnicity group: _____

Age last birthday: _____ years

Have you studied economics before? YES NO (Delete one)

If "yes", to what level? (Tick highest level to which studied)

- GCSE
- A level
- Bachelor's degree
- Master's degree
- Ph.D.

What is your expected income from all sources, before tax, in the next 12 months? (Include loans, parental contributions, earnings, gifts, etc.)?

£ _____

END OF QUESTIONS; THANK YOU FOR YOUR HELP!

Appendix C: Further analytic details

In this Appendix we present further details regarding the various analyses presented in the main body of this paper. These are as follows:

Table C.1: presents tests of differences between WTP measure within and across (i) schemes and (ii) treatments;

Tables C.2.1 to C.2.7 report distributional details and outlier sensitivity analyses for the impact upon values for Scheme A of the various design dimensions of our experiment. Table C.2.1 reports distributional details for the various levels of the TYPE variable (defined generally for all schemes below the table with specific coding for Scheme A given within the first four columns of the table). Table C.2.2 presents distributional details for the impacts of the variables CALC, SPH, STEP and EVENT_SPLIT upon values for Scheme A. Tables C.2.1 and C.2.2 utilise the entire data set of 256 value estimates of which 7 were non-responses coded as missing values. Tables C.2.3 and C.2.4 repeat these analyses but omit the three highest WTP values to permit a sensitivity analysis of outlier effects. Table C.2.5 and C.2.6 extend this outlier analysis by further omitting the next two highest values. Table C.2.7 completes this analysis for Scheme A values by reporting statistical significance tests for the various permutations of design effect and outlier exclusion analysed. This shows that non-parametric tests are essentially unaffected by the exclusion of outliers. In contrast parametric tests are highly susceptible to the treatment of outliers. This reflects the non-normal distribution of responses and underlines the decision to use non-parametric tests in the main body of this paper.

Tables C.3.1 to C.3.3 repeat the above analysis for Scheme H values but omit consideration of outlier effects both because these mimic those for Scheme A values and because we have no a-priori reason for suspecting that these values are motivated by strategic considerations. Table C.4.1 to C.4.3 repeat this analysis for Scheme P values.

Table C.5 to C.7 provides further analysis of a number of others raised in the paper. Table C.5 considers further the impact of the SPH and CALC design dimensions upon values for Scheme A. Table C.6 examines whether the excess of SPH_{CA} over all other (stated and calculated) measures of the value of Scheme A is still preserved when the comparison is narrowed to contrast SPH_{CA} with just the stated WTP measures for Scheme A derived from other treatments. The results given in this table show that this narrowing of the field of comparison does not substantially reduce the strong significance of the difference between the calculated value for Scheme A derived from treatment SPH and stated values obtained from other treatments. Finally Table C.7 provides further distributional data for the analysis given in Table 8 of the main text of the paper.

Table C.1: Tests of WTP measure differences within and across schemes and treatments

Variable	SHA _{II}	SHA _{CP}	SHA _A	SHPA _{II}	SHPA _P	SHPA _A	SHPA _{CA}	AHA _{II}	AHA _{CP}	AHA _A	AHPA _{II}	AHPA _P	AHPA _A	AHPA _{CA}	SPH _P	SPH _{II}	SPH _{CA}
SHA _{II}	1.000																
SHA _{CP}	0.000	1.000															
SHA _A	0.000	0.000	1.000														
SHPA _{II}	0.888	0.000	0.351	1.000													
SHPA _P	0.006	0.001	0.010	0.000	1.000												
SHPA _A	0.302	0.000	0.896	0.000	0.000	1.000											
SHPA _{CA}	0.075	0.000	0.411	0.000	0.000	0.005	1.000										
AHA _{II}	0.739	0.000	0.620	0.572	0.001	0.457	0.093	1.000									
AHA _{CP}	0.000	0.703	0.000	0.000	0.001	0.000	0.000	0.000	1.000								
AHA _A	0.115	0.000	0.533	0.037	0.000	0.473	0.842	0.000	0.000	1.000							
AHPA _{II}	0.625	0.000	0.227	0.789	0.102	0.233	0.075	0.473	0.000	0.117	1.000						
AHPA _P	0.047	0.020	0.010	0.053	0.486	0.003	0.000	0.016	0.002	0.000	0.005	1.000					
AHPA _A	0.313	0.000	0.861	0.260	0.004	0.770	0.790	0.450	0.000	0.888	0.000	0.000	1.000				
AHPA _{CA}	0.122	0.000	0.503	0.088	0.001	0.398	0.775	0.179	0.000	0.851	0.000	0.000	0.002	1.000			
SPH _P	0.102	0.000	0.015	0.061	0.071	0.001	0.000	0.026	0.000	0.000	0.556	0.408	0.033	0.005	1.000		
SPH _{II}	0.562	0.000	0.743	0.294	0.000	0.646	0.147	0.564	0.000	0.261	0.273	0.001	0.675	0.290	0.000	1.000	
SPH _{CA}	0.002	0.000	0.056	0.000	0.000	0.022	0.146	0.001	0.000	0.027	0.002	0.000	0.153	0.295	0.000	0.000	1.000

Shaded cells = Non parametric two related samples (Wilcoxon) test used
 Unshaded cells = Non parametric two independent samples (Mann-Whitney U) test used

Table C.2.1: Distribution of WTP values for Scheme A across all levels of the TYPE variable (with the latter variable defined as shown in the table): Full sample of 256 responses minus 7 non-responses coded as missing values

TYPE	CALC	SPH	STEP	n	Mean WTP Good A	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std. Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
1	0	0	1	76	110.21	15.39	79.55	140.87	134.18	5.00	40.00	72.50	142.50	900.00
2	1	0	1	38	138.76	32.96	71.98	205.54	203.17	9.00	55.00	90.00	150.00	1000.00
3	0	0	0	67	101.58	9.37	82.88	120.29	76.69	.00	40.00	100.00	150.00	300.00
4	1	0	0	28	116.68	17.37	81.05	152.31	91.89	.00	32.50	100.00	200.00	290.00
5	1	1	1	40	131.38	11.77	107.56	155.19	74.46	10.00	80.00	120.00	161.25	360.00
Total				249	116.37	7.79	101.01	131.73	123.06	0.00	47.50	95.00	150.00	1000.00

TYPE coded as follows:

- 1 = stated values from stepwise disclosure treatments with Scheme H valued first (SHA & SHPA; not statistically different – see main text)
- 2 = calculated values from stepwise disclosure treatments with Scheme H valued first (SHPA)
- 3 = stated values from advance disclosure treatments with Scheme H valued first (AHA & AHPA; not statistically different – see main text)
- 4 = calculated values from advance disclosure treatments with Scheme H valued first (AHPA)
- 5 = stated values (Schemes P and H) or calculated value (Scheme A) from stepwise disclosure treatments with Scheme P valued first (SPH)

Table C.2.2: Distribution of WTP values for Scheme A across all levels of the CALC, SPH, STEP and EVENT_SPLIT variables (definitions below table): Full sample of 256 responses minus 7 non-responses coded as missing values

Variable	Level	n	Mean WTP Good A	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
CALC	0	143	106.17	9.26	87.86	124.47	110.73	.00	40.00	80.00	150.00	900.00
	1	106	130.14	13.34	103.70	156.58	137.30	.00	60.00	100.00	153.75	1000.00
SPH	0	209	113.50	9.01	95.74	131.26	130.25	.00	40.00	85.00	150.00	1000.00
	1	40	131.38	11.77	107.56	155.19	74.46	10.00	80.00	120.00	161.25	360.00
STEP	0	95	106.03	8.34	89.48	122.58	81.26	.00	40.00	100.00	180.00	300.00
	1	154	122.75	11.50	100.02	145.48	142.77	5.00	50.00	92.50	150.00	1000.00
EVENT_SPLIT	0	77	103.38	10.44	82.58	124.17	91.60	5.00	40.00	90.00	120.00	500.00
	1	172	122.19	10.26	101.93	142.46	134.62	.00	50.00	100.00	150.00	1000.00
Total		249	116.37	7.79	101.01	131.73	123.06	0.00	47.50	95.00	150.00	1000.00

CALC = 1 if the value under investigation was calculated (as defined previously); = 0 if the value was stated directly

STEP = 1 if the value under investigation was elicited from a stepwise disclosure choice set; = 0 if it was elicited from an advance disclosure choice set

SPH = 1 if the value under investigation was elicited from the design in which Scheme P was presented first (i.e. sample SPH); = 0 if the value was elicited from a design in which Scheme H was presented first.

EVENT_SPLIT = 1 for values of Scheme A elicited from designs where prior stated values for both Scheme H and Scheme P were elicited; = 0 for values of Scheme A elicited from designs where prior stated values for Scheme H only were elicited.

Table C.2.3: Distribution of WTP values for Scheme A across all levels of the TYPE variable (with the latter variable defined as shown in the table): Full sample of 256 responses minus 7 non-responses coded as missing values and 3 responses of £1000, £900, £900.

TYPE	CALC	SPH	STEP	h	Mean WTP Good A	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std. Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
1	0	0	1	75	99.68	11.38	77.01	122.35	98.52	5	40.00	70.00	120.00	500
2	1	0	1	36	93.69	10.27	72.84	114.55	61.64	9	45.00	85.00	130.00	260
3	0	0	0	67	101.58	9.37	82.88	120.29	76.69	0	40.00	100.00	150.00	300
4	1	0	0	28	116.68	17.37	81.05	152.31	91.89	0	32.50	100.00	200.00	290
5	1	1	1	40	131.38	11.77	107.56	155.19	74.46	10	80.00	120.00	161.25	360
Total				246	106.41	5.35	95.88	116.94	83.84	0	43.75	95.00	150.00	500

Table C.2.4: Distribution of WTP values for Scheme A across all levels of the CALC, SPH, STEP and EVENT_SPLIT variables (definitions below Table C.2.2): Full sample of 256 responses minus 7 non-responses coded as missing values and 3 responses of £1000, £900, £900.

Variable	Level	N	Mean WTP Good A	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
CALC	0	142	100.58	7.43	85.88	115.27	88.59	00	40.00	80.00	150.00	500.00
	1	104	114.38	7.51	99.48	129.27	76.60	00	60.00	100.00	150.00	360.00
SPH	0	206	101.56	5.91	89.91	113.22	84.86	00	40.00	85.00	150.00	500.00
	1	40	131.38	11.77	107.56	155.19	74.46	10.00	80.00	120.00	161.25	360.00
STEP	0	95	106.03	8.34	89.48	122.58	81.26	00	40.00	100.00	180.00	300.00
	1	40	131.38	11.77	107.56	155.19	74.46	10.00	80.00	120.00	161.25	360.00
EVENT_SPLIT	0	151	106.65	6.97	92.87	120.43	85.70	5.00	50.00	90.00	150.00	500.00
	1	77	103.38	10.44	82.58	124.17	91.60	5.00	40.00	90.00	120.00	500.00
Total		169	107.79	6.18	95.60	119.99	80.31	00	50.00	100.00	150.00	500.00

Table C.2.5: Distribution of WTP values for Scheme A across all levels of the TYPE variable (with the latter variable defined as shown in the table): Full sample of 256 responses minus 7 non-responses coded as missing values and 5 responses of £1000, £900, £900, £500, £500

TYPE	CALC	SPH	STEP	h	Mean WTP Good A	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std. Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
1	0	0	1	73	88.71	8.60	71.56	105.86	73.50	5.00	40.00	70.00	110.00	350.00
2	1	0	1	36	93.69	10.27	72.84	114.55	61.64	9.00	45.00	85.00	130.00	260.00
3	0	0	0	67	101.58	9.37	82.88	120.29	76.69	00	40.00	100.00	150.00	300.00
4	1	0	0	28	116.68	17.37	81.05	152.31	91.89	00	32.50	100.00	200.00	290.00
5	1	1	1	40	131.38	11.77	107.56	155.19	74.46	10.00	80.00	120.00	161.25	360.00
Total				244	103.18	4.88	93.58	112.79	76.17	00	41.25	92.50	150.00	360.00

Table C.2.6: Distribution of WTP values for Scheme A across all levels of the CALC, SPH, STEP and EVENT_SPLIT variables (definitions below Table C.2.2): Full sample of 256 responses minus 7 non-responses coded as missing values and 5 responses of £1000, £900, £900, £500, £500

Variable	Level	N	Mean WTP Good A	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
CALC	0	140	94.87	6.34	82.33	107.41	75.05	00	40.00	80.00	138.00	350.00
	1	104	114.38	7.51	99.48	129.27	76.60	00	60.00	100.00	150.00	360.00
SPH	0	204	97.66	5.28	87.24	108.07	75.45	00	40.00	82.50	150.00	350.00
	1	40	131.38	11.77	107.56	155.19	74.46	10.00	80.00	120.00	161.25	360.00
STEP	0	95	106.03	8.34	89.48	122.58	81.26	00	40.00	100.00	180.00	300.00
	1	49	101.37	5.98	89.56	113.18	72.97	5.00	47.50	90.00	150.00	360.00
EVENT_SPLIT	0	151	106.65	6.97	92.87	120.43	85.70	5.00	50.00	95.00	150.00	350.00
	1	76	98.16	9.16	79.91	116.41	79.86	5.00	40.00	85.00	120.00	350.00
Total		244	103.18	4.88	93.58	112.79	76.17	00	41.25	92.50	150.00	360.00

Table C.2.7: Design determinants of WTP for Good A: Sensitivity analysis across non-parametric and parametric tests

Explanatory Variable ⁽¹⁾	Non parametric test ⁽²⁾	n = 249 ⁽³⁾ p	n = 246 ⁽⁴⁾ p	n = 244 ⁽⁵⁾ p	Parametric test ⁽²⁾	n = 249 ⁽³⁾ p	n = 246 ⁽⁴⁾ p	n = 244 ⁽⁵⁾ p
TYPE	Kruskal-Wallis ⁽⁶⁾	0.057	0.033	0.020	ANOVA	0.559	0.240	0.047
CALC	Mann Whitney U	0.025	0.034	0.002	ANOVA	0.129	0.203	0.048
SPH	Mann Whitney U	0.006	0.003	0.002	ANOVA	0.401	0.039	0.010
STEP	Mann Whitney U	0.736	0.940	0.918	ANOVA	0.299	0.955	0.642
EVENT_SPLIT	Mann Whitney U	0.243	0.346	0.287	ANOVA	0.266	0.702	0.489

Notes:

- (1) Dependent variable = WTP for good A (either stated or calculated)
- (2) All tests all 2 tailed
- (3) dataset excluding 7 non-respondents (total of 256 interviewed)
- (4) excludes 3 observations of £1000, £900 and £900
- (5) excludes 5 observations of £1000, £900, £900, £500 and £500.
- (6) Monte Carlo Kruskal-Wallis test based on 10,000 iterations.

Table C.3.1: Distribution of WTP values for Scheme H across all levels of the TYPE variable (with the latter variable defined as shown in the table): Full sample of 256 responses minus 7 non-responses coded as missing values

TYPE_H	CALC	SPH	STEP	n	Mean WTP Good H	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std. Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
1	0	0	1	80	82.05	10.44	61.25	102.86	91.05	5.00	25.00	52.00	100.00	500.00
2	1	0	1	40	59.13	13.91	30.95	87.31	85.74	.00	13.75	40.00	71.25	500.00
3	0	0	0	68	77.55	8.10	61.37	93.73	66.33	.00	20.00	50.00	100.00	300.00
4	1	0	0	28	59.68	10.67	37.78	81.57	56.46	-25.00	10.00	35.00	110.00	160.00
5	0	1	1	40	81.53	7.70	65.94	97.11	48.72	5.00	50.00	70.00	100.00	240.00
Total				249	74.74	4.74	65.42	84.07	74.73	-25.00	20.00	50.00	100.00	500.00

Table C.3.2: Distribution of WTP values for Scheme P across all levels of the CALC, SPH, and STEP variables (definitions below Table C.2.2): Full sample of 256 responses minus 7 non-responses coded as missing values

Variable	Level	N	Mean WTP Good H	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
CALC	0	188	80.29	5.49	69.45	91.13	74.33	.00	30.00	60.00	100.00	500.00
	1	68	59.36	9.14	41.12	77.61	74.22	-25.00	10.00	40.00	100.00	500.00
SPH	0	216	73.44	5.45	62.71	84.18	78.76	-25.00	20.00	50.00	100.00	500.00
	1	40	81.53	7.70	65.94	97.11	48.72	5.00	50.00	70.00	100.00	240.00
STEP	0	96	72.28	6.55	59.28	85.28	63.82	-25.00	20.00	50.00	110.00	300.00
	1	160	76.26	6.52	63.38	89.14	80.89	.00	25.00	51.00	100.00	500.00
Total		249	74.74	4.74	65.42	84.07	74.73	-25.00	20.00	50.00	100.00	500.00

Table C.3.3: Design determinants of WTP for Good H: Sensitivity analysis across non-parametric and parametric tests

Explanatory Variable ⁽¹⁾	Non-parametric test ⁽²⁾	n=249 ⁽³⁾	Parametric test ⁽²⁾	n=249 ⁽³⁾
TYPE H	Kruskal-Wallis ⁽⁴⁾	0.026	ANOVA	0.415
CALC	Mann Whitney U	0.005	ANOVA	0.051
SPH	Mann Whitney U	0.039	ANOVA	0.532
STEP	Mann Whitney U	0.933	ANOVA	0.684

Notes:

- (1) Dependent variable = WTP H
- (2) All tests are two-tailed
- (3) Full dataset excluding 7 non-responses
- (4) Monte-Carlo Kruskal-Wallis test based on 10,000 iterations.

Table C.4.1: Distribution of WTP values for Scheme P across all levels of the TYPE variable (with the latter variable defined as shown in the table): Full sample of 188 responses minus 5 non-responses coded as missing values

TYPE_P	CALC	SPH	STEP	n	Mean WTP Good P	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std. Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
1	0	0	1	38	54.16	15.89	21.96	86.35	97.95	4.00	10.00	30.00	50.00	500.00
2	1	0	1	38	27.63	11.15	5.05	50.22	68.71	-30.00	.00	5.00	25.75	400.00
3	0	0	0	28	44.50	6.81	30.53	58.47	36.02	.00	12.50	45.00	73.75	120.00
4	1	0	0	39	18.31	3.66	10.89	25.73	22.89	-10.00	.00	10.00	25.00	100.00
5	0	1	1	40	49.85	4.64	40.47	59.23	29.32	5.00	30.00	47.50	58.75	120.00
Total				183	38.59	4.43	29.85	47.33	59.94	-30.00	5.00	25.00	50.00	500.00

Table C.4.2: Distribution of WTP values for Scheme P across all levels of the CALC, SPH, and STEP variables (definitions below Table C.2.2): Full sample of 188 responses minus 5 non-responses coded as missing values

Variable	Level	n	Mean WTP Good P	Standard Error of Mean	95%CI Lower Bound	95% CI Upper Bound	Std Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
CALC	0	106	49.98	6.18	37.73	62.23	63.62	.00	20.00	40.00	51.25	500.00
	1	77	22.91	5.79	11.38	34.44	50.82	-30.00	.00	10.00	25.00	400.00
SPH	0	143	35.44	5.50	24.58	46.31	65.76	-30.00	2.00	20.00	50.00	500.00
	1	40	49.85	4.64	40.47	59.23	29.32	5.00	30.00	47.50	58.75	120.00
STEP	0	67	29.25	3.87	21.53	36.97	31.65	-10.00	.00	20.00	50.00	120.00
	1	116	43.98	6.59	30.94	57.03	70.94	-30.00	10.00	30.00	50.00	500.00
Total		183	38.59	4.43	29.85	47.33	59.94	-30.00	5.00	25.00	50.00	500.00

Table C.4.3: Design determinants of WTP for Good P: Sensitivity analysis across non-parametric and parametric tests

Explanatory Variable ⁽¹⁾	Non-parametric Test ⁽²⁾	n=183 ⁽³⁾	Parametric test ⁽²⁾	n=183 ⁽³⁾
TYPE P	Kruskal-Wallis ⁽⁴⁾	0.000	ANOVA	0.039
CALC	Mann Whitney U	0.000	ANOVA	0.002
SPH	Mann Whitney U	0.000	ANOVA	0.180
STEP	Mann Whitney U	0.097	ANOVA	0.110

Notes:

- (1) Dependent variable = WTP P
- (2) All tests are two-tailed
- (3) Full dataset excluding 5 non-responses
- (4) Monte-Carlo Kruskal-Wallis test based on 10,000 iterations.

Table C.5: Further analysis of the impact of SPH and CALC upon values for Scheme A

From Table 7 (main text) we can see that the CALC and SPH effects appear to be the major drivers of within scheme variation in values. However, these variables overlap significantly in that all of the values for Scheme A derived from treatment SPH are calculated rather than stated. To control for this three further categories of values for Scheme A were derived;

- (i) Stated values for Scheme A (which by default exclude any observations from treatment SPH where stated values were not elicited);
- (ii) Calculated values for Scheme A excluding those from treatment SPH;
- (iii) Calculated values for Scheme A from treatment SPH.

Table C.5 presents summary WTP values and significance tests for differences between the above categories.

Table C.5: Further analysis of the impact of SPH and CALC upon values for Scheme A

WTP Scheme A measure	Count	Mean	Median	p ¹	p ²
Stated (not asked for in SPH treatment)	148	106.17 (9.26)	80.00	0.354	0.006
Calculated (excluding SPH)	68	129.39 (20.27)	95.00		
Calculated (SPH only)	40	131.38 (11.77)	120.00	–	

- Notes: ¹ Mann Whitney U test for difference between two value measures
² Kruskal Wallis test for difference between three value measures.

Table 8 confirms again that, including all observations, values for Scheme A do differ significantly across the various dimensions embodied in our experimental design. However, removing the calculated values derived from our SPH treatment allows us to control for the bottom-up ordering effect embodied in that approach. Testing the remaining Scheme A values shows no significant difference between stated and calculate values. This is not an ideal test as we

have no observations of the value of Scheme A when presented as the first good encountered by respondents. However, this does suggest that the SPH effect is the major driving force between the stated versus calculated value disparity observed in our results.

Table C.6: Does the SPH (SBU) approach result in calculated A which is larger than stated A by other treatments, i.e. is $SPH_{CA} > (SHA_A, SHPA_A, AHA_A, AHPA_A)$?

Scheme A WTP measure	Count	Mean	Standard Error of Mean	Std Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
SPH_{CA}	40	131.38	11.77	74.46	10.00	80.00	120.00	161.25	360.00
($SHA_A, SHPA_A, AHA_A, AHPA_A$)	148	106.17	9.26	110.73	.00	40.00	80.00	150.00	900.00

A Mann Whitney U test confirms that the two above distributions are significantly different ($p = 0.003$). Therefore, the significant excess of SPH_{CA} over all other (stated and calculated) measures of the value of Scheme A is still preserved when the comparison is narrowed to contrast SPH_{CA} with just the stated WTP measures for Scheme A derived from other treatments.

Table C.7: Distributional data for the analysis given in main text Table 8: Comparing stated WTP for Scheme A with values calculated from stepwise first responses for Scheme H and Scheme P

	Count	Mean	Standard Error of Mean	Std Deviation	Minimum	Percentile 25	Median	Percentile 75	Maximum
STATED	148	98.83	8.64	103.30	.00	40.00	75.00	120.00	900.00
CALC1	40	128.68	11.45	70.59	22.00	70.00	120.00	162.50	315.00
CALC2	40	133.39	17.85	110.06	25.00	70.00	100.00	146.25	550.00

STATED = stated values for Scheme A ($SHA_A, SHPA_A, AHA_A, AHPA_A$)

CALC1 = Calculated value for Scheme A derived by summing first response stepwise values $SHA_H + SPH_P$

CALC2 = Calculated value for Scheme A derived by summing first response stepwise values $SHPA_H + SPH_P$

Mann Whitney U test for difference between STATED and CALC1 gives $p = 0.001$

Mann Whitney U test for difference between STATED and CALC2 gives $p = 0.009$

Therefore the sum of 1st responses for H and P (where respondents are unaware of other goods, i.e. SHA_H or $SHPA_H$ for good H and SPH_P for good P) yields a calculated value for A (denoted CALC1 for $SHA_H + SPH_P$ and CALC2 for $SHPA_H + SPH_P$) which exceeds that obtained from stated estimates of WTP A ($SHA_A, SHPA_A, AHA_A, AHPA_A$). This implies that single good (part) valuations, added together, will overestimate the value of combined good (whole) values.

