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Sensitivity to scale in stated preference valuation methods. A comparison of methods based on valuation of heath in Denmark

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Abstract
We compare two methods of stated preference valuation techniques – dichotomous choice contingent valuation and choice experiments – to test for the prevalence of embedding. The test is based on a survey of willingness to pay for the preservation of heath areas in Denmark. Using only one outcome alternative and a status quo in the choice experiment we can compare the two methods using exactly the same estimation procedure. Thereby the differences found can be attributed to the different questioning formats alone. We find differences between the methods, especially regarding the sensitivity to scale.

***Keywords*:** Environmental valuation, stated preferences, choice experiment, contingent valuation, heath, nature conservation

1. Introduction

To be able to design and implement the best possible decisions concerning e.g. environmental conservation and biodiversity protection, policy makers need commensurate value assessments of the non-marketed benefits associated with these activities. One approach to the measurement of non-markets benefits is economic valuation in monetary terms. Economic valuation is based on the assumption that individual preferences for a non-market good can be measured in terms of individuals' Willingness To Pay (WTP) for the provision of the good in question. While the theoretical basis for economic valuation is by now well defined there are still unresolved methodological problems associated with the estimation of WTP. A fundamental question is how do we best make respondents reveal their true preferences, if they have any? Another issue is the intermittent lack of economic rationality in the WTP pattern observed. Insensitivity to scale of the good considered is a special problem in this context. It has proven to be particularly difficult to verify the consistency of individuals' choices where non-use values[1] are involved. Stated preference techniques are the only methods which can capture non-use values; and unfortunately these techniques rely on hypothetical transactions rather than observed behaviour. In this study we will compare two such methods – contingent valuation and choice experiments and discuss the difference in information provided and WTP obtained.

It is beyond the scope of this paper to address all problems associated with stated preference valuation methods. A comprehensive description of these techniques can be found in Bateman et al. (2002). In the following we will focus on the probably most central problem associated with habitat valuation, i.e. embedding. Embedding means that WTP is insensitive to scale or quality of the good being valued. For example, respondents may state the same WTP for a small part of an environmental good as for the entire good.

[1] Non-use value is usually attributed to individuals' satisfaction from knowing that species and ecosystems exist (existence value) and satisfaction from considering the interests of future generations (bequest value).

2. Stated preference valuation techniques

Contingent Valuation and Choice Experiments are the most significant expressed preference techniques within the field of economic valuation. The *Contingent Valuation* (CV) method stipulates a scenario for the preservation or provision of a non-market good, e.g. an environmental service. Having explained the characteristic of the service, the rules of provision, access, method of payment etc. respondents are asked to consider their willingness to pay (e.g. through taxes) for the benefit in question. Whereas CV focuses on a whole scenario *Choice Experiments* (CE) examine the response of individuals to changes in the attributes of a scenario. For example, a habitat improvement could be characterised by the levels of various species it supports, recreational access and payment levels. The choice experiment then examines the trade-offs made by individuals when choosing between different attribute profiles.

2.1 The Contingent Valuation Method

Contingent valuation has been used extensively to estimate use as well as non-use values of environmental goods during the last three decades (for an overview see Smith, 2004). Several WTP elicitation methods have been developed. The *open-ended* format allows respondents to freely state their willingness to pay, whereas the *dichotomous choice* or closed-ended format asks if the respondent would pay some specified amount (varied across the sample). The dichotomous choice procedure resembles the way consumers make choices in a real market. Particular impetus was given to the dichotomous choice approach when it was recommended by the NOAA panel (Arrow et al., 1993).

As noted the CV method faces some critical problems, especially related to respondents' comprehension of the good provided. This may lead to embedding as defined above (see e.g. Carson et al., 2001; Carson and Mitchell, 1995; Hanemann, 1995). Failure to bring about rational responses has caused some economists to question the validity of the method (Kahnemann and Knetsch, 1992; Kahneman *et al*., 1999), whereas others have emphasised the need for better design in surveys and awareness of possible reasons for lack of scale sensitivity (Carson et al., 2001; Giraud et al., 1999; Rollins and Lyke, 1998). Asking respondents several questions concerning different levels of the good may bring about internal sensitivity to scope (though not necessarily, e.g. Giraud et al., 1999), but already the NOAA panel (Arrow et al., 1993) noted that this procedure may force consistency because respondents will feel bound by their first response, and answer the following in a way to be consistent. Hence, it is generally recommended to evaluate scope in split samples, e.g. expose respondents in subsamples varying first questions with regard to willingness to pay.

2.2 The Choice Experiment Method

CE and CV are quite different in their description of changes in an environmental good. CV relies on the precise description of a change in the environmental good as such, whereas CE relies on the precise description of changes in the attributes of the environmental good (Boxall et al., 1996).

The first application of CE within environmental economics was Adamowicz et al. (1994) and the first application to non-use values was Adamowicz et al., 1998a). In CE respondents are asked to choose between different choice sets. The choice sets are described by attributes of the environmental good – e.g. a habitat as outlined above – which facilitates the estimation of marginal values of the attributes. It may be a way to get around embedding problems since sensitivity to the level of the good provided is to a larger extent inherent in the method (see e.g. Hanley et al., 1998b; Lehtonen et al., 2003). In CE the respondents are asked to choose between often quite complex choice sets, where the level of attributes is varied across choice sets. Often the level of more than one attribute is changed from one

choice set to another and that makes it much more difficult for the respondent to control/manipulate his internal consistency in choices. Therefore, internal evidence of scope sensitivity is a stronger test here than in CV. This is especially important for non-use valuation since external validity tests are more difficult here (Adamowicz et al., 1998b).

2.3 Using CV and CE to test for embedding problems

When using CE a crucial question is whether environmental goods can be described by their components alone (as also questioned by Hanley et al., 1998b). Is an attribute based description of an environmental good better or worse than a more 'holistic' description? It can be argued that it is not always possible to describe an environmental good by its attributes. It is obvious that preserving for example certain species is not possible without preserving habitats supporting these species. Nor is it possible to enjoy the recreational values of an environment if it is not preserved. On the other hand, many of the environmental projects being evaluated relates to specific changes in habitats – establishment of trails, increased protection of biodiversity, etc. – which actually represent marginal changes in just the attributes of an environmental good (see e.g. Hanley et al., 1998b).

As mentioned, especially CV is apt to problems of embedding (see e.g. Carson et al., 2001; Carson and Mitchell, 1995, Kahnemann and Knetsch 1992). Economic theory tells that the value of a comprehensive environmental good should be higher than the value of a part of that good. But what if it turns out that the part is valued higher than the whole? For example it could be that a specific species shows a higher value in a valuation study than the habitat with this as well as other species. This could be due to differences in interpretation of the good being valued – that the divisibility and quantification is of the good is not so easily understood by respondents. One could also imagine that if parts are being valued, then the sum of the parts might be larger than the value of the whole – because the single components are not so easily forgotten or caries other cognitive values than does the whole. On the other hand, if important attributes are not considered, or the interdependencies between them are overlooked, a larger value of the whole than of the sum of the parts would be expected. In the present study we have investigated the embedding possibilities mentioned above using CE as well as CV techniques.

2.4 Comparisons of CV and CE results

Previous comparisons of WTP estimates in CV and CE show diverging results. . In a study of hunter's preferences Boxall et al. (1996) find much lower values from CE than CV. They argue that part of the reason for this might be that the hunters did not fully understand the scenario described in the CV survey. Comparing CE with an open ended CV Hanley et al. (1998b) find little difference between the two methods. In another study Hanley et al. (1998a) find little difference between CE and a dichotomous choice CV, but in both cases WTP values were considerably larger than from an open-ended CV specification. Also Lehtonen et al., 2003) find little difference between CV and CE in a comparison of forest conservation programmes as do Adamowicz et al. (1998a). In a study of charity Foster and Mourato (2003) find that WTP-measures from CE was larger than for CV when the whole of the good was valued and smaller when only parts was valued. Accordingly, they conclude that CE is more sensitive to the quantity provided, not only in upward direction, but also downward. As seen, the empirical results are ambiguous with respect to the type of difference found when comparing WTP estimates in CV and CE. This is probably due to differences in survey settings. Therefore, the precise framing of the WTP scenario in the two methods is important. This will be the focus in the following.

CE and CV are quite different in their description of changes in an environmental good. CV relies on the precise description of a change in the environment as such whereas

CE relies on the precise description of the attributes constituting such a change (Boxall et al., 1996). This points at the importance of the description and thereby the interpretation of the good being valued. Adamowicz et al. (1998b) argue that since it is not an everyday task for respondents to value environmental goods the structure of CE as compared to CV might cause respondents to create preferences on the way – after reflecting on the information provided. In a CV setting they have shorter time to form preferences.
Another complication is the statistical methods applied to estimate WTP. CV and CE share the same theoretical background – the random utility framework (e.g. Boxall et al., 1996; Hanley et al., 1998b; McFadden, 1974). However, WTP may be estimated using different statistical approaches. As e.g. Leon (1996) shows different estimators can result in very different results. In the present study we have applied the same statistical approach (a logit model) in the two valuation surveys, using CV and CE respectively. In order to do so the CE survey was specified with only one outcome alternative (and a status quo scenario) for each choice set. Thereby its construction is conceptually identical to the CV scenario. Hence, any differences estimated will be due to the different valuation scenario formats and presentations – and not differences in statistical estimation procedures. In this respect our approach differs from previous comparisons of CV and CE. In the investigations that we know of more than one alternative to the status quo have been presented in the CE choice sets. Consequently, a conditional[2] model has been used to estimate the results (see e.g. Greene, 2002).

We will start by describing the case area (heath) and thereafter the valuation approaches. Section 4 describes the survey and Section 5 the results. We will finish in Section 6 by a discussion of the results put in relation to the description of the good and the question of embedding.

3. Heath in Denmark

The origin of the Danish heath can be traced back to over-exploitation of poor soils since the bronze-age, and they covered more than 600,000 hectares by the year 1822 (Hansen, 1970). Today, the Danish heath areas are mainly located in the western and northern parts of Jutland and cover roughly 80,000 hectares, or approximately 2% of the total land area (Buttenschön, 1993). The drastic reduction in area can be attributed largely to cultivation of the heath (Hansen, 1970). Today, heath areas are protected by law from being converted into other uses. Nevertheless, atmospheric nitrogen deposition and lack of the nutrient-removing traditional agricultural practices are causing grass, bushes and trees to take over. The natural process of nitrogen deposition is currently accelerated by nitrogen being deposited from nearby farms and traffic. The nutrient-poor heath has a special flora and fauna which is not found elsewhere in Denmark. 25 species are red-listed as either acutely threatened or vulnerable (Stoltze and Pihl, 1998), and in Denmark are only found on the heath. All species also exist outside Denmark. Furthermore, the heath has a cultural value as a landscape type, e.g. described in the national romantic literature. A brief telephone survey among responsible regional and state authorities suggests that currently about a fourth of the area is managed such as to preserve the heath ecosystem; the reminder is slowly being overgrown.

4. Method

Both CV and CE are based on the random utility framework (McFadden, 1974). Furthermore CE builds on the idea that the utility of a good is a function of its attributes (Lancaster, 1966). The underlying assumption is that respondents will choose such as to maximise their utility. Hence, the well-known random utility model is the fundament for estimation:

[2] Conditional on the alternatives within a choice set.

$$U_{ij} = V_{ij}(x_j, z_i, t) + \varepsilon_{ij}. \quad (1)$$

In this model U_{ij} is the *i*'th individual's utility of the good *j*. V_{ij} is a deterministic term depending of the good's characteristics x_j, z_i the individual's characteristics and the price *t*. The term ε_{ij} is stochastic in the sense that its variation can not be observed by the analyst. The probability that the respondent will choose alternative 1 (over alternative 0 – the status quo) can then be described as

$$\Pr(yes_i) = \Pr(u_1(y_i - t_i, z_i, \varepsilon_{1i}) > u_0(y_i, z_i, \varepsilon_{0i})) \quad (2)$$

where u_1 is the utility of good 1, u_0 of good 0 and y_i is the individual's income. The other parameters are as above. Assuming that *u* is linear in income and its other deterministic parameters and the error term is logistically distributed, the probability of an individual *i* choosing an alternative can be defined by the logit model:

$$\Pr(yes_i) = \frac{1}{1 + \exp(-(\mathbf{az}_i / \sigma_L - \beta t_i / \sigma_L))}, \quad (3)$$

where α, β, σ_L are parameters of the model. For further description of the model see e.g. Haab and McConnell (2003). As we have only a status quo and one alternative in CE, the responses were difference coded, making them directly comparable with CV.

5. Survey

Each respondent received a questionnaire with a separate fact sheet, describing the current status, distribution and amount of heath, the biodiversity unique for the heath, the extent of public access and the recreational facilities. Biodiversity was described as a specified number of threatened species. The respondents were told that specific initiatives could be made to preserve the endangered species. This to distinguish it from habitat preservation which could to a large extent be secured without preserving the particular endangered species.

The questionnaire consisted of three parts. The first part contained introductory questions about knowledge and opinions of heath and general nature conservation issues. Then came a dichotomous choice question of WTP. The second part contained the choice experiment and a short description of the attribute levels. The attribute levels are shown in Table 1. The payment vehicle was an extra yearly income tax earmarked for that and only that purpose. The third part contained questions regarding the respondents' socio-demographic characteristics.

Table 1. Attributes and their levels and coding. Bold marks status quo

Attribute	Description given to the respondent	Coding and levels
Area	Area of the total 80,000 ha, which appear as typical heath.	**0 = 20,000 ha** 2 = 40,000 ha 4 = 60,000 ha 6 = 80,000 ha
Species preservation	How many of the 25 red-listed species on the heath will be preserved	**0**, 5, 12 or 25 species
Access	The extent of public access to heath areas	**0 = Access everywhere** -1 = Access restricted to paths and roads
Recreational facilities	The presence of facilities such as tables and benches, toilets, etc.	**0 = No** 1 = Yes
Price	Extra yearly income tax on your household	**0**, 50, 100, 200, 300, 500, 700 or 1,000 DKK/year

In the CV we chose to split the sample such that half of the respondents received questions regarding preserving 40.000 ha and the other half 80.000 ha. This design allowed for an external scope test between the splits, with respect to area. The price levels were the same (except for the zero cost). The contingent valuation question was described by text as (translated from Danish):

'*Imagine a project regarding protection of the Danish heathlands. The project will increase the area which is treated and thus preserved as typical heath from 20.000 ha today to 40.000 ha /80.000 ha. Thereby no heath area/40.000 ha heath will disappear over the coming years*[3]*. With an increased and targeted preservation effort all the 25 endangered plant- and animal species will survive in Denmark. Access and facilities will not be changed.*

Imagine that the above mentioned project will only be accomplished if decided in a referendum. If the majority of Danes vote in favour of the project it will be adopted by law and all Danish households will pay an extra yearly income tax which exactly finance the proposal. This extra income tax will be placed in a special fund which will only be used for this purpose. If the proposal would cost your household XX DKK per year in extra income tax, would you then vote yes or no? (mark one of the boxes below – please bare in mind that the money would be withdrawn from your normal budget whereby you would have less at your disposal for other goods)'

Following this, respondents were asked why they had answered as they did, and after reminding them that the proposal only concerns the preservation of the heath and related endangered species and not other nature protective initiatives, whether they would still vote in favour.

In the choice experiment the respondents were asked to choose between a status quo case and one alternative. An example of a choice-set is given in Figure 1. We used a fractional factorial design of 32 questions (both orthogonal and balanced), which again was

[3] 'Some years' is not specified further, also not on the information sheet

blocked into 4 blocks, such that 4 groups of respondents (for each version) were presented with 8 choice sets[4]. The order of the choice sets within the blocks was randomised.

Choice set 2: Do you prefer the present situation or the suggested alternative?

	Present situation	Alternative
Typical heath of the total 80,000 ha	20,000 ha	80,000 ha
Number of preserved species	0	0
Access	Access everywhere	Restricted to roads and paths
Recreational Facilities	No	Yes
Extra yearly income tax on your household	DKK 0	DKK 500
	↓	↓
Choose only one	☐	☐

Figure 1. An example of a choice set (translated from the Danish questionnaire). The example shown is from the version with a quantitative description of species. The qualitative description of species only differs in the second attribute.

The socioeconomic characteristics of gender, age, education, employment status, geographic location and household income of the survey respondents were asked in the end of the questionnaire and compared to relevant information from Statistics Denmark. In general the respondents represented the Danish population well (see Boiesen et al., 2005 for further details).

In May 2004 the questionnaires were sent to a random sample of 784 Danish citizens between the ages 18 and 70 drawn from the Central Office of Civil Registration. After 3 weeks 40% had responded and a new questionnaire was sent to the remaining 60%. In total this gave a respond rate of 59% with 2% lacking too much information to be useable.

6. Results

Table 2 shows the logit estimates for the choice experiment, and Table 3 shows the logit estimates for the similar contingent valuation. As we had follow-up questions in the contingent valuation study, we sorted the results such that 'don't-know' responses were coded as no, respondents who only marked the reason for support was 'general environmental support' were removed (they also had the option to choose heath specifically) as were respondent who did not believe the scenario or were otherwise indicating protest to the method. Finally respondents who had said 'yes' and when reminded that it was only support for heath and not other environmental goods said 'no' were coded as 'no'. Protests to the payment vehicle was tried included, but due to bad formulation of the question and a contemporary tax stop by the government which was very popular, the large majority, even of the yes-sayers ticked that box. Consequently we found it hard to interpret as protests, but rather as an indication of a general political opinion. The logit estimates of this interpreted result are shown in Table 4. As probit estimates gave very similar results, only the logit estimates are shown.

[4] Fractional factorial design is a reduced design as compared to all combination possibilities where focus is on securing balance and orthogonality between the different attributes. For a good description of these design issues, see Kuhfeld (2004)

Tabel 2. Logit estimates from the choice experiment

Variable	Coefficient	Std.err.	z	P>z	MRS
Area (10.000 ha)	0,0560323	0,0169974	3,3	0,001	25,25
No. of surviving species	0,0238459	0,0040295	5,92	0,000	10,74
Access	0,2052769	0,0760723	2,7	0,007	92,49
Recreational facilities	-0,0011098	0,0757489	-0,01	0,988	-0,5
Price	-0,0022195	0,0001281	-17,33	0,000	1
Constant	0,2984336	0,1013072	2,95	0,003	134,46
N=3168 (453 respondents replying on 1-8 choiceset)					
Log likelihood	-1997				
χ^2	384,64				
Pseudo-R^2	0,0878				

Table 3. Logit estimates for the contingent valuation survey, full sample

Variable	Coefficient	Std. Error	z	P>|z|	MRS
Constant	1,3624	0,3911	3,48	0,000	737
Area	-0,0194	0,0557	-0,35	0,727	-11
Price	-0,0018	0,0004	-5,15	0,000	
N	376				
Log likelihood	-233,66				
X^2	0,0000				
Pseudo-R^2	0,0567				

Notice that the 'Area' preserved attribute is not significant in the CV model whereas it is in the CE. Also the number of species preserved and access to the areas are significant in the choice experiment (these were not varied in CV). Only facilities do not seem to be important.

Table 4. Logit estimates for the contingent valuation survey when the sample is reduced according to interpretation
of follow-up question

Variable	Coefficient	Std. Error	z	P>|z|	MSR
Constant	1,0070	0,3884	2,59	0,010	375
Area	-0,0245	0,0550	-0,45	0,656	-9
Price	-0,0027	0,0004	-6,85	0,000	
N	389				
Log likelihood	-239,58				
χ^2	0,0000				
Pseudo-R^2	0,1062				

Table 5 compare the derived WTP estimates from the different models with a non-parametric estimate (a lower-bound Turnbull estimate, see Haab and McConnell, 2003) for calculation procedure hereof). It is seen that the results for CE and the full sample of CVM are very similar when both are estimated with a logit model, whereas the the lowerbound Turnbull estimates gives lower results. The CV shows no sensitivity to the amount of heath preserved, whereas CE clearly does (and also does for the number of species preserved). Consequently

the WTP for the CE logit estimates, where a small area is preserved, is lower for CE than for CV (logit), whereas the opposite is the case when the large area is preserved.

A crucial question is how to perform interpretation of the CE data through follow-up questions. If we make the rough assumption that the respondents excluded from CVM are also excluded from CE the respective WTP estimates becomes 451 DKK[5]/40 000 ha and 558 DKK/80 000 ha respectively. Alternatively we could exclude respondents who consequently rejects or accepts an alternative. This results in estimates of 510 DKK/40 000 ha and 596 DKK/80 000 ha, but some of the excluded respondents might be true zero bidders or have WTP higher than the suggested bids.

Table 5. WTP estimates for the different models, DKK

WTP estimates	**Logit-estimator**			**Lowerbound-turnbull**	
	CE	**CVM -full sample**	**CVM - interpreted sample**	**CVM -full sample**	**CVM - interpreted sample**
Preserving 40.000 ha	596	695	339	524	295
Preserving 80.000 ha	697	653	302	516	322

7. Discussion and conclusion

Like several other studies the present investigation demonstrated the prevalence of embedding. For the CV part of the analysis the questionnaire allowed for an *external* test of scope-sensitivity. As the results in Table 3 and Table 4 clearly indicate, the 'Area' attribute has no explanatory power in the Logit-models and hence the null-hypothesis of 'no scope-sensitivity' cannot be rejected. In fact, in most of the models, the 'Area' attribute even have the wrong sign (it is not significant though). Only when we use the Turnbull-estimator on the reduced sample do we arrive at a set of WTP-estimates, where larger area is related to larger WTP – but still not in significant measures. Accordingly, when using the CV methods we experience embedding problems.

The CE-results presented in Table 2 permit an *internal* scope-sensitivity test and here the results reject the null hypothesis of 'No scope sensitivity' as the model implies a linear increase in WTP with 'Area' of 25 DKK/10,000 ha/year/household. The scope-sensitivity is found in a setting where each respondent is faced with a number of different choice sets. Therefore, the question arise if the more attribute focused structure of the CE implies that people become aware of their true tradeoffs among attributes – as Adamowicz et al. (1998b) argue – or if the structure inspires them to express preferences which they realise fit the purpose of the questionnaire, but preferences they do not truly hold. This latter possibility would be an argument in support of the NOAA-panel pointing out the potential weakness of internal scope-sensitivity tests (Arrow et al 1993).

However, there is a great difference between the complexity facing the respondent in a CE setting and the CV questions applied in many embedding analyses. Typical examples are those of Heberlein et al. (2005) and Veisten et al. (2004), where respondents in a CV survey are presented with two or three questions concerning parts of a good or the entire good, e.g. one or two species or the entire biodiversity of a particular habitat. This should make it quite easy for the respondent to consider the consistency of his answers in relation to scope. In the CE, on the other hand, the respondents are asked to consider often quite complex choice sets, where the level of attributes is varied across choice sets. Often the level of more than one attribute is changed from one choice set to another and that makes it much more difficult for the respondent to check the internal consistency of his choices. In the

[5] One Euro is equal to about 7.5 DKK.

current case two attributes were varied across four different levels and the two remaining across two levels – creating a much larger complexity. Therefore, internal evidence of scope sensitivity is a stronger test here than in CV.

A second question relates to the magnitude of the WTP estimates in the surveys using CV and CE respectively. As mentioned previously when using the same estimator differences in WTP estimates between CE and CV must be due to differences in the valuation setting – and not differences in statistical estimation techniques. When using the "full sample" in the CV survey CV and CE provide WTP estimates of similar manitudes. But in CV surveys the sample often has to be reduced due to protest zero bidding and strategical bids[6]. Such a trimming of the sample is more difficult to perform in CE due to the many choice sets where the reckoning behind the answers may be different in different choice sets. Follow-up questions in the CE survey were not used in the present study. Part of the problem may have been solved by the inherent internal scope test in CE, but the difference in size of WTP shows that it might not be sufficient. External scope tests as well as removal of strategic answers would be useful in future CE studies. But probably the problem lies as much in the CV as in the CE – do the follow-up questions in CV reveals the true? It would be interesting to analyse the difference in a study where the CV scenario was described in the same reductionist way – with focus on attribute levels – as in CE. Thereby it could be tested whether it is the description of the good which causes the difference between the two methods or the evaluation scenario as such.

We conclude that the CE survey presented here provides reasonably strong indications of scope sensitivity. In other words, there is no inherent evidence of embedding in the CE survey – in contrast to the parallel CV experiment. Thus, the findings in the present study support the conclusion in Munro and Hanley, 1999) that, all other things being equal, CE provides higher, but also more correct estimates for goods which can be described by their attributes.

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[6] A protest zero bid is voting 'no' as a protest against the payment vehicle or valuation scenario whereas a strategic answer is voting 'yes' expecting that 'someone else' are going to pay and not the respondent himself. See e.g. Blamey et al. (1999) for a discussion hereof.

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