How much are people willing to pay for silence?¹

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ABSTRACT

Despite its major importance in the urban environment, the problem of noise has received little attention from environmental economists. In this paper we estimate the value of a noise reduction program in a Spanish city. The chosen technique is contingent valuation with a one and one-half bound question format. Through our estimations we have found, first of all, that urban residents generally value noise negatively and, specifically, that a Spanish household is willing to pay approximately 4 euros per year per dB reduced. A further finding is that there is no scope sensitivity effect; which means that households display a willingness to pay different amounts for two different degrees of noise reduction.

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

Noise, which continues to be one of the main environmental problems facing Europe, is gaining in importance as a result of the rise in noise levels that comes about with increasing economic activity. Noise is something to which we are exposed throughout life. It is exposure to levels above 40 dB(A) that begins to influence our well being, while levels above 60 dB(A) are considered detrimental to our health.\(^2\) Excessive levels of noise have both physiological, and psychological consequences. The physiological effects include, for example, hearing impairment, disturbed sleep, high blood pressure, stomach ulcers and other digestive disorders. Among the psychological effects we can also mention greater levels of anxiety, irritability and nervousness; it also influences social behaviour and cognitive development (Bolaños and Ochoa, 1990; Guski, 1989). High noise levels have a negative impact not only on health but also on other areas of life, and therefore give rise to economic consequences. Exposure to high levels of noise decreases the ability 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).\(^3\) Other economic consequences are losses in property value and increased health expenditure. Noise affects not only urban areas and human health, but also the natural environment.

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 of over 55dB(A) (EEA, 1999), a problem that is becoming more serious, despite corrective measures and improvements in car and truck design.\(^4\) Greater economic activity has brought about this increase in the level of road noise and the trend is expected to prevail in the future.

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2 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, known as A-weighting. The range for everyday noise on this scale goes from 45 to 115 dB(A). To describe the impact of noise on humans, the so-called Equivalent Sound Pressure Level ($L_{eq}$) is calculated, that is, the mean value of sound intensity over time expressed in decibels.

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

4 The EU noise standards have been lowered 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 widespread application of low noise technology, resulting in decreases in engine and exhaust noise, for example. 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.
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 exceeding 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. The development of high-speed trains will also lead to increases in the noise level generated by this means of transport. Sources of noise linked to industry and recreational activities are difficult to compile because of the wide variety involved, 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 5\(^{th}\) 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 several options are available. First, technological and engineering actions such as low-noise product development, insulation for sound-proofing homes and the development of low-noise tyres and surfaces are ways of reducing noise emission. Second, the planning of land use can also help by separating incompatible functions and establishing quiet areas or noise-abatement zones. Additionally, educational and informative measures, such as increasing the noise awareness of the population by providing information either on the number of complaints made, or on the increase in noise resulting from high-speed driving, could also help to lower noise levels. Finally, legal action would also be required, in other words, it would be necessary to fix limits or approve guidelines, after 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 certainly be costly and their implementation

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5 See the "Environment in the European Union at the Turn of the Century" as reported in the EIONET Noise Newsletter, European Environmental Agency, no. 2, September 1999.
6 See Dobris Assessment, p.5, Ch.16.
would only be justified if the economic benefits of noise reduction are a matter of importance to European citizens. Noise, in economic terms, is a negative externality and a public “bad,” however, it is one of the pollution problems that has attracted least attention among environmental economists. There have been no comprehensive studies to evaluate the social cost of the different types of urban noise and the benefits to be gained from 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), and O’Byrne (1985) 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)).

Relatively few contingent valuation (CV) studies have been conducted to assess the value of city noise reduction. One of the major reasons for this may be the difficulty involved in constructing a good CV survey able to provide an accurate description of a reduction in noise that would be easily understandable for respondents. Many of these studies, Saelensminde (1999) and Pommerehne (1988) among others, ask respondents to value percentage reductions in noise levels without checking to make sure that people understand what such a reduction would mean to them. Recently, however, several studies have explored new ways of describing noise reductions that are easier for respondents to understand. Vainio (1995, 2001) has applied the contingent valuation method (CVM) in order to estimate the willingness to pay (WTP) for reducing traffic-noise to such a considerable extent that “the street would become a residential street”. Navrud (2000) and Lambert et al. (2001) describe noise reduction in terms of annoyance and elicit the WTP for a noise reduction program that will eliminate some determined levels of annoyance.

The main goal of this paper is to advance in this direction by using the contingent valuation method to estimate the economic value of a reduction in noise. More specifically, we estimate the economic value of a reduction in the volume of noise tolerated by the inhabitants of a medium-sized Spanish city. We describe the change in noise reduction level by referring to the noise levels endured
by respondents at different times of day and on different days of the week. Furthermore, in applying the CVM to estimate the economic value of a reduction in noise, we use the one and one-half-bound format recently proposed by Cooper and Hanemann (1995) and by Cooper et al. (2002). The one and one-half-bound format is less likely to result in follow-up response bias than the double bound and triple bound alternatives. Furthermore, this method still retains much of the efficiency of the double bound alternative and requires less information than either the double bound or triple bound models. Because of its novelty, we outline a brief description of the OOHB one and one-half-bound methodology in the next section.

The contingent valuation method, however, has not been exempt of criticism. A second important goal of this paper is to assess the relevance of a major contingent valuation caveat, i.e., its lack of sensitivity to different levels of provision of a public good. Therefore, we test for the presence of any scope sensitivity effect in our study. In their 1992 paper, Kahneman and Knetsch criticise the contingent valuation method, by showing that in certain cases people attach the same value to different goods. To avoid this critique we test for the presence of any scope sensitivity effect. We carry out a double test in which we first measure noise objectively and compare the sums that respondent are willing to pay for different degrees of noise reduction. We repeat this exercise by measuring noise subjectively. In both cases, we reject the existence of any scope sensitivity effect.

The next section presents and briefly analyses the one and one-half-bound methodology. In the third section, we discuss the survey design, 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 the one and one-half-bound estimated models. In section seven the results for the scope sensitivity test are presented and then discussed. 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 Kristölm pointed out in his 1990 paper
and thesis- that individuals have an approximate idea of the amount of money that they are willing to pay 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. 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. (2002).

These authors propose an alternative question setting to the classical single bound and double bound question formats: the one and one-half-bound format. Bishop and Heberlein presented the single format in 1979 in which each respondent is quoted a single monetary amount and asked if he or she is willing to pay that amount. Years later, Hanemann, Loomis and Kanninen (1991) introduced the double bound method where respondents are presented first with a price as in the single bound case, but, having once responded, are quoted a different price and again asked if they are willing to pay that second amount. Though the double bound format provides more efficient coefficient estimates than those facilitated by the single bound method, this does not mean that it is 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), and Cooper et al. (2002) 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 OOHB format, a specification that should significantly reduce the risk of the survey moving into a bargaining setting when the interviewer proposes a follow-up bid.

OOHB question format 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 may range from a lower to an upper bound, called BIDL and BIDU, respectively, (i.e. BIDL < BIDU). Application of this methodology involves the following steps: first, before being asked to answer the questions that elicit willingness to pay, the respondent is informed about both the lower and upper bounds, referred to as the limits of the expected cost of the environmental good. Next, the
interviewer randomly chooses one of these two points as the initial value at which 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 one and one-half-bound log-likelihood function can be written as:

$$\ln L(\Theta) = \sum_{i=1}^{N} \left\{ d_{i}^{n} \ln \pi^{n}(\text{BIDL}_{i}) + d_{i}^{yy} \ln \pi^{yy}(\text{BIDU}, \text{BIDL}_{i}) + d_{i}^{yy} \ln \pi^{yy}(\text{BIDU}_{i}) \right\}$$

where, $i$ are individuals; $\pi^{jl}$, 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 sum quoted 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 $\pi^{jl}$ is found to be the interval between two bids, e.g. $\pi^{jn} = \pi(\text{BIDL} \leq \text{WTP} < \text{BIDU}) = \Lambda(\text{WTP} \leq \text{BIDU}) - \Lambda(\text{WTP} < \text{BIDL})$, where $\Lambda(\cdot)$ is the cumulative distribution function. In our case we choose the logistic distribution function $\Lambda(\beta x)$ to carry out our estimations. Since $\pi^{y} = \pi^{ny}, \pi^{yy} = \pi^{ny}$ and $\pi^{yn} = \pi^{n}\pi$, the likelihood function can be simplified to:

$$\ln L(\Theta) = \sum_{i=1}^{N} \left\{ d_{i}^{yn} \ln \pi^{yn}(\text{BIDU}, \text{BIDL}_{i}) + d_{i}^{yn} \ln \pi^{yn}(\text{BIDU}_{i}) \right\}$$
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 to be used in the estimation process, as are obtained in the double bound. However, only one vector is used as a BID independent variable in the estimation, as is the case in a single bound model. The elements from which this BID variable is derived are a combination of the BIDL and BIDU vectors; whether it is the lower or the upper bid value that is included in the BID variable to estimate the model depends on the respondent’s reply. Thus, if the BIDL were to be drawn first and the respondent were to say 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. Additionally, the probability associated with that (Yes, No) answer would be represented by: 
\[ \pi^{yn} = \pi(BIDL \leq WTP < BIDU) = \Lambda(WTP \leq BIDU) - \Lambda(WTP < BIDL). \]
However, if the answer were YES to both 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 \[ \pi^{yy} = \pi(BIDU \leq WTP < \infty) = 1 - \Lambda(WTP \leq BIDU). \]
Likewise for a (No, No) response, where the probability associated with the response can be represented by \[ \pi^{nn} = \Lambda(WTP \leq BIDL). \]

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 taken were above 65 db(A), that is the upper limit recommended by the World Health Organisation (WHO), while the 75 dB (A) level, that 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 conducted on the basis of telephone interviews, which were held during December 1999. 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 designed to elicit respondents’ willingness to pay, and
iii) features of the respondents’ personal profile.

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 to which they were exposed. Among other questions, we
asked: i) what 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) what type of noise was more disturbing at each time of
day. Through this range of 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 residents in Pamplona. Thus, for example, we asked respondents to rank noise
against other urban problems, such as security on the streets and in the neighbourhood, and garbage
collection. In this way, noise is placed in the wider context of urban problems, in order to avoid
part-whole bias.

In the second section of the survey, we presented the features of the provision of the good,
“noise reduction” and elicited the amount that the respondents would be willing to pay for a particular
degree of 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 most of us are familiar with the
steps involved in building a public garden, we are less aware of the possible ways of achieving a
reduction in noise levels. We therefore described the three measures that the city council apply if the
noise reduction program were approved. The first of these 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 serves a double purpose: first, it serves as an indicator of which of these
policy measures is seen to be 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 used examples to describe the likely implications of these three measures in terms of noise reduction. We pointed out that such measures would have implications for both day-time and night-time noise, and therefore, our description included examples of both day and night reductions. Once the degree of noise reduction had been successfully explained to the respondent, we presented the questions concerning valuation. We pointed out that the measures envisaged by the city council are costly and that respondents will have to contribute to finance them if they are finally approved. We informed them that a research team from the *Universidad Pública de Navarra* had estimated the cost of such policies, and presented each respondent with an estimated interval for those costs. The extreme values of this interval coincide with the upper and lower bids that would later be presented to the respondent in the elicitation question. In this formulation the cost of the good in question was placed in a framework of uncertainty. The interviewer claimed to be uncertain about the exact cost of the good, but assured the respondent that she knew it to lie somewhere within the interval defined by the extreme values BIDL and BIDU. As a method of payment we chose to present increases on city taxes, since we found this to be the least troublesome, because other city services, such as garbage collection, are paid through city taxes. We then asked about each individual’s WTP.

The values of the BIDL and BIDU ranged between 3.12 € and 62.5 €. 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. Three intervals of variation for the lower and upper bids were chosen: i) 3.12 € and 21.87 €; ii) 12.5 € and 43.75 €; and iii) 25 € and 62.50 €. The questions were asked in *pesetas* the old Spanish currency, (1€ =166 pesetas). The sample was therefore 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 (12.5 €) while the other half is presented with the corresponding BIDU (i.e. (43.75 €)). 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 what is the most he is willing to pay for the reduction in 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 asked for the reasons for their attitude, in order to isolate 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 BIDL amount, if the answer was still negative, they were asked the maximum they were willing 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. Those who answered affirmatively to the suggested upper bound, were also asked for the maximum they would be willing to pay. Finally, in the third section of the questionnaire we asked for the respondents’ personal data, such as age, gender, and income level. To obtain complementary information we also asked respondents if they had invested any amount in insulation for their homes.

As we pointed out in the introduction, one of the main goals of this study was to test for any possible scope effect. We distinguished between two possible degrees of reduction in day-time noise levels. Half of the sample was asked to value option 1 and the other half 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 the same day 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 a 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 remaining half with the other. The night-time noise level was maintained constant for the whole sample.

4. Definition of the variables used in the estimation
Recall that, when applying the OOHB question format, 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 to the upper bid: yes, no-yes, no-no.

The variable BID, which refers to the first price offered to the respondent, is used as an independent variable in the OOHB estimation. As we said before, if the low bid was drawn first, for example (12.5 €), and the respondent said YES to this, and NO to the follow-up bid (i.e. 43.75 €) the bid value considered in the BID vector was 12.5 €. However, if the answer was YES to the first offer and YES to the second, the bid value included in the bid vector was 43.75 €. If, on the other hand, the upper bid was drawn first (i.e. 43.75 €) then the BID variable took the higher value 43.75 € if the answer to the first question was YES. Similarly, the variable took the value, 12.5 €, if the answers were NO to the first question and YES to the second.

Several sociological variables were also defined. Noise is perhaps the most educationally related environmental externality. We have found several previous studies to show that the higher the level of education the greater the annoyance experienced from noise. To estimate the effect of educational level on a person’s willingness to pay for a degree of noise reduction, we introduced the variable UNIVER that takes a value of 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 who had invested in insulation for their homes and those who had not. A person who has already invested in defensive measures is more likely to be sensitive to noise. Therefore, we defined the dummy variable ISOLA that takes a value of 1 if they have invested in insulation and 0 otherwise.

In addition, we also expected respondents who attach a high value to the noise reduction program proposed by the city council to show more 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
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, through 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 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. Once all the observations 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 a value of 1 for those individuals whose answers to the three selected questions are closer to the answers for the more sensitive group, and a value of 0 otherwise.

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

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7 Respondents were asked to give a value between 0 (minimum) and 10 (maximum).
presents the usual problems in this type of studies, because, a large proportion of respondents failed to answer this question. We were not surprised, therefore, 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, and grouped on this basis, 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 noisy environments or are not greatly disturbed by them. On the other hand, old people’s hearing capacity is diminished and this could be the reason why 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 scope effect and therefore we divided the sample into two groups. Each group was asked to value a different degree of noise reduction, Alternative 1, or Alternative 2. We introduced the variable OPTION that takes a value of 0 if the respondent values the reduction in the level of noise that takes place “between a working day during working hours and the same day at 9:30 p.m.” (i.e. Alternative 1) and a value of 1 if he values the difference between “working hours and Sunday mornings” (i.e. Alternative 2). If there is no scope sensitivity effect we expect the option that represents the greater noise reduction to be more 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.

8 The distance was measured with the Euclidean distance.
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. 53.8% of the population emerged as finding night-time noise 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 cause of noise during the daytime are the activities of the city works department.

When compared with other problems in the city, noise reduction was not considered a priority. Neighbourhood security, dirt and litter 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 5.79. 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 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 the installation of either primary or secondary double glazing. In only 20.7% of cases did the cost of the investment exceed 1,803 €.

9 The other problems mentioned score above 6 on this same question.
Finally, we should mention that there were 188 zeros (31.3% of the sample). We follow the recommendations of the National Oceanic and Atmospheric Administration report by Arrow et al. (1993) and differentiate between real zeros and protest zeros. Therefore, 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.” On the other hand protest zeros were interpreted when the reasons given were: i) “I already pay enough in taxes to the local council” and ii) “Noise cannot be reduced with these policies”. These reasons account for 133 protest answers.

6. One and one-half-bound estimations

We obtained the OOHB estimations using Cooper et al. (2002) routine. To perform these estimations we have assumed a logistic distribution for the WTP. The results obtained are presented in Table 3. In particular we present two estimations first for the full sample -with protest zeros- and second for the sample excluding protest zeros. Sample size excludes 8 observations where no answers were obtained for the dichotomous choice valuation questions. We expected the coefficient of the BID variable to be negative and significant, and thus to show that the higher the price quoted, the lower the proportion of affirmative answers. This result emerges to be true in the two estimated equations.

Furthermore, when attempting to determine whether a reduction in the level of noise will increase respondents’ well-being, it is of primary importance to compute the welfare measures. For calculating these measures we estimate a spike model for the expected WTP function following Cooper et al. (2002). We assume that there is some positive probability that an individual may be indifferent to a given noise reduction and therefore, in this event, his willingness to pay would be zero.

\[ \text{We also fitted a probit model to this data set that produced very similar results.} \]
We model indifference as being equivalent to a probability mass or spike at zero. The point estimated for WTP mean is calculated by integrating this density function between 0 and $\infty$.

In the full sample case, the mean unrestricted willingness to pay in the one and one-half-bound model is 21.86 € per year and 26.41 € per year when protest zeros are excluded. The corresponding confidence intervals were computed using the jack-knife method, with 1,000 repetitions in each case. Using this methodology it is possible to obtain an approximation of the distribution of the WTP from the original CV data set. First, for a sample of size N a new data set is generated by drawing N observations, with replacement, from the original data set. Each observation of the original data set is assigned a 1/N probability of being drawn. For each new data set new logit coefficients are estimated using the maximum likelihood estimation method. Those estimated coefficients are used to calculate the expected WTP. And this sequence of events is repeated T times to form the empirical distribution for the expected WTP. The standard deviations from this distribution are calculated and also the confidence intervals. The results of these estimations are also presented in Table 3. The reported WTP corresponds to the point estimates. Clearly, in our case, the expected willingness to pay is positive indicating that a reduction in the level of noise will improve the well-being of the inhabitants of Pamplona.

**TABLE 3 ABOUT HERE**

Not only the price or bid would have an effect on the dependent variable, however. As we said before, we expect other characteristics of the population to have an impact on the WTP for some noise reduction, therefore, we introduce several explanatory variables in our regression equation. Henceforth, we will only report the estimated results without protest zeros. These results are presented in Table 4. The effective sample size for the models with socio-economic variables is thus 419 and, for the models including the SENSI variable, the sample is further reduced to 404 observations due to some item non-response on one or more of the segmentation variables. As expected, the variable VALPRO presents a significant and positive parameter estimate in all regressions, showing that respondents who attach a high value to the noise control program proposed in the survey also give a greater proportion of affirmative answers for such a noise reduction program than respondents who do not value the program as highly. Further, the respondents who assign a
high value to the reduction measures proposed in the survey do not necessary coincide with those who are most disturbed by noise. However, we also expect respondents who are most disturbed by noise to be more willing to pay for some noise reduction. Therefore, we introduce the variable SENSI to test this hypothesis. Recall that SENSI takes a value of one for persons highly sensitive to noise and zero otherwise and, as expected, the estimated coefficient is positive in all equations. Note that, even with the introduction of SENSI, the variable VALPRO remains significant. Accordingly, 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.

As we have 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, revealing that our hypothesis was correct, people with a university degree show more willingness to pay for a decrease in the level of noise to which they are exposed. This is frequently found in this type of studies: the higher a person's level of formal education, the lower his/her tolerance of unwanted sound. People with higher levels of education are usually employed in intellectual work or jobs that demand greater concentration; they are therefore more likely to be disturbed by the presence of noise than people in other types of work. Therefore, these individuals show more willingness to pay for a reduction in the noise level than others who are less highly educated. Furthermore, the variable UNIVER presents a positive correlation with income level and agents with higher income levels usually demand a higher quality of life, which includes less unwanted noise.

TABLE 4 ABOUT HERE

The variable ISOLA is never significant, which shows that families that have already invested some of their income in defensive measures are not willing to pay any more than other citizens for additional degrees of noise reduction. There are two possible explanations for this. Even though households that have invested in defensive measures demonstrated a lower tolerance for noise than other members of their community, once the investment is in place, their level of disturbance is the same or lower than that of their neighbours, and they therefore have no reason to pay more. On the other hand, these families may also consider that they have already invested enough money in noise reduction devices. Other variables were considered in the regressions, such as age, gender or income
level. Since the estimated coefficients of these variables were never significant in these estimated regressions, it was decided that they should be dropped.

7. Test for scope sensitivity

We introduced the variable OPTION in the estimated regressions equation to test for a “scope sensitivity effect.” Scope or scale effects arise when respondents do not distinguish differences in the quantity of the good under valuation. Therefore, in order to avoid critiques such as those made by Kahneman and Knetsch (1992) and Desvousges et al. (1993), we tested to see whether people attach different values to different degrees of noise reduction. 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 the OOHB estimation procedures. The single bound results were very similar, for brevity, only the OOHB results are presented here.

The estimated results, which were presented in Table 4, showed that the sign of the variable OPTION is positive and significant, which means that respondents value Alternative 2 more highly. These results are also confirmed in the OOHB estimations presented in Table 5, where we introduced OPTION as the only explanatory variable. In other words, the inhabitants of Pamplona place a higher value on the reduction in noise level that takes place on Sunday morning. The significance of this parameter showed that there is no scope sensitivity effect, that is, different degrees of reduction in the noise level are valued differently. Furthermore, when we estimate a separate regression for each Alternative, we see that Alternative 2 is valued more highly than Alternative 1. This confirms our finding that there is no scope sensitivity effect, in as much as the reduction in the level of noise that takes place on Sunday morning is more highly valued. However, we need to know if whether the OPTION variable presents the correct sign, that is, whether this result ($WTP_{alt2} >$)

11 For example, this last author reported no difference of the willingness with respect to the number of waterfowl that could be
WTP, is consistent with the real noise reduction. This result would be consistent if Alternative 2 represents a greater reduction in the level of noise than Alternative 1.

TABLE 5 ABOUT HERE

Though noise can be objectively measured in decibels dB(A), the level of noise disturbance 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)) may give rise to different levels of disturbance, depending on the physiological characteristics of the individuals, the kind of activity they have to carry out, or on other environmental or personal factors. We have therefore considered two measures of noise, one is “subjective”, while the other is “objective.”

We obtain the “subjective” measurement of noise by means of the questionnaire. In the survey, we asked respondents to rank three moments in the day according to the level of noise endured: i) working hours during working days, ii) night hours (i.e. 9:30 p.m.) on 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. The 91.0% of the population ranked “working hours on 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 Sunday morning hours were the least noisy time of the week. That is, the biggest reduction in the level of noise would take place between the level perceived during “working hours on working days and that perceived in Sunday morning hours.” If noise is considered as a “bad” we should, however, expect the option that represents the greatest 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 nuisance 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. Therefore, the results obtained in Tables 4 and 5 assure, first, that there is no scope sensitivity effect and that the OPTION variable presents the correct sign according
to the subjective perception of those inhabitants of Pamplona who are willing to pay more for a greater reduction in the level of noise.

For “objective” measures of noise, we use the noise levels measured for the city of Pamplona. Observations were carried out in a wide variety of city locations. Most locations were measured for noise only during working hours, but in five neighbourhoods, a continuous (24 hour) measure of noise 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 these measurements 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 by 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.\footnote{12 We had measures of the level of noise corresponding to the 9 p.m. to 10 p.m. period, but these exhibited very high variability.} An average of the levels of noise during working hours was also calculated to obtain the noise level 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, \textit{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, \textit{i.e.} La Chantrea, San Juan and Segundo Ensanche. These measurements are presented in Table 6.

\begin{table}
\centering
\caption{Table 6}
\begin{tabular}{|c|c|}
\hline
Type of Neighbourhood & Average Noise Level \\
\hline
Casco Viejo & \textbf{123} \\
San Jorge & \textbf{124} \\
La Chantrea & \textbf{125} \\
San Juan & \textbf{126} \\
Segundo Ensanche & \textbf{127} \\
\hline
\end{tabular}
\end{table}

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 \textit{CV} and \textit{SJo}) and a second for La Chantrea, San Juan and Segundo Ensanche (henceforth in the tables \textit{CH}, \textit{2EN} and \textit{SJ}). The estimated results obtained are presented in Table 7.\footnote{13 Owing to their small sample size, these two groups failed to provide consistent results and therefore no OOHB models are presented.} Due to the
scarcity of data, we include in these estimations only those explanatory variables that were significant in all the previous regression equations. These tables show that those neighbourhoods in which there is a more marked reduction in the level of noise on Sunday morning (Casco Viejo and San Jorge) are consistently willing to pay more for this reduction than for the reduction that takes place at 9:30 p.m. In other words, willingness to pay in these neighbourhoods is consistently different for the two options presented.

Therefore, we also reject the existence of any scale or scope effect also when taking into account the “objective” measure of noise for the neighbourhoods of Casco Viejo and San Jorge, where respondents show more willingness to pay for a greater reduction of noise in objective terms. However, we cannot entirely rule out the presence 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. In these cases the coefficient of the variable OPTION is non-significant, showing that the inhabitants of these neighbourhoods are not willing to pay more for a greater reduction in the level of noise. This result can be justified, however, because the general level of noise in these neighbourhoods is lower and there is less difference between the noise levels at 9:30 p.m. on a weekday and on Sundays mornings than there is in the more noisy neighbourhoods, as can be observed in Table 6. In other words, in the neighbourhoods of San Juan and Segundo Ensanche, in particular, it could prove difficult to distinguish between the levels of noise at 9:30 p.m. and on Sunday mornings.

Summarising, most of the tests performed show people to be generally willing to pay more for a greater decrease in noise level and therefore these results enable us to rule out the presence of any scope sensitivity effect. Further investigation is needed, however, to explain the differences encountered when comparing “subjective” and “objective” measures of disturbance from noise. Individuals are known to differ in their perception of various types of transport noise, for example, for the same noise level of 60 db(A), approximately 15% of people claim to be highly annoyed when this comes from aircraft noise, 10% when it is a question of road noise only 5% when it is produced by a
From our study it emerges that sensitivity can also differ between different days of the week, and that other factors (apart from source) may interfere in people's perception of noise as a nuisance. In particular, we would need to find out what psychological or sociological factors intervene in the fact that the decreases in noise levels that take place “between working hours on a working day and Sunday morning” are almost always ranked as being greater than those that take place “between working hours on a working day and 9:30 p.m. of the same day” even though this is not the case. As an initial approximation, we suggest that the sensation of calm and relaxation associated with Sunday morning must clearly have an influence on results.

Additionally, we observe that respondents in the noisier neighbourhoods were willing to pay more for a noise reduction than respondents in quieter neighbourhoods. 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 of approximately 28.16 €, while in the less noisy neighbourhoods (La Chantrea, Segundo Ensanche and San Juan) willingness to pay stands at 23.87 €. In other words, at first sight, respondents in noisier neighbourhoods seem to be willing to pay more for a reduction in noise than respondents in quieter neighbourhoods, even though, paradoxically, the neighbourhoods of San Jorge and Casco Viejo are two of the city’s low-income neighbourhoods. Recall that we have not introduced income as an independent variable in the regression equation because we had a large number of non-responses that would have greatly reduced the number of observations.

TABLE 7 ABOUT HERE

8. Concluding remarks

We have applied contingent valuation methodology to estimate the economic value of a non-market good, i.e., a reduction in the level of noise in a Northern Spanish city. The results clearly indicate that households display a positive willingness to pay for a reduction in noise, which in turn shows that such a reduction will improve the well-being of the inhabitants of Pamplona. In particular,
we have estimated a mean WTP that varies between approximately 26 and 29 € per household, per year. Our estimated household willingness to pay falls close to the values estimated in other European studies. However, it must be kept in mind that many methodological differences exist among these studies, each of which uses at least a different estimation technique, question format, and/or vehicle of payment.

Our household willingness to pay (without protest zeros) represents 0.27% of total annual income, which is not much lower than the 0.32% reported in Vainio (1995 and 2001) in his CV study of noise reduction for the city of Helsinki. Furthermore, our household willingness to pay per dB, per year falls close to the 4 € mark. The Vainio study, in the meantime, reports an approximate WTP per dB, household and year that oscillate between 6 and 9 €, while Garrod et al. (2001) and Scarpa et al. (2001) report a estimated mean WTP for traffic calming measures in three English towns of about 2-4 € per dB, per household, per year. Lambert et al. (2001) focusing on the Rhone-Alpes region reported an estimated WTP of 7 €. Other studies, however, have estimated a higher WTP, see, for example, Navrud (2000), who, in his Norwegian study, reports a willingness to pay of between 21 and 34 € per dB, per household, per year. Clearly, the discrepancies in the findings of these studies can be explained, not only by the different methodologies used, but also by factors relating to different income levels, institutional settings, cultures and preferences.

We see a further positive contribution of our study in the fact that we have shown there to be no scope sensitivity effect. We employed two alternative means, one, a measure of “subjective” perception, the other, a measure of “objective” perception of noise annoyance. Summarising, our results show that there is no scope sensitivity effect and that the tests performed therefore show that most people are willing to pay more for larger decreases in the level of disturbance from noise. Further investigation is needed, however, to sort out the differences encountered when comparing “subjective” and “objective” measures of noise. Our study shows that the decrease in noise that takes place “between working hours on a working day and a Sunday morning” are almost always ranked as being greater than that which takes place “between the working hours of a working day and 9:30 p.m. of the same day”, even though this is not actually the case. This difference between “subjective” and “objective” ranking seems to suggest that people are less annoyed by exposure to noise on non-working days. If this conclusion were proved to be true, it would imply that policy-
makers should focus their efforts on reducing noise exposure on working days.
References


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

<table>
<thead>
<tr>
<th>Cost Interval</th>
<th>N</th>
<th>%</th>
<th>Bid drawn first</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.12 - 21.87 €</td>
<td>192</td>
<td>32.0</td>
<td>3.12 €</td>
<td>104</td>
<td>54.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21.87 €</td>
<td>88</td>
<td>45.8</td>
</tr>
<tr>
<td>12.5 - 43.75 €</td>
<td>200</td>
<td>33.3</td>
<td>12.5 €</td>
<td>109</td>
<td>54.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>43.75 €</td>
<td>91</td>
<td>45.5</td>
</tr>
<tr>
<td>25.00 - 62.5 €</td>
<td>208</td>
<td>34.6</td>
<td>25 €</td>
<td>111</td>
<td>53.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>62.5 €</td>
<td>97</td>
<td>47.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>600</td>
<td>100</td>
<td></td>
<td>600</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Citizen Sensitivity to Noise

<table>
<thead>
<tr>
<th>Noise disturbance suffered in</th>
<th>SENSI = 1 More noise sensitive</th>
<th>SENSI=0 Less noise sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neighbourhood***</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>House***</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>City***</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Percentage of Sample</td>
<td>59%</td>
<td>41%</td>
</tr>
</tbody>
</table>

*** Significant at the 99% confidence interval
Table 3. OOHB Results

<table>
<thead>
<tr>
<th></th>
<th>OOHB Estimation with protest zeros</th>
<th>OOHB Estimation without protest zeros</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>T-Statistic</td>
</tr>
<tr>
<td>Constant</td>
<td>1.03045</td>
<td>9.815***</td>
</tr>
<tr>
<td>Bid</td>
<td>-0.000216</td>
<td>-13.710***</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-649.66608</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>592</td>
<td></td>
</tr>
<tr>
<td>E(WTP)</td>
<td>21.86 €</td>
<td></td>
</tr>
</tbody>
</table>

Confidence intervals for mean WTP

<table>
<thead>
<tr>
<th></th>
<th>With protest zeros</th>
<th>Without protest zeros</th>
</tr>
</thead>
<tbody>
<tr>
<td>99% CI</td>
<td>20.24 - 23.23 €</td>
<td>25.33 - 27.32 €</td>
</tr>
<tr>
<td>95% CI</td>
<td>20.77 - 22.93 €</td>
<td>25.62 - 27.09 €</td>
</tr>
<tr>
<td>90% CI</td>
<td>20.90 - 22.75 €</td>
<td>25.75 - 26.97 €</td>
</tr>
</tbody>
</table>

*** Significant at the 99% confidence level
Table 4. OOHB estimations with socio-economic variables for the sample without protest zeros

<table>
<thead>
<tr>
<th>Variable</th>
<th>Without option and sensi</th>
<th>With option and without sensi</th>
<th>Without option and with sensi</th>
<th>With option and sensi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.2972 (5.72)***</td>
<td>1.0930 (4.33)***</td>
<td>1.2040 (4.59)***</td>
<td>1.0333 (3.74)***</td>
</tr>
<tr>
<td>Price</td>
<td>-0.3031 (14.56)***</td>
<td>-0.3054 (14.56)***</td>
<td>-.3101 (14.33)***</td>
<td>-0.3125 (14.32)***</td>
</tr>
<tr>
<td>Valpro</td>
<td>.7442 (3.53)***</td>
<td>.7564 (3.57)***</td>
<td>.8176 (3.80)***</td>
<td>.8260 (3.83)***</td>
</tr>
<tr>
<td>Isola</td>
<td>.1206 (.61)</td>
<td>.1532 (.76)</td>
<td>.1229 (.60)</td>
<td>.1519 (.74)</td>
</tr>
<tr>
<td>Univer</td>
<td>.5802 (2.56)***</td>
<td>.5717 (2.55)***</td>
<td>.5546 (2.42)***</td>
<td>.5520 (2.39)***</td>
</tr>
<tr>
<td>Option</td>
<td>-</td>
<td>.4058 (2.10)***</td>
<td>-</td>
<td>.3822 (1.92)*</td>
</tr>
<tr>
<td>Sensi</td>
<td>-</td>
<td>-</td>
<td>.2161 (1.07)</td>
<td>.1815 (.89)</td>
</tr>
<tr>
<td>LogL</td>
<td>-438.28</td>
<td>-436.06</td>
<td>-415.95</td>
<td>-414.09</td>
</tr>
<tr>
<td>N obs.</td>
<td>419</td>
<td>419</td>
<td>404</td>
<td>404</td>
</tr>
</tbody>
</table>

Confidence Intervals

<table>
<thead>
<tr>
<th>E(WTP)</th>
<th>28.42 €</th>
<th>28.78 €</th>
<th>28.79 €</th>
<th>29.03 €</th>
</tr>
</thead>
<tbody>
<tr>
<td>99%</td>
<td>27.21-29.32 €</td>
<td>27.62-29.61 €</td>
<td>27.50-29.56 €</td>
<td>27.80-29.71 €</td>
</tr>
<tr>
<td>95%</td>
<td>27.44-29.17 €</td>
<td>27.95-29.42 €</td>
<td>27.83-29.41 €</td>
<td>28.25-29.58 €</td>
</tr>
<tr>
<td>90%</td>
<td>27.62-29.06 €</td>
<td>28.08-29.34 €</td>
<td>27.98-29.35 €</td>
<td>28.38-29.52 €</td>
</tr>
</tbody>
</table>

T-statistics are in parentheses ***, **, * Significant at the 99%, 95% and 90% confidence level respectively.
Table 5. OOHB Estimation results with the option variable without protest zeros

<table>
<thead>
<tr>
<th></th>
<th>Full Sample with option variable</th>
<th>For alternative 1</th>
<th>For alternative 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>T-Statistic</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Constant</td>
<td>1.8896</td>
<td>11.68***</td>
<td>2.0301</td>
</tr>
<tr>
<td>Bid</td>
<td>-0.2910</td>
<td>-15.00***</td>
<td>-0.3180</td>
</tr>
<tr>
<td>Option</td>
<td>0.3388</td>
<td>1.85*</td>
<td></td>
</tr>
<tr>
<td>Log-likelihood</td>
<td></td>
<td></td>
<td>-479.37</td>
</tr>
<tr>
<td>N Obs.</td>
<td></td>
<td></td>
<td>459</td>
</tr>
<tr>
<td>E(WTP)</td>
<td>26.97 €</td>
<td></td>
<td>26.33 €</td>
</tr>
<tr>
<td>99% CI</td>
<td>25.54 - 28.01 €</td>
<td></td>
<td>24.88 - 27.54 €</td>
</tr>
<tr>
<td>95% CI</td>
<td>25.93 - 27.74 €</td>
<td></td>
<td>25.34 - 27.26 €</td>
</tr>
<tr>
<td>90% CI</td>
<td>26.11 - 27.65 €</td>
<td></td>
<td>25.44 - 27.12 €</td>
</tr>
</tbody>
</table>

T-statistics are in parentheses. ***, **, * Significant at the 99%, 95% and 90% confidence level respectively.
Table 6. Noise Measurement by Neighbourhood

<table>
<thead>
<tr>
<th>Neighbourhood</th>
<th>Working Hours</th>
<th>Working Days at 09:30 p.m.</th>
<th>Sunday Morning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casco Viejo</td>
<td>71,1</td>
<td>72,0</td>
<td>68,6</td>
</tr>
<tr>
<td>San Jorge</td>
<td>75,1</td>
<td>71,3</td>
<td>67,3</td>
</tr>
<tr>
<td>La Chantrea</td>
<td>60,0</td>
<td>51,6</td>
<td>59,3</td>
</tr>
<tr>
<td>San Juan</td>
<td>65,6</td>
<td>63,3</td>
<td>65,3</td>
</tr>
<tr>
<td>II Ensanche</td>
<td>69,6</td>
<td>64,6</td>
<td>66,3</td>
</tr>
</tbody>
</table>
Table 7. OOHB estimations for neighbourhoods with continuous noise measurement

<table>
<thead>
<tr>
<th>Variables</th>
<th>Without Explanatory Variables</th>
<th>With Explanatory Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CV and SJ, 2EN, SJ</td>
<td>CV and SJ, 2EN, SJ</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.52 (3.83)***</td>
<td>1.43 (4.96)***</td>
</tr>
<tr>
<td></td>
<td>1.32 (1.97)**</td>
<td>0.73 (1.75)*</td>
</tr>
<tr>
<td>Price</td>
<td>-0.33 (5.75)***</td>
<td>-0.25 (7.87)***</td>
</tr>
<tr>
<td></td>
<td>-0.35 (5.24)***</td>
<td>-0.25 (7.88)***</td>
</tr>
<tr>
<td>Option</td>
<td>1.32 (2.43)**</td>
<td>-0.02 (.06)</td>
</tr>
<tr>
<td></td>
<td>1.27 (2.32)**</td>
<td>0.08 (.25)</td>
</tr>
<tr>
<td>Valpro</td>
<td></td>
<td>.85 (1.36)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.91 (2.57)**</td>
</tr>
<tr>
<td>Univer</td>
<td></td>
<td>-.93 (1.73)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.04 (0.13)</td>
</tr>
<tr>
<td>N.Obs.</td>
<td>59</td>
<td>146</td>
</tr>
<tr>
<td>E(WTP)</td>
<td>28.16 €</td>
<td>23.87 €</td>
</tr>
<tr>
<td></td>
<td>28.95 €</td>
<td>27.30 €</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-63.11</td>
<td>-160.34</td>
</tr>
<tr>
<td></td>
<td>-60.69</td>
<td>-156.98</td>
</tr>
</tbody>
</table>

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

Valuation questions in the survey (Alternative 2; 3.12-21.87 € 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 earlier. 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 3.12 € and 21.87 € per household per year.

Would you be willing to pay 21.87 € 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

NIGHTTIME: Saturday evening to Monday Evening

If interviewee answers no then ask]

And what about 3.12 € 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?

_______________ Euros

[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.”