How much are people willing to pay for silence? A one and one-half-bound DC CV estimate

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ABSTRACT

Noise is a major urban problem that has not received much attention from environmental economists. In this paper we present an attempt to value a noise reduction program in a Spanish city. Contingent valuation has been applied using both one and one-half bound and open-ended question formats. The one and one-half bound question format avoids the bargaining processes which are inherent to multiple bound dichotomous choice question formats without the information loss associated with single bound formats. Through our estimations we have found that, first, noise has a negative value for urban residents and, second, that there is no embedding effect. We also are able to conclude that some type of biases (*i.e*. guilt) tend to decrease or disappear with the implementation of the one and one-half question format, however, other biases still prevail *(i.e.* indignation).

Keywords: *Urban environment; noise; contingent valuation; one and a half bound question format.*

1. Introduction

Noise remains one of the main environmental problems in Europe, and its importance is rising due to the growing noise levels associated with the increase in economic activity. We are exposed to noise throughout life, exposure to levels above 40 dB(A) starts influencing our well being, and levels above 60 dB(A) are considered detrimental to our health.[1] Excessive noise levels have physiological, and psychological consequences. The physiological effects include, for example, hearing damage, sleep disturbance, high blood pressure, stomach ulcers and other digestive diseases. Among the psychological effects we can also mention increases in levels of anxiety, annoyance and nervousness; it also influences social behaviour and cognitive development (Bolaños and Ochoa, 1990; Guski, 1989). High noise levels have negative implications not only for health but also for other types of human activities, and result, therefore, in economic consequences. Exposure to high levels of noise decreases the capacity to concentrate, increases the likelihood of errors of perception, interferes with communication, and causes difficulties in the learning process among children (Grandjean and Gilgen, 1976).[2] Other economic consequences are losses in property value and increased health expenditure. Noise not only affects urban areas and human health, but also has effects on the natural environment.[3]

Major sources of noise are road, air, and rail traffic, together with industry and recreational activities. Road traffic is responsible for 32% of the European Union (EU) population being exposed to noise levels above 55dB(A) (EEA, 1999) and its importance is increasing, despite corrective measures and improvements in car and truck design.[4] The rise in the level of economic activity has brought about this increase in the level of road noise and the trend is expected to prevail in the future. A 30% increase in passenger car transportation is expected for the period (1995- 2010), this figure rises to 50% when referred to freight transportation[5]. Second in importance is airport and air-traffic noise, 3 million people are exposed to aircraft noise over 55dB(A). Even though noise exposure at major European airports is unlikely to see any increase before 2010 -due to the phasing out of noisier aircraft- noise, exposure from regional airports is expected to increase beyond that date. Another source of concern is the progressive trend to shift freight transport from day to night-time. Also the development of high-speed trains will lead to increases in the noise level generated by this means of

[1] Noise level is determined by measuring the intensity of sound pressure levels in decibels (dB). Decibels are measured on a logarithmic scale, ranging from 0 (human audibility threshold) to 130 (pain threshold). For most purposes however, this scale is weighted by the frequency sensitivities of the human ear, know as A-weighting. The range for everyday noise on this scale goes from 45 to 115 dB(A). To describe the impact of noise in humans, the so-called Equivalent Sound Pressure Level (Leq) is calculated, that is, the mean value of sound intensity over time expressed in decibels.

[2] Also the WHO (1993) has demonstrated that the capacity of language acquisition in certain populations such as young children can sharply decrease in environments with high levels of noise.

[3] This paper focuses on the valuation of urban noise but it is worth noting that research results also point to stress reactions on animals with an acute sense of hearing as responses to high levels of noise (Umweltbundesant, 1987, as reported in the EEA (1995)).

[4] The EU noise standards have decreased from above 90 dB(A) for heavy lorries and 80 dB(A) from passenger cars in 1972 to 80 and 74 dB(A) in 1996, respectively. These reductions in standards have been made possible by significant applications of low noise technology, giving rise for example to decreases in engine and exhaust noise. However, the European Environmental Agency (EEA) points out that nowadays the dominant source of road noise is caused by the friction of tyres on the roads at speeds above 40 and 50 km/hour.

[5] See the "Environment in the European Union at the Turn of the Century" as reported in the EIONET Noise Newsletter, European

transport. Noise sources associated with industry and recreational activities are difficult to compile because of their great variety, however, there is strong evidence of an increase in citizen complaints about street noise and locally concentrated sources such as sports arenas and discotheques.

The European Commission has reacted to these trends and already in its 5th Environmental Action Programme stated that "no person should be exposed to noise levels which endanger health and quality of life."[6] To attain this goal and correct the above-mentioned tendencies there are several options available. First, technological and engineering actions such as low-noise product development, insulation of dwellings against noise and the development of low-noise tyres and surfaces can reduce noise emission. Second, the planning of land use can also be helpful by separating out incompatible functions and establishing areas of silence or noise abatement zones. Additionally, educational and informative measures, such as increasing the noise awareness of the population by either providing information on the number of complaints made, or on the noise level increase resulting from high speed driving, could also help to achieve noise reduction. Finally, legal action would also be required, in other words, it would be necessary to define limits or approve guidelines, by agreeing on criteria for measuring noise, minimum requirements for the acoustic properties of dwellings, and the enforcement of such regulations.

Any such abatement measures would almost surely be costly and their implementation would only be justified if the economic benefits of noise reduction are of importance to European citizens. Noise is, in economic terms, a negative externality and a public "bad," however, it is one of the pollution problems that has attracted least attention among environmental economists. There are no comprehensive studies that evaluate the social cost of the different types of urban noise and the benefits of its reduction. Most studies focus on the evaluation of the social cost of airport noise. More specifically, a large proportion of noise reduction benefit studies focus on measuring the loss in property value associated with aircraft noise using the hedonic price method (HPM). Collins and Evans (1994) and Yamaguchi (1996) applied the HPM to study the loss in property values associated with aircraft traffic noise produced by the Manchester and London airports. In the United States, Levesque (1994), O'Byrne (1985) and Nelson (1978, 1979) have also applied this methodology to a study of the economic impact of aircraft noise. Additionally, HPM is also the methodology most widely used to study the values associated with road traffic noise reductions, (Soguel (1994) and Renew (1996)). To our knowledge, only Vainio (1995) has applied the contingent valuation method (CVM) to estimate the willingness to pay (WTP) for the reduction of traffic-noise-related externalities for the city of Helsinki.

Environmental Agency, no. 2, September 1999.
[6] See Dobris Assessment, p.5, Ch.16.

One of the goals of this paper is to advance in that direction by estimating the economic value of a noise reduction by the CVM. More specifically, we estimate the economic value of a reduction in noise a medium-sized Spanish city. The CVM, however, has not been exempt of criticism. In this paper we evaluate the relevance of two major CVM caveats. First, the presence of bias to the follow-up responses in DC models and, second, lack of sensitivity to different levels of provision of a public good. We test for the presence of these two effects in our study. In order to estimate the economic value of a reduction in noise by CVM we apply the one and one-half-bound model (OOHB) proposed by Cooper and Hanemann (1995). While this method has a lower potential for follow-up response bias than the double bound (DB) and triple bound (TB) alternatives, the OOHB method still retains much of the efficiency of the DB alternative and requires less information than DB and TB models. In the next section we outline a brief description of the OOHB methodology, to our knowledge, this method has not yet been applied to any valuation problem with real data. In the third section, we discuss the survey design, the question format and model construct, and explain the data collection process. In the fourth and fifth sections, we present the definition of variables used in the estimation and the representative summary statistics, respectively. Section six presents the results from both the OOHB estimated model and the test for scope sensitivity. In the last section we summarise the major conclusions of the study.

2. Methodology: One and one-half-bound question format

The basic assumptions underlying the CVM are - as Kristöm pointed out in his 1990 paper and thesis- that individuals know approximately the maximum amount of money that they are WTP to acquire the good under evaluation, and that individuals will report the true value, given that the survey has been designed optimally. The application of this methodology, however, can give rise to several problems that may cause valuation biases that result in the emergence of differences between the real and the reported values. In this paper we dedicate special attention to reducing question format bias by applying the methodology proposed by Cooper and Hanemann (1995) and Cooper et al. (2000).

Cooper and Hanemann (1995), proposed an alternative question setting to the classical SB and DB question formats: *the one and one-half-bound model*. Bishop and Heberlein presented the SB format in 1979. Years later, Hanemann, Loomis and Kanninen (1991) showed that the DB method provides more efficient coefficient estimates than those facilitated by the SB method. But the DB format is not totally error free. Carson *et al*. (1992), Cameron and Quiggin (1994), McFadden and Leonard (1993), and Kanninen (1995) give different reasons to explain how the responses to the second bid may be inconsistent with the responses to the first. The main one of these is that respondents switch from a market setting for the first bid to a bargaining setting for the second bid, making it difficult to compare the responses to the two bids. Cooper and Hanemann (1995) present a solution to this problem by devising a multiple bound method that is free of response bias to the follow-up bid. Specifically, they construct the so-called one and-one-half bound model (OOHB) a specification that should significantly reduce the possibility of the survey moving into a bargaining setting when the interviewer proposes a follow-up bid.

OOHB methodology assumes that there is uncertainty about the cost of providing the good to be valued. The interviewer only knows an interval of variation for this cost, which can range from a lower to an upper bound, called BIDL and BIDU, respectively, (i.e. BIDL < BIDU). The application of this methodology will consist of the following steps: first, before the questions that elicit willingness to pay are asked, the respondent is informed about both the lower and upper bounds, referred to as limits of the expected cost of the environmental good. Next, the interviewer chooses at random one of these two points as the initial value to elicit the respondent's willingness to pay. Then, if BIDU is chosen and the respondent says NO, the respondent is asked if he is willing to pay BIDL. Similarly, if BIDL were the first value asked and the respondent says YES, then the respondent would be asked if he is willing to pay BIDU. In the other two cases the elicitation process stops when the first price proposed is BIDU and the respondent says YES, and if the first price proposed is BIDL and the answer is NO.

Thus, the elicitation process can result in six sets of answers. If the lower-end bid (BIDL) is randomly drawn as the starting bid, then the possible response alternatives are: no, yes-no and yes-yes. If the upper-end bid (BIDU) is randomly drawn as the starting bid, the possible response paths are: yes, no-yes and no-no. So that, the OOHB log-likelihood function can be written as:

$$\ln L(\theta) = \sum_{i=1}^{N} \left\{ \begin{array}{l} d_i^{n} * \ln \pi^{n}(BIDL_i) + d_i^{ny} * \ln \pi^{yn}(BIDU_i, BIDL_i) + d_i^{yy} * \ln \pi^{yy}(BIDU_i) + \\ d_i^{y} * \ln \pi^{y}(BIDU_i) + d_i^{ny} * \ln \pi^{ny}(BIDU_i, BIDL_i) + d_i^{nn} * \ln \pi^{nn}(BIDL_i) \end{array} \right\}$$

where, i are individuals; π^{jl}, is the probability of the jl^{th} response, where j can take two values Yes or No depending on whether the respondent is willing to pay the initial value presented in the elicitation question. Similarly, l will take value Yes or No depending on the answer to the follow up value presented in the elicitation question (that is, j=Y or N, and l=Y or N); finally d^{jl} is the binary indicator variable.

The probability π^{jl} is found as the interval between two bids, e.g. $\pi^{yn} = \pi(BIDL \leq WTP < BIDU) = \Phi(WTP \leq BIDU) - \Phi(WTP < BIDL)$, where $\Phi(.)$ is the cumulative distribution function. In our case we choose the logistic distribution function $\Phi(\beta x)$ and use the Gauss 3.1 routine developed by Cooper (2000) to carry out our estimations. Since $\pi^{n} = \pi^{nn}$, $\pi^{yn} = \pi^{ny}$ and $\pi^{yy} = \pi^{y}$, the likelihood function can be simplified to:

$$\ln L(\theta) = \sum_{i=1}^{N} \left\{ \begin{array}{l} \left[d_i^{n} \vee d_i^{nn}\right] * \ln \pi^{nn}(BIDL_i) + \left[d_i^{yn} \vee d_i^{ny}\right] * \ln \pi^{yn}(BIDU_i, BIDL_i) + \\ \left[d_i^{yy} \vee d_i^{y}\right] * \ln \pi^{yy}(BIDU_i) \end{array} \right\}$$

Note that the OOHB estimation method presents each respondent with two bids, the lower and upper bids, or BIDL, and BIDU, respectively. Therefore, we could obtain two estimated parameters if these two bid vectors were used in the estimation process, as in the DB model, however, only one vector is used as a BID independent variable in the estimation, as in a SB model. The elements that this BID variable results from is a combination of the BIDL and BIDU vectors; whether it is the lower or upper bid value that is included in the BID variable to estimate the model depends on the respondent's reply. Thus, if the BIDL was drawn first and the respondent said YES to this first bid, and NO to the follow-up bid, only the low bid value would be included in the BID independent variable used in the estimation. And the probability associated with that (Yes, No) answer would be represented by: $\pi^{yn} = \pi(BIDL \leq WTP < BIDU) = \Phi(WTP \leq BIDU) - \Phi(WTP < BIDL)$. However, if the answer was YES to the first and second bids, the bid value included in the BID independent variable would be the upper bound and the probability associated with it would be $\pi^{yy} = \pi(BIDU \leq WTP < \infty) = 1 - \Phi(WTP \leq BIDU)$. Similarly for a (No, No) response, where the probability associated with the response can be represented by $\pi^{nn} = \Phi(WTP \leq BIDL)$.

3. Survey Design

The city selected for this study, Pamplona, is located in the northern part of Spain, between the Pyrenees and the Cantabrian Sea. It can be considered, with respect to noise, to be average among Spanish cities of its size (approximately 300,000 inhabitants). The acoustic map of the city, drawn up in 1997, shows that 59 percent of the measurements were above the 65 db(A), that is the upper limit recommended by the WHO, but the 75 dB (A) level, the level considered harmful by the WHO, was reached in only 9 per cent of the cases, (Arana and Garcia 1990; Arana 1997). In this study the average noise level was 67.1 dB(A).

The survey was carried out through telephone interviews, which were held from December

1998 to December 1999[7]. The city was divided into 14 neighbourhoods and the interviews were distributed among them according to their population. The survey content was structured in three sections: i) description of the good being valued, ii) explanation of the circumstances under which the good will be provided and formulation of the questions that elicit the respondents' willingness to pay, and iii) personal characteristics of the respondents.

The goal of the first set of questions is to focus the respondent's attention on the good to be valued considering their daily relationship with noise. We started by formulating questions that would help people recall the everyday noise levels that they were exposed to. Among other questions, we asked: i) which type of noise was more disturbing for the respondent; ii) when noise was more of a nuisance, during the day or at night; and iii) which type of noise was more disturbing at each time of day. With all these questions we expected respondents to recall the noise levels to which they were usually exposed and, therefore, to be able to understand the noise reduction proposed. In this first section of the survey, we also included questions that would help us to rank the importance of urban noise for Pamplona inhabitants. Thus, for example, we asked respondents to rank the noise together with other urban problems like safety on the streets and in the neighbourhood, and garbage collection. In this way noise is placed in the wider context of urban problems and in order to avoid part-whole bias.

In the second section of the survey, we presented the characteristics of the provision of the good "noise reduction" and elicited the amount that the respondents would be willing to pay for a particular noise reduction. In other words, we explained how a reduction in the noise level would be provided, what the baseline level of provision would be, who would provide this reduction, how it would be provided, and the method of payment. Note that, although almost everybody is familiar with the steps involved in building a public garden, we are less informed about the possible ways of providing a reduction in noise levels. Therefore, we described the three measures that the city hall was to follow if the noise reduction program were approved. The first measure involves conducting a noise control campaign; the second, developing a program of surveillance that would include fines for infringement; while the third would require covering street traffic lanes with noise absorbing asphalt. Likewise, we asked respondents to value each of these measures independently (from highly effective to non-effective). This valuation has a double goal, first, it serves as an indicator of which of these policy measures is seen as more useful, and second, it forces the respondent to think about each measure.

Once the attention of the respondent is focused on the noise reduction problem, we describe, by means of examples, what the implications would be in terms of noise reduction of these three

[7] No major changes occurred with respect to noise in Pamplona during the survey period.

measures. We point out that such measures would have implications for both, day and night-time noise, and therefore, our description includes examples of day and night reductions.[8] Once the amount of the noise reduction has been communicated to the respondent we present the valuation questions. We point out that the measures chosen by the city hall are costly and that respondents will have to contribute to finance them if they are finally approved. We inform them that a research team from the *Universidad Pública de Navarra* has estimated the cost of such policies, and we present the respondent with an estimated interval for those costs. The extreme values of this interval coincide with the upper and lower bids that will later be presented to the respondent in the elicitation question. In this formulation the cost of the good in question is placed in a framework of uncertainty. The respondent is told that the interviewer is uncertain about the exact cost of the good, but knows that it lies somewhere within the interval defined by the extreme values BIDL and BIDU. As a way of payment we chose to present increases on city taxes, we found that this was the least troublesome method because other city services are paid through city taxes, for example, trash collection services. We then asked about each individual's WTP.

The values of the BIDL and BIDU ranged between 500 pts. (3.12 euros) and 10,000 pts (62.5 euros). These values were chosen after conducting several experimental open format surveys, where we asked for the maximum willingness to pay. Our bid choice aimed to cover the central 95% of the observed WTP distribution (Cooper, 1993). Three intervals of variation for the lower and upper bids were chosen: i) 500 pts (3.12 euros) and 3,500 pts. (21.87 euros); ii) 2,000 pts. (12.5 euros) and 7,000 pts. (43.75 euros); and iii) 4,000 pts. (25 euros) and 10,000 pts. (62.50 euros). Therefore the sample was divided into three sub-samples. The total sample size is of 600 observations, distributed as shown in Table 1. Note that in order to set up these values we did not consider the real cost of the program and therefore these were not real cost estimates.

TABLE 1 ABOUT HERE

Half of each sub-sample is presented, as a first value, with a BIDL (for example, in the case of the second interval, 2,000 pts.) and the other half is presented with the corresponding BIDU (i.e. 7,000 pts.). If the BIDL is drawn and the respondent is willing to pay the value specified, we then ask if he is willing to pay the corresponding BIDU. If the respondent is not willing to pay the amount corresponding to the lower bid, we then enquire about the maximum willingness to pay for the reduction on the noise level. Though this last question is not necessary when applying OOHB methodology, we asked the open-ended question to enable us to perform additional estimations and consistency tests. Also, in the event that respondents were not willing to pay any positive amount we

[8] We pointed out that the day time reduction in the noise level "would be like switching from the level of noise that exists in the neighbourhood on a weekday during working hours to the level of noise that exists on a weekday at 9:30 p.m.". For the night time reduction

asked for the reasons that led to that attitude in order to isolate the protest zeros.

A similar process was carried out when we chose BIDU as our starting value. If respondents answered negatively, they were then asked if they were willing to pay the amount corresponding to the BIDL, if the answer still was negative they were asked for their maximum willingness to pay. In this case, as before, if they were not willing to pay any positive amount, they were asked to give the reasons for their attitude. Also, if they answered affirmatively to the suggested upper bound, they were asked for their maximum willingness to pay. Finally, in the third section of the questionnaire we ask for the respondents' personal data, such as age, gender, and income level. Also, to obtain complementary information we ask if respondents have invested at all in insulation for their homes.

As we pointed out in the introduction, an additional goal of this study was to test for any possible *embedding effect.* We distinguished between two possible reductions in the level of noise during the day-time. Half of the sample was asked to value option 1 and the other half was asked to value option 2. Under the first alternative we requested the respondent to value the reduction in noise-level that takes place between "a working day during working hours and a weekday at 9:30 p.m." The other half of the sample was asked to value the reduction in noise-level that takes place between "a working day during working hours and Sunday morning." In order to isolate the effect of the bid from the effect of the noise reduction option, half of the respondents for each bid were faced with one option and the other half of the respondents was faced with the other. The night-noise level was maintained constant for the whole sample.

4. Definition of the Variables Used in the Estimation

We use two models to estimate the evaluation functions: i) OOHB, and ii) OLS. For the OOHB model we follow Cooper and Hanemann's (1995) methodology. Under this specification the dependent variable takes 6 different values depending on which bid was drawn first and on the respondent's answer path. The six possible paths were mentioned in the methodology section, three correspond to the lower bid no, yes-no, yes-yes; and three correspond to the upper bid yes, no-yes, no-no. For the OLS estimation the dependent variable is the response to the open-ended question.

The variable PRICE, which refers to the first price offered to the respondent, is used as an independent variable in the OLS regression, while the BID variable is used in the OOHB estimation. As we said before, if the low bid was drawn first, for example 2,000 pts, and the respondent said YES to this first bid, and NO to the follow-up bid (i.e. 7,000 pts.) the bid value considered in the BID

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we explained that it would signify a change from "the level of noise on a Saturday night to that of a Monday night" vector was 2,000 pts. However, if the answer was YES to the first offer and YES to the second, the bid value included in the bid vector was 7,000 pts. If, on the other hand, the upper bid was drawn first (i.e. 7,000 pts.) then the BID variable took a value of 7,000, if the answer to the first question was YES and a value of 2,000 if the answer to the first question was NO and to the second question YES.

Several sociological variables were also defined. Noise is perhaps the most educationally related environmental externality. We have found that previous studies often show that the higher the level of education the greater the annoyance felt from noise. To estimate the effect of educational level on the willingness to pay for a noise reduction, we introduced the variable UNIVER that takes value 1 if the respondent has a university degree and 0 otherwise. We expected this variable to be positive and significant. We also distinguished between respondents that had invested in insulation for their homes and those who had not. A person that has already spent some money on defensive investments is more likely to be sensitive to noise. Therefore, we defined the dummy variable ISOLA that takes value 1 if they have invested in insulation and 0 otherwise.

In addition, we also expected respondents that give a high value to the noise reduction program proposed by the city council to show greater willingness to pay for it than other citizens.Thus, we defined the dummy variable VALPRO that takes a value of 1 if the program proposed is highly valued by the respondent and 0 otherwise. Specifically, the variable VALPRO takes a value of 1 if, in the evaluation question, the respondent attributed a value of 7 or more to the noise reduction program, and 0 otherwise[9].

But this is not the only survey question we can use to measure respondents' sensitivity to noise. In addition, we asked respondents to declare the level of nuisance suffered from different types of noise. Specifically, we asked respondents, in three different questions, to assign a number between 0 and 10 to the level of disturbance suffered from noise, i) in the city, ii) in their particular neighbourhood and iii) at home. Using the responses to these three questions we defined the dummy variable SENSI that takes value 1 when the respondent is "highly sensitive" to the nuisance caused by noise and 0 otherwise. In order to define what we mean by a "highly sensitive" individual, we classified respondents in two groups using an iterative 2-means cluster analysis (Malhorta, 1993). This methodology calculates two average cluster means - one for the highly sensitive individuals and one for the insensitive individuals in the sample- and assigns observations to one group or the other depending on the difference between their response and that average. This procedure works as follows: first, we select an initial cluster centre, in our case we chose the extreme responses 0 and 10. Next, each observation was assigned to the cluster with the closest cluster centre.[10] Once all the observations

9 Respondents were asked to value between 0 (minimum) and 10 (maximum).
10 The distance was measured with the Euclidean distance.

had been assigned to a group, a new mean for each group was calculated. These means are the two new cluster centres. Then the difference between the new cluster centres and the original ones were computed. If this difference is below a given number, the process stops, otherwise the second step is repeated with the new means and the cluster centres are updated. The process is repeated reiteratively until a minimum change or a maximum iteration number is reached. The cluster centres for our two groups are given in Table 2. Therefore, SENSI takes value 1 for those individuals whose answers to the three selected questions are closer to the answers for the more sensitive group, and takes value 0 otherwise.

TABLE 2 ABOUT HERE

Although other sociological variables, such as level of income, age, and gender were considered, none of them resulted significant in the relevant regressions. The INCOME variable presents the usual problems in this type of studies. On the one hand, a large proportion of respondents did not answer this question and, on the other, there was no guarantee that the replies were truthful. Therefore we were not surprised by the lack of significance of this variable. We also tried using an occupational variable as a proxy for the income variable. In the survey respondents were asked about their profession, we grouped them by professions, taking into account their average income level but the results continued to be insignificant. Neither gender, nor age was significant. For gender we did not have any a priori expectation, however, we expected middle-aged people to value the absence of noise more highly. Young people usually either enjoy it or are not greatly disturbed by noisy environments. On the other hand, old people's hearing capacity is diminished and this could be the reason that they are less bothered by high noise levels. Additionally, we attempted to discover the characteristics of families that were willing to pay larger amounts of money for a noise reduction. We asked, for example, whether there was any family member with a chronic illness or disease. We expected this type of families to be more sensitive to excessive noise levels, but this factor proved non-significant.

As we said before, we were also interested in testing for any possible embedding effect and therefore we divided the sample into two groups. Each group was asked to value a different noise reduction, Alternative 1 and Alternative 2. We introduced the variable OPTION that takes value 0 if the respondent values the reduction in the level of noise that takes place "between a working day during working hours and a weekday at 9:30 p.m." (i.e. Option 1) and value 1 if he values the difference between "working hours and Sunday mornings" (i.e. Option 2). If there is no scope sensitivity effect we expect that the option that represents the greater noise reduction is the most highly valued.

5. Some descriptive statistics

As mentioned, the total sample size was 600, comprising 43.1% men and 56.8% women. We also obtained a representative sample of educational levels: 24.2% of the population had only primary studies, 17.7% had finished basic education (8 years), 24.4% had finished high school, and approximately 24% of the population had undergone university studies (either at bachelor or masters level). Most of the respondents were flat owners, specifically 87.5% of the total sample were owners and only 11.8% were tenants.

Respondents showed less tolerance of night-time noise than of daytime noise. It turns out that 53.8% of the population said that night noise was more disturbing, compared to the 38.5% that find day-time noise more disturbing. Trash trucks were signalled as the origin of the most disturbing noise during the night. With respect to day-time noise, 33.3% of the population reported being disturbed by traffic noise. When respondents were asked which type of traffic noise they considered more disturbing, 87.3% of them mentioned motorcycle noise, even though there are 15 times more cars than motorcycles in Pamplona. Another focus of noise during the daytime are the activities of the city works department.

When compared with other city problems noise reduction was not considered a priority problem. Neighbourhood security, the cleanness of the city and dog excrement were considered more important problems. Nevertheless over 50% of the total sample gave noise a score of 5 or over when asked if it was an important issue in their neighbourhood, the average score being 5.7[11]. There is also consensus among respondents in considering that high levels of noise are dangerous for health, most consider stress to be the main problem caused by noise. In general 95.3% of the population are happy with their neighbourhood and enjoy living there.

However, 227 people, that is the 37.8% of the sample, have had insulation work carried out in their homes to combat cold and/or noise. In order to distinguish between these two reasons for insulating we also asked what the main reason for the investment had been. For 21.9% of those who had made the investment, the main reason was excessive noise level, for 39.3% it was to insulate from the cold and 34.8% of the population said for both reasons equally. The types of investment made were most often either to install primary and secondary double glazing. In only 20.7% of cases did the cost of the investment exceed 300,000 pts. (1,803 euros).

Finally, we should mention that there were 188 zero (31.3% of the sample) and 41 (6.8% of the sample) don't know responses to the open ended question. Following NOAA panel recommendations, zero answers had a follow-up question in order to detect whether these zeros were real or protest-based. People who do not consider noise a major problem and, thus, would not be willing to pay for a program aimed at reducing noise would give real zeros. Reasons we interpret as real zero are the following: i) "*I do not notice noise*", ii) "*I do not consider it important*" and iii) "*I'm not interested in noise reduction.*" These reasons account for 133 answers. On the other hand protest zeros were interpreted when the reasons given were: i) "*I already pay enough taxes to the local council*" and ii) "*Noise cannot be reduced with these policies*".

6. Estimated Results

6.1 One and One-Half-Bound Estimations

We have estimated the mean unrestricted WTP by using the OOHB estimation routine developed by Cooper (2000). To perform these estimations we have assumed a logistic distribution for the real WTP. Sample size excludes 8 observations where no answers were obtained for the dichotomous choice valuation questions. We also present the estimation of a SB model that includes only the information regarding the first bid. The results obtained are presented in Table 3.a for the full sample -with protest zeros- and Table 3.b for the sample excluding protest zeros. In the first case the mean unrestricted WTP for the OOHB model is 4764.49 pesetas per year (28.63 Euros), and 6776.02 pesetas per year (40.71 Euros) for the SB model. The corresponding confidence intervals were computed using Krinsky and Robb's (1986) methodology. The estimations of the unrestricted mean between these two methods clearly differ, only the 99% and 95% confidence intervals overlap. The results are confirmed when protest zeros are excluded.

By comparing these results we can see that the information added by applying OOHB methodology increases efficiency by reducing the estimated confidence intervals. The SB estimation models collect less information from each respondent and, therefore, a larger sample is required in order to attain the same level of estimation precision. To overcome this problem, traditionally, the initial bid is supplemented by subsequent dichotomous choice questions in a multi-bound format (Bateman *et al*. 1996). The OOHB methodology supplements the initial bid with a follow-up question that depends on the answer to the first bid and, therefore, increases the sample information, thereby increasing efficiency. An additional measure of the superior reliability of the OOHB model, in this particular exercise, is that the estimated confidence intervals for the OOHB method contain the true mean obtained from responses to the open ended question 4121,95 ptas[12].. This is not the case,

11 The other problems mentioned score above 6 on this same question.

[12] This avoid also the problem of the impact of functional assumptions in parametrical estimation of WTP of DC question formats (Barreiro

however, with the SB estimation.

TABLES 3.a and 3.b ABOUT HERE

It is a well-known fact that the gains in efficiency afforded by the multiple-bound format (double and triple-bound) come at a price: that is, the presence of response bias to the follow-up bids. The consistency of multiple-bound models implies that the responses to the different bids are independent of previous bounds and are uniquely determined by the rational preferences of the respondent. In other words, all responses – to first, second and third bids- should be drawn from the same distribution. Several authors, however, have reported results that reject this fact. McFadden (1994), who presents the most detrimental critique for the DC models, argues that the willingness to pay elicited from this type of survey format comes from "constructed" instead of rational preferences. The power of his argument could invalidate not only the responses to the follow-up bids but also to the first bid and overthrow the validity of the dichotomous choice model. Other authors have presented additional arguments that justify different effects across bounds but that do not jeopardise the application of DC models.

Hanemann *et al*. (1991) argue that, for reasons of *fatigue and weariness,* respondents may wish to terminate the survey as quickly as possible and therefore a change in the type of response can come earlier than it might otherwise. That is, a respondent who has answered YES to the first bid may be concerned that an additional affirmative response will give rise to additional questions and may therefore decide to terminate the questioning by answering NO to the follow-up bid. The same argument holds if the answer to the first bid was negative, though, in this case, fatigue would give rise to an early affirmative response.

A second source of bias was proposed by Cameron and Quiggin (1994) and Bateman *et al.* (1999). These authors suggest that feelings of *indignation* and *guilt* could be possible causes of bias in the answers to the second bid. Theoretically, responses should be independent of the stage or bound at which they were formulated and collected. However, when a respondent has replied affirmatively to the first bid he may resent being asked to pay a higher amount, which is when a feeling of indignation may appear. Such feeling may precipitate the appearance of negative responses in an increasing-bid path. In a decreasing-bid path, in contrast, a feeling of guilt may appear. Respondents that declare themselves unwilling to pay the amount stated in the first bid may feel embarrassed when they are presented with a lower follow-up bid, and feel obliged to answer affirmatively in this case.

Other types of effects are likely to influence both the first and second bids*: free-riding* and *yea*

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and Perez 1999)

saying. Free riding behaviour appears in the provision of public goods that are likely (or are believed to be likely) to be provided independently of the answers and if the respondent suspects that the amount of to be paid is related to his stated answers. In such cases, the proportion of negative answers increases for any given price, even though this increase does not necessarily affect each bound equally (see Bateman *et al*., 1999). *Yea saying,* on the other hand, would increase the probability of bid-acceptance for any given bid amount (Mitchell and Carson, 1989).

In their paper "Bound and Path Effects in Double and Triple Bounded Dichotomous Choice Contingent Valuation," Bateman *et al*. (2000) show that, owing to some of the cited biases, DC models tend to be internally inconsistent. Conversely, the OOHB format should be able to reduce these biases because, as Cooper and Hanemann (1995) argue, "the respondent is informed from the beginning what the possible range is and does not know which end the initial bid will come from, the respondent has little incentive to move to a bargaining mode when responding to the follow-up bid." Therefore, we expect some of these biases to decrease and even disappear with the OOHB format. Next, following Bateman *et al*. (2000), we test for this hypothesis.

Note that if we estimate two SB functions, one from the first bid responses and one from the second bid, then the estimated functions should coincide if they come from the same distribution. In other words, the estimated curves, acceptance responses and welfare measures should coincide, independently of bid order. In order to test this possibility, five bid functions are estimated, two from the answers to the first bid -with and without protest zeros- and three from the answers to the second bid. The results of this estimation are presented in Table 4. The number of observations - when protest zeros are excluded- used in the first bid estimation is 460 (2nd column, Table 4) and in the second bid 283 (3rd column), the difference is due to the fact that, in the second bid estimation, we drop those respondents that answer negatively to a lower bid or affirmatively to a high bid. Note, however, that the dropping of these respondents biases the answers to the second bid. Therefore, in order to estimate these regressions, we assume that if a respondent has answered affirmatively to a high bid (when asked first) he would also, if questioned, have agreed to pay the corresponding lower bid.

Similarly, we assume that respondents answering negatively to the low bid (when asked first) would also have answered negatively to the high bid, if questioned. This analysis is presented with and without protest zeros in columns 4 and 5 of Table 4. For this particular example, the number of protest zeros corresponding to low bids is 71 out of a total of 324 responses, that is, 21.9%; and for the high bid the number is 62 out of a total of 276, that is, 22.4%. Therefore, the presence of these zeros should not affect the result of the test. Columns 4 and 5 of Table 4 present the estimated results of the SB for the answers to the second bid, including those respondents that answered negatively to a lower bid or affirmatively to a high bid. It is not clear that the probability of acceptance responses decreases from the first to the follow-up bid.

Comparing columns 1 and 4, that is, including protest zeros, the probability of acceptance responses increases from the first to the second bid. It is only when we take the third column as a reference that the probability of acceptance responses really decreases from the first to the second bid. Also the differences between the respective mean and median willingness to pay are quite large and only one - the 99% - confidence interval overlaps.

TABLE 4 ABOUT HERE

Note, however, that this analysis cannot tell us whether there is a real inconsistency as presented by McFadden (1994) or simply some type of bias to the follow-up bid (that does not necessary imply that the answers to the first bid are invalid). It could be that inconsistency only remains in the increasing path, and could be attributed to some type of indignation reaction that could be minimized with an extended explanation of the meaning of the upper and lower bounds presented to the respondent. In order to test for this hypothesis, we introduce three dummy variables – Ascen, Descen, and Hbid- in the model. They are designed to identify the bound and path to which every answer belongs. DESCEN takes value 1 for a respondent answering to the follow-up bid when the follow-up bid is low. If there is a *guilt* effect we should expect this variable to be positive and significant. ASCEN, meanwhile, takes value 1 for a respondent answering to the follow-up bid when the follow-up bid is high and 0 otherwise. And HBID takes value 1 for a respondent answering to the first bid when this is a high bid. If there is *indignation*, *weariness* or some type of free-riding strategic behaviour in the answer to the second bid we expect the difference between the estimated coefficients of Hbid and Ascen to be positive and significant. The results of this estimation are presented in Table 5.

TABLE 5 ABOUT HERE

Results show that the variable Descen is non-significant, which means that there is no bias in the descending path, that is, there is no *guilt effect*. However, the difference between the estimated coefficients of Hbid and Ascen proves significant (with t = 2.09 with protest zeros and t = 2.13 without protest zeros) suggesting, in both cases, the presence of an *indignation effect*. In order to further test these results, we have constructed the cumulative bid-acceptance response proportion for each bid ordered by initial bid, the results are presented in Table 6. Note that we have six initial bids, these bids were presented to the respondents in three pairs. As before, in order to construct this table we assume that if a respondent answers affirmatively to a high bid he would also have accepted to pay the corresponding lower bid, if questioned. Therefore, the probability of respondents accepting to pay a charge of 500 pesetas would result from adding up the respondents that answered affirmatively to the first bid (3,500 pts), plus the respondents that answered negatively to the first bid but positively to the second (14 + 55 = 69, or 78.4 % of the sample respondents that were offered 3,500 ptas. as a first bid). Similarly, we assume that respondents answering negatively to the low bid when asked first would also have answered negatively to the high bid, if questioned.

TABLE 6 ABOUT HERE

If there were no bias present on the responses to the second bid, the proportion of acceptance responses should be the same, irrespective of the bid order. The guilt and weariness bias would imply a larger proportion of affirmative answers when the price was presented as a follow-up bid. When a bid of 500 pesetas was suggested as initial bid, the proportion of respondents willing to pay that amount was 76.7%. When that bid was presented as a follow-up bid, the proportion of affirmative responses was 78.4%. A similar interpretation could be made for the initial bids of 2,000 and 4,000 pesetas. If there were guilt or weariness, we would expect the proportion of affirmative responses to decrease significantly when moving from right to left along the low bid rows of Table 6.

Additionally, if there were indignation, we would expect the proportion of affirmative answers to increase when moving from left to right on the high bid rows. For example, when a 3,500 bid was offered as an initial bid, the proportion of affirmative responses was 62.5%. When, however, a bid of 500 pesetas was suggested as an initial bid, the proportion of respondents willing to pay the follow-up bid of 3,500 was 53.4%. In the z-score column of Table 6 the results of a difference in proportion test are presented.[13] Two-tailed tests were performed to detect the existence of differences between these rates. Results reveal that the null hypothesis of no existence of guilt cannot be rejected. The null hypothesis for the indignation effect, however, can be rejected in two of the three cases at the 5% significance level.

These results appear to suggest that the OOHB method reduces the bias resulting from guilt, while not completely eliminating the bias in the increasing-bid path. Additional justification for this asymmetric result could be, for example, that a "new type" of free-riding behaviour that only appears in the increasing path, is facilitated by the OOHB format. In other words, in the OOHB format, the

13 The equation for the relevant test is:

$$z = \frac{(p_1 - p_2)}{\sqrt{\left(p_1\left(\frac{1-p_1}{n_1}\right) + p_2\left(\frac{1-p_2}{n_2}\right)\right)}}$$

interval of possible cost of provision is given prior to the elicitation question, therefore, the respondent may answer affirmatively if faced with the lower price, because he has been informed that it is the lowest possible cost of providing the good. However, when faced with the higher follow-up bid, he may feel that if he appears less interested in the public good than he actually is, he will be required to pay less while still being able to enjoy the good. This effect has no implications for the decreasing-path as free-riding should appear in both bids.

The presence of "government wastage" and "quality reduction" type biases seems more difficult to justify in OOHB formats if the cost interval presented to the respondent, before the elicitation question, has been widely justified. In our case, we have mentioned that it was the *Universidad Pública de Navarra,* an independent and respected institution, who calculated these costs.[14] This information should have been enough to eliminate these possible biases. However, this can remain a point for further research in future experiments where different types of justification for the cost interval can be offered and tested. So we can conclude that, even though the OOHB format does not completely eliminate the biases to the second bid, we have been able to decrease the biases to the descending follow-up question or guilt bias.

6.2 OLS Estimation Results

We estimate the WTP value functions for the open-ended question using OLS models. The results of these estimations are present in Table 7. The conclusions from these estimations are similar to those obtained from the OOHB model. The sample used for these models excludes protest zeros and item non-responses (133 and 41 observations, respectively). An outlier detection process was carried out and answers above 10,000 pesetas per year were excluded (accounting for 16 observations). The effective sample size for models with socio-economic variables is thus 409 and for the models including the "***sensi***" variable the sample is further reduced to 394 observations due to item non-response to one or more of the segmentation variables. The result for the observed mean WTP, excluding protest zeros and outliers, as described above, is 4,122 pesetas per year.

TABLE 7 ABOUT HERE

We present four regression models using OLS estimation. The estimated coefficient of the

14 The precise wording was "By taking data from similar programs, a research team from the Universidad Pública de Navarra has estimated the cost to be somewhere between 500 and 3,500 pesetas per household per year. "

variable Price shows increases in the WTP due to the initial price presented to the respondent. It is positive and significant in all regressions. Most models for open ended valuation answers, which are proceeded by dichotomous choice questions, show this pattern. It has been suggested that this could imply anchoring bias (Mitchell and Carson, 1989) but this notion can be rejected, since mean WTP answers to OE questions are not significantly different when grouped by price offered.

As expected, the variable VALPRO presents a significant and positive parameter estimate, showing that respondents who attach a high value to the noise control program are also willing to pay more for such a reduction program than respondents that do not value the program as highly. We also expect persons that are more disturbed by noise to be willing to pay a more for a noise reduction. Therefore, we introduce the variable SENSI that takes value 1 for persons highly sensitive to noise. Note that, even with the introduction of SENSI, the variable VALPRO remains significant, meaning that people who are more sensible to noise are not necessarily those who attach a greater value to the noise control program. Moreover, and as expected, both coefficients are positive, indicating that a higher valuation of the program and a high level of sensitivity to noise led to greater willingness to pay. We tested for multicollinearity, using Belsley's (1980) method. The condition number obtained for these regressions was always below 20, thus showing no evidence of multicollinearity.

As mentioned before, we expected more highly educated people to be more annoyed by noise and, therefore, to be willing to pay more. The estimated coefficient corresponding to the variable UNIVER is positive and significant in all regressions, showing that people with a university degree show greater willingness to pay for silence. The variable ISOLA is not significant, which shows that families that have already spent some income on defensive investments are not willing to pay for additional noise reductions. Other variables were considered in the regressions, such as age, gender or income level. The estimated coefficients of these variables were never significant for these estimated regressions. We decided, therefore, to drop these variables. To prevent any heterokedasticity problems we used the heterokedasticity-consistent estimator of the OLS matrix of variances and co-variances (White, 1980).

6.3 Test for scope sensitivity

We introduced the variable OPTION in the estimated regressions equation to test for a "scope sensitivity effect." We tested to see whether people give different values to different goods in order to avoid critiques such as those proposed by Kahneman and Knetsch (1992). Under Alternative 1, respondents are asked to value in monetary terms a decrease in the level of noise similar to the reduction that takes place "between the working hours of a working day and 9:30 p.m. of the same day." Under Alternative 2, respondents value the reduction in the level of noise that takes place “between the working hours of a working day and Sunday morning." We tested for the presence of this scope effect using both the OLS and OOHB estimation procedures.

The OLS estimated results, which are presented in Table 7, show that the sign of the variable OPTION is positive and significant, meaning that respondents value Alternative 2 more highly. In other words, the inhabitants of Pamplona value more highly the reduction in noise level that takes place on Sunday morning. The significance of this parameter shows that there is a scope sensitivity effect, that is, different reductions in the level of noise are valued differently. In the case of the OOHB estimation – presented in Table 8 - the variable OPTION is not significant. If, however, we estimate a separate OOHB regression for each Alternative, we see that Alternative 2 is valued more highly than Alternative 1, although differences are non-significant according to an overlapping confidence intervals test. This result confirms the OLS findings, in that the reduction in the level of noise that takes place on Sunday morning is more highly valued. However, we need to know if the variable OPTION presents the correct sign, that is, whether this result ($WTP_{alt2} > WTP_{alt1}$) is consistent with the real noise reduction, or if Alternative 2 represents a greater reduction in the level of noise than Alternative 1.

TABLE 8 ABOUT HERE

Though noise can be objectively measured in decibels dB(A), the level of noise disturbances suffered by the population does not usually coincide with the objective measure of noise. That is, two noises of the same measured intensity (i.e. same level of dB(A)) can give rise to different levels of disturbance, depending on the physiological characteristics of the individuals, on the activities they carry out, or on other environmental or personal factors. Therefore, we have considered two measures of noise, one subjective, the other objective.

We obtain the subjective measurement of noise through the questionnaire. In the survey we have asked respondents to rank three moments in the day according to the level of noise suffered: i) working hours during working days, ii) night hours (*i.e*. 9:30 p.m.) during the working days, and iii) Sunday morning hours. The question was asked twice, first we asked them to rank the three situations from the noisiest to the least noisy, and later on in the survey we asked the contrary, that is, to rank the alternatives from the least to the most noisy. 91.0% of the population ranked "working hours during working days" as the noisiest period of the day. The results were similar for the second question, the rank order was the same and 85.6% of the sample considered that the Sunday morning hours were the least noisy part of the week. That is, the biggest reduction in the level of noise would take place between "working hours during working days and Sunday morning hours." If noise is considered as an "bad" we should, however, expect the option that represents a greater noise reduction to be the most highly valued. That is, the variable OPTION should present a positive and significant parameter estimate. According to the subjective perception of noise annoyance described above, the sign of the estimated coefficient corresponding to the variable OPTION is appropriate. That is, we would expect willingness to pay for Alternative 2 to be greater.

For objective measures of noise, we consulted Arana *et al*. (1997, 1989) who measured the noise level for the city of Pamplona in a wide variety of city locations. Most measures took place only during working hours, but for five neighbourhoods, a continuous (24 hours) measure of noise level was recorded. This continuous measurement enables us to compare the different levels of noise in the same location during 24 hour periods. The continuous measurements were taken for the neighbourhoods of: *Casco Viejo, La Chantrea, San Jorge, San Juan, and Segundo Ensanche*. From the measurements obtained by Arana *et al*., we have obtained the average level of noise in these neighbourhoods in the three periods considered in our survey. First, the Sunday morning noise level was calculated averaging the level of noise measured between 10 a.m. and 1 p.m. To obtain the level of noise at 9:30 p.m., we calculated the average of noise between 9 and 11 p.m.[15] An average of the levels of noise during working hours was also calculated to obtain the noise during working hours on working days. These results left us with two types of neighbourhoods i) those where the level of noise is higher during working days at 9:30 p.m. than on a Sunday morning, *i.e*. *Casco Viejo and San Jorge*, and ii) those where the level of noise is higher on Sunday mornings than at 9:30 p.m. on a working day, *i.e. La Chantrea, San Juan and Segundo Ensanche*. These measurements are presented in Table 9.

TABLE 9 ABOUT HERE

We expected the OPTION variable to be positive and significant for the first type of neighbourhood, and negative and significant for the second type. To test these expectations we estimated two regression equations, one for *Casco Viejo* and *San Jorge* (henceforth in the tables *CV and SJo)* and a second one for *La Chantrea, San Juan* and *Segundo Ensanche* (henceforth in the tables *CH, 2EN and SJ)* .The estimated results obtained are presented in Table 10.[16] This table shows that the neighbourhoods that present a larger reduction in the level of noise on Sunday morning are consistently willing to pay more for this reduction than for a reduction in the level of noise corresponding to 9:30 p.m. In other words, these neighbourhoods present a willingness to pay consistently different for the two options presented.

Therefore, we reject the existence of embedding effect even when we take into account the "objective" measure of noise for the neighbourhoods of *Casco Viejo* and *San Jorge, w*here respondents

15 We had measures of the level of noise corresponding to the 9 p.m. to 10 p.m. period, but these presented very high variability.
16 No OOHB models are presented as, owing to their small sample size, these two groups failed to provide consistent results.

show greater willingness to pay for a bigger reduction in terms of the objective measure of noise. However, we cannot clearly reject the existence of a scope sensitivity effect if we take into account the objective measures of noise in the quieter neighbourhoods of *La Chantrea, San Juan and Segundo Ensanche.* This result can be justified, however, because the general level of noise in these neighbourhoods is lower and it is difficult to distinguish between the levels of noise at 9:30 p.m. and on Sundays mornings.

This result shows that there is an important difference between the annoyance caused by the level of noise in one type of neighbourhood and the other. The neighbourhoods where the level of noise is higher both on working days at 9:30 p.m. and on Sunday mornings, show a willingness to pay approximately 3,983 ptas higher than in other less noisy neighbourhoods (La Chantrea, Segundo Ensanche and San Juan) where the willingness to pay is 3,750 ptas. In other words, respondents in noisier neighbourhoods seem to be willing to pay more for a noise reduction than respondents in quieter neighbourhoods. To further test this hypothesis, we introduced the dummy variable Noisyneigh that takes value 1 for the neighbourhoods of *San Jorge and Casco Viejo*, which are noisier, and 0 for the neighbourhoods *of La Chantrea, San Juan and Segundo Ensanche.* The estimated coefficient is clearly positive but only significant at the 15% level, showing that inhabitants of the noisier parts of the city are willing to pay more. This results turns out to be more relevant when we consider that *Casco Viejo* and *San Jorge* are two of the city's low-income neighbourhoods.

Note also that the parameter of the ISOLA variable is only significant for the neighbourhoods of *Casco Viejo and San Jorge* where it has a negative sign. These, as we have shown before, are the neighbourhoods which suffer, a higher average noise level. The negative value of this parameter indicates that families that have already invested on insulation from noise are less willing to pay than the rest. This could be because they have already solved their problem, *i.e*. they no longer suffer from noise, or it could also be a way of showing their reluctance for further expenditure when they have already invested in noise protection

TABLE 10 ABOUT HERE

7. Concluding remarks

We have applied the one and one-half-bound (OOHB) methodology to estimate the economic value of a non-market good, a reduction in the level of noise in a Northern Spanish city. The results indicate that the household willingness to pay for a noise reduction is about 4,765 pts. per year. Our household willingness to pay represents 0.19% of total annual income, which is significantly lower than the 0.32% reported in Vainio (1995) in his CV study of noise reduction for the city of Helsinki. Comparing the estimations obtained via the OOHB method and the SB method, we can observe that the restricted WTP point estimate is lower and there is a large gain in efficiency. That is, the size of the confidence interval greatly decreased for the OOHB model. These results confirm the findings of Cooper and Hanemann (1995).

We have also tested for the presence of response bias to the follow-up bids (indignation, guilt and weariness). We have found that the OOHB format reduces the presence of guilt bias or weariness in the decreasing bid-path but no evidence was found of a reduction of biases on the increasing-bid path. But in the OOHB format another type of free-riding behaviour may appear, though only in the increasing path.

Furthermore, and as was expected, we show that respondents who attach a high value to the noise control program, are highly sensitive to noise or possess a higher level of education are also willing to pay more than others for such a noise reduction program.

Finally, we also test for a scope sensitivity effect, that is, whether different reductions in the noise level are valued differently. We have employed two alternatives means to measure this effect, subjective perception of noise annoyance and an objective measure of noise level. In the first case, a scope sensitivity effect was found to be present, in other words, different reductions in the noise level were valued differently. But, with the objective measure we can reject the presence of any embedding effect, partly because in quieter neighbourhoods we are unable to obtain any clear confirmation.

References

- ARANA, M. (1997). "*Estudio y Evaluación de la Problematica del Ruido en Pamplona y Poblaciones Colindantes*". Fase I. Mimeo.

- ARANA, M. (1989). "*Estudio del Ruido Ambiental en Pamplona*", Tesis Doctoral. Universitat d'Alacant, Alacant, Spain.

- ARANA, M. and GARCÍA, A. (1990). "Estudio del ruido ambiental en Pamplona". *Revista de Acústica 1 y 2.*

- BARREIRO, J. and PÉREZ AND PÉREZ, L. (1999): "Parametric and non-parametric modelisation of dichotomous choice contingent valuation questions". *Comunicación al 3rd Seminar on Environmental and Resource Economics*, Girona, Junio.

- BATEMAN, I.J.; LANGFORD, I.H.; JONES, A.P.; KERR, G.N (2000). "Bound and path effects in double and triple bounded dichotomous choice contingent valuation". *Discussion Paper University of East Anglia, Norwich, United Kingdom.*

- BATEMAN, I.J. , et al. (1996). "Household willingness to pay and farmer's willingness to accept compensation for establishing a recreational woodland". *Journal of Environmental planning and management*, 39 (1), 21-43.

- BATEMAN, I.J. , LOVETT, A.A. and BRAINARD, J.S. (1999). "Developing a methodology for benefit transfers using geographical information systems: modelling demand for woodland recreation". *Regional Studies*, 33 (3), 191-205.

- BESLEY, D.A. (1980). "On the efficient computation of the Non-linear Full-Information Maximum-Likelihood estimator." *Journal of Econometrics*, 14 (2), 203-225.

- BOLAÑOS, F., and J.M. OCHOA (1990). "*Medida y control del ruido"*, Ed. Boixareu, Barcelona.

- CAMERON, T.A. and J. QUIGGIN (1994). "Estimation using contingent valuation data from a Dichotomous Choice with Follow-up Questionnaire," *Journal of Environmental Economics and Management,* 27(3), p.218-234.

- CARSON, R. T. et al. (1994). "Contingent valuation and revealed preference methodologies: comparing the estimates for quasi-public goods". *University of California, San Diego*. Department of Economics, Working Paper, 94-07, pages 14.

- CARSON, R., R. MITCHEL, M. HANEMANN, R. KOPP, S. PRESSER and P. RUUD (1992). "A Contingent Valuation Study of Lost Passive Used Values Resulting from the Exxon Valdez Oil Spill". *Report to the Attorney General of Alaska*. NRDA1nc, La Jolla CA.

- COLLINS, A., and A. EVANS, (1994). "Aircraft noise and residential property values: an artificial neural network approach.." *Journal of the Transport Economics and Policy,* May, 144-52.

- COOPER, J.C. (1993). "Optimal bid selection for dichotomous choice contingent valuation surveys". *Journal of Environmental Economics and Management*, 24 (1), 25-40.

- COOPER, J.C. and M. HANEMANN, (1995). "Referendum contingent valuation: how many bounds are enough?". *Working Paper, ERS-USDA*, Food Consumption and Economics Division, July.
- COOPER, J.C.; HANEMAN, M. and SIGNORELLO, G. (2000). " One and one-half bound dichotomous choice contingent valuation". Working Paper Economic Research Service, USDA, Washington, DC.
- EEA (1995). "*Europe's Environment: The Dobris Assessment"*. Eds. D. Stanners and P. Bourdeau. Copenhagen. Office for Official Publications of the European Communities, Luxembourg and Elsevier Science Ltd., Oxford, UK.
- EEA (1999). "*Environment in the European Union at the turn of the Century"*, Copenhagen. Office for Official Publications of the European Communities, Luxembourg and Elsevier Science Ltd., Oxford, UK.
- GRANDJEAN, E., and A. GILGEN (1976). "*Environmental factors in urban planning"*. Taylor and Francis Ltd., London.
- GUSKI, R. (1989*). "El ruido. Efecto de los sonidos no deseados"*, Ed. Herder, Barcelona.
- HANEMANN, M. (1984). "Welfare evaluation in contingent valuation experiments with discrete responses." *American Journal of Agricultural Economics*, 66, 332-341.
- HANEMANN, M., J. LOOMIS, and B. KANNINEN, (1991). "Statistical efficiency of double-bounded dichotomous choice contingent valuation." *American Journal of Agricultural Economics*, 73 (4), 1255-1263.
- KAHNEMAN, D. and KNETSCH, J.L. (1992). "Valuing public goods: the purchases of moral satisfaction". *Journal of Environmental Economics and Management*, 22 (1), 57-70.
- KANNINEN, B.J. (1995). "Bias in discrete response contingent valuation". *Journal of environmental economics*, 28 (1), 114-125.
- KRINSKY, I. and ROBB, A. L. (1986). On approximating the statistical properties of elasticities. *Review of Economics and Statistics*, 68 (4), 715-719.
- KRISTÖM, B. a) (1990). "Economics of including recreation as a purpose of Easter water projects." *Journal of Farm Economics*, 46, 1148-1157.
- b) (1990). "Valuing environmental benefits using the contingent valuation method. An econometric analysis". *Ph.D. University of Umea*.
- c) (1995) "Theory and applications of the contingent valuation method". Comunicación en el curso "Economía Ambiental" de la UIMP. Barcelona, Junio.
- LEVESQUE, T.J. (1994). "Modelling the effects of airport noise on residential housing markets: a case study of Winnipeg International Airport," *Journal of Transport Economics and Policy*, 199-210.
- MALHOTRA, N.K. (1983). "*Marketing research*". An applied orientation. Prentice Hall.
- MCFADDEN, D. (1994). Contingent valuation and social choice. American Journal of Agricultural Economics, 76 84), 689-708.
- MCFADDEN, D. and G. LEONARD (1993). "Issues in contingent valuation of environmental

goods: methodologies for data collection and analysis" in J.A. HAUSMAN (ed.) *Contingent Valuation a Critical Assessment.* North Holland, Amsterdam.

- MITCHELL, R.C. and CARSON, R.T. (1986). "Some comments of the State of the Arts Assessment of the Contingent valuation method draft report: appendix". Cummings-Brookshire-Schulze Ed. Valuing environmental goods: an assessment of the contingent valuation method, 237-245.
- MITCHELL, R.C. and CARSON, R.T. (1989). "Using surveys to value public goods: the contingent valuation method". *Washington D.C. Resources for the future*, xix, 463.
- O'BYRNE, P.H. et al., (1985). "Housing values, census estimates, disequilibrium and the environmental costs of airport noise: a case study of Atlanta." *Journal of Environmental Economics and Management*, 12, 169-178.
- NELSON, J.P. a) (1978). "Residential choice, hedonic prices and the demand for urban air quality." *Journal of Urban Economic*, 5, 357-369.
- b) (1979). "Airport noise, location, rent and the market for residential amenities." *Journal of Environmental Economics and Management,* 6, 320-331.
- RENEW, W.D. (1996). "The relationship between traffic noise and house price". *Conference of the Australian Acoustical Society*, Brisbane, 13-15th November, 1996.
- SOGUEL, N. (1994). "Evaluation monetaire des atteinties a l'environment: une étude hedoniste et contingente sûr l'impact des transports", *Imprimerie de l'Evolve SA Neuchatel*.
- VAINIO, M. (1995). "Traffic noise and air pollution: valuation of externalities with the hedonic price and contingent valuation methods", *PhD thesis, School of Economic and Business Administration, Helsinki.*
- WHITE, H. (1980). "A heteroskedasticity-consistent covariance matrix estimator and direct test for heteroskedasticity". *Econometrica*, 48 (4), 817-838.
- WHO (1993). "The Environmental Health Criteria Document on Community Noise". Report on the *Task Force Meeting, Düsseldorf, Germany*, 24-28 November, 1992. World Health Organization, WHO Regional Office for Europe, Copenhagen.
- YAMAGUCHI (1996). "Sustainable investment and resource use", *UNESCO/Paternon, Caraforth.*

Table 1. Distribution of observations by initial price used in the one and a one half bound question

Cost Interval in ptas.	n	%	Bid drawn first in ptas	n	%
500 – 3,500	192	32.0	500	104	54.2
			3,500	88	45.8
2,000 – 7,000	200	33.3	2,000	109	54.5
			7,000	91	45.5
4,000 – 10,000	208	34,6	4,000	111	53.4
			10,000	97	47.6
TOTAL	600	100		600	

Source: Own calculations

Table 2. Citizen Sensitivity to Noise

Noise disturbance suffered in	SENSI = 1 More noise sensitive	SENSI=0 Less noise sensitive
Neighbourhood***	7	3
House***	5	3
City***	7	5
Percentage of Sample	59%	41%

*** Significant at the 99% confidence interval
Source: Own calculations

Table 3a: Logit results for the full sample

	OOHB Estimation		SB Estimation	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	1.03045	9.815***	0.88129	5.928***
Bid	-0.000216	-13.710***	-0.00013	-4.814***
Log-likelihood	-649.66608		-391.81	
N	592		592	
Unrestricted mean WTP	4,764.49		6,776.02	
Krinsky and Robb confidence intervals for mean WTP (pesetas per year)				
	OOHB		SB	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
99% CI	3,728.04	5,717.72	4,943.83	10,208.59
95% CI	4,051.45	5,492.17	5,433.34	8,896.82
90% CI	4,167.93	5,356.52	5,633.41	8,521.76

*** Significant at the 99% confidence level

Source: Own calculations

Table 3b: Logit results for the sample without protest zeros

	OOHB Estimation		SB Estimation	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	2.04931	13.880***	1.94203	9.52***
Bid	-0.00029	-13.794***	-0.00018	-5.682***
Log-likelihood	-482.26		-247.28	
N	460		460	
Unrestricted mean WTP	7,049.88		10,403.28	
Krinsky and Robb confidence intervals for mean WTP (pesetas per year)				
	OOHB		SB	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
99% CI	6,164.82	7,976.55	8,218.68	15,460.51
95% CI	6,376.51	7,736.74	8,587.31	13,603.08
90% CI	6,505.30	7,594.74	8,875.95	12,831.15

*** Significant at the 99% confidence level

Source: Own calculations

Table 4. Comparison of SB logistic estimations based on the responses at specified bounds with and without protest zeros

Variables	1st Bid Estimation		2nd Bid Estimation		
	With Zeros	Without Zeros	Real	With Zeros	Without Zeros
Constant	0.88129 (5.92)***	1.94202 (9.52)***	0.47517 (1.90)*	0.9209 (5.83)***	1.8444 (9.06)***
Bid	-.00013 (4.81)***	-.00010 (2.44)**	-.00019 (2.44)**	-.0002 (6.69)***	-.0003 (8.49)
Log-Likeh. N obs.	-391.81 592	-247.28 460	-223.54 283	-372.4 592	-266.96 460
Unrestricted Mean WTP	6,776.02	10,351.33	4,812.76	4,604.5	6,148
Krinsky and Robb confidence intervals for mean WTP					
99% CI	4,943 - 10,208	8,352-15,040	-16,368-8,741	2,820-4,853	5,251-7,230
95% CI	5,433 - 8,896	8,796-13,565	579-7,547	3,097-4,628	5,458-6,896
90% CI	5,633 - 8,521	9,023-12,960	1,614-6,818	3,246-4,550	5,565-6,752

Source: Own calculations

Table 5: Comparison of SB logistic estimations based on the responses at specified bounds with double sample.

Variables	With Protest Zeros	Without Protest Zeros
Constant	.86640 (6.24)***	1.9123 (10.22)***
Bid	-.00012 (4.17)***	-.0001 (3.02)**
Descen	.05775 (.332)	.1288 (.505)
Ascen	-.95275 (4.50)**	-1.4718 (5.74)***
Hbid	-.05636 (.26)	-.3352 (1.21)
Log likelihood N obs.	 1184	 920

Source: Own calculations

Table 6: Cumulative bid-acceptance response rates, two-tailed Z scores and effects from respondents facing different initial bids.

Interval 500 - 3,500				
	1st Bid Offered		Z score	Effect
	500	3500		
Prob. Yes 500	76.7	78.4	-.28	No guilt
Prob. Yes 3,500	53.4	62.5	-1.27	No Indignation

Interval 2,000 - 7,000				
	1st Bid Offered		Z score	Effect
	2000	7000		
Prob. Yes 2,000	60.0	48.9	1.33	No guilt
Prob. Yes 7,000	14.2	36.6	3.63	Indignation

Interval 4,000 - 10,000				
	1st Bid Offered		Z score	Effect
	4000	10000		
Prob. Yes 4,000	57.8	69.0	-1.67	No guilt
Prob. Yes 10,000	29.3	48.8	2.90	Indignation

Source: Own calculations

Table 7. OLS value functions (socio-economic variable) for whole sample with and without option variable and with and without noise sensitivity variable

Variable	Without option and sensi	With option and without sensi	Without option and with sensi	With option and sensi
Intercept	933.9	636.4	603.4	384
	(2.40)**	(1.52)	(1.37)	(0.83)
Price	0.42	0.42	0.43	0.43
	(9.40)***	(9.43)***	(9.30)***	(9.34)***
Valpro	1,299	1,300	1,362	1,366
	(4.04)***	(4.08)***	(4.31)***	(4.32)***
Isola	384.1	425.3	374	406.2
	(1.29)	(1.43)	(1.25)	(1.35)
Univer	1,090	1,066	1,032	1,012
	(3.36)***	(3.29)***	(3.20)***	(3.19)***
Option	-	552.2	-	483.5
		(1.93)*		(1.7)*
Sensi	-	-	558.3	501
			(1.87)*	(1.68)*
Adj.R^2	0.19	0.20	0.21	0.21
N obs.	409	409	394	394
Condi#	5.82	6.60	6.95	7.63

T-statistics are in parentheses ***, **, * Significant at the 99% , 95% and 90% confidence level respectively.
Source: Own calculations

Table 8. OOHB Estimation results with option variable (Logistic distribution)

	Full Sample with option variable		For alternative 1		For alternative 2	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	1.0010168	7.558***	1.15869	7.387***	0.912208	6.469***
Bid	-0.000216	-13.71***	-0.252615	-10.16***	-0.18344	-9.139***
Option	0.013854	0.3773				
Log-likelihood	-649.59		-315.697		-331.217	
N Obs.	592		281		311	
Unrestricted mean WTP	4,764.49		4,586.79		4,972	
95% CI	3,866.92- 5,571.96		3,688.4-5,496.17		3,894.5-6,091.59	

Significant at the 99% confidence level

Source: Own calculations

Table 9. Noise Measurement by Neighbourhood

Neighbourhood	dB(A) in Leq.		
	Working Hours	Working Days 21:30	Sunday Morning
Casco Viejo	71,1	72,0	68,6
San Jorge	75,1	71,3	67,3
La Chantrea	60,0	51,6	59,3
San Juan	65,6	63,3	65,3
II Ensanche	69,6	64,6	67,3

Source: Arana 1987

Table 10. OLS value functions (socio-economic variable) for neighbourhoods with continuous noise measurement with and without noise sensitivity variable

	OLS					
	Without sensi			With sensi		
Variables	All neighbour.	CV and SJo	CH, 2EN,SJ	All neighbour.	CV and SJo	CH, 2EN,SJ
Intercept	54.37	-223.43	293.81	-8.67	-633.02	207.24
	(0.08)	(0.23)	(.37)	(0.01)	(0.57)	(0.24)
Price	0.43	0.69	0.38	0.43	0.68	0.38
	(6.84)***	(5.79)***	(5.14)***	(6.50)***	(5.41)***	(4.94)***
Valpro	1584	1008.84	1744.79	1622	972.81	1783.95
	(3.33)***	(1.35)	(2.97)***	(3.36)***	(1.24)	(2.99)***
Isola	-301.30	-1321.10	109.09	-490	-1489.80	-75.36
	(0.69)	(2.00)*	(0.20)	(1.10)	(2.12)*	(0.13)
Univer	1220	2360.43	1116.94	1135	2185.85	1094.66
	(2.61)***	(3.38)***	(1.85)*	(2.39)***	(2.84)***	(1.79)*
Option	742.06	2081.44	278.78	675.00	1809.84	321.20
	(1.78)*	(3.18)***	(0.53)	(1.52)	(2.45)***	(0.58)
Noisyneig	615.3			595.7		
	(1.51)	-	-	(1.41)	-	-
Sensi				451	881.90	348.48
	-	-	-	(1.3)	(1.24)	(0.63)
Adj.R^2	0.22	0.45	0.20	0.25	0.48	0.21
N Obs.	204	58	145	193	54	138
Condi#	7.30	6.82	6.88	8.15	7.98	7.74

T-statistics are in parentheses . ***, **, * Significant at the 99% , 95% and 90% confidence level respectively.

Source: Own calculations

Appendices

Valuation questions in the survey (*Alternative 2; 500-3,500 cost interval BIDU drawn first*)

15) From the experience of the effect of similar programs in cities like Pamplona it is possible to reduce both day and night-time noise by applying all the measures described before.

To give you an idea of what this reduction would mean, we can assure you that daytime noise would be reduced from the working day level to that of a Sunday morning*. Regarding night noise it would mean a reduction from the level on a Saturday night to that of a Monday night. What overall score would you give such a program on a scale of 0 to 10? _______

As you know, this program would be costly and the local council would need to ask citizens to pay for it by introducing a local tax increase. By taking data from similar programs, a research team from the Universidad Pública de Navarra has estimated the cost to be somewhere between 500 and 3,500 pesetas per household per year.

Would you be willing to pay 3,500 pesetas per year in order to reduce the level of noise as described before?

YES ☐ NO ☐

[*INTERVIEWER: if the interviewee has any doubts regarding the reduction in noise level, please repeat:*

DAYTIME: weekday morning to Sunday morning

NIGHTIME: Saturday evening to Monday Evening

If interviewee answers no then ask]

And what about 500 pesetas per year?

YES ☐ NO ☐

[Ask all]

What would be the most you would be willing to pay in order to reduce the level of noise in Pamplona?

_______________Pesetas

[If the answer is 0 or less than 0 then ask]

What are your reasons for not wanting to pay for such a program?

* The alternative scenario used for the scope sensitivity test had this description "daytime noise would be reduced from the working day level to that of a working day at 9:30 p.m."