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ECONOMIC BENEFITS OF A PROGRAM TO REDUCE TRANSPORTATION AND COMMUNITY NOISE - A CONTINGENT VALUATION SURVEY

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ABSTRACT
Environmental valuation techniques can be successfully used to estimate the social costs of noise annoyance experienced by households. A Contingent Valuation (CV) survey of 600 households affected by noise in two Norwegian communities found a mean willingness-to-pay (WTP) of about 120 euro/household/year for a public program that would reduce transportation and community noise. The program would eliminate indoor and reduce outdoor noise annoyance by 50 %, and eliminate noise annoyance in parts of the nearby recreational forest area. Results indicate that neither recorded noise levels (in dBA) from different sources nor level of annoyance stated by respondents had a significant effect on their WTP. However, whether respondents felt annoyed by road traffic noise or not in Oslo had a significant effect on the probability of supporting the program at a cost. Similar effects were not found for railway and aircraft noise.

1 - INTRODUCTION

Measures to reduce transportation and community noise are costly to implement, and an obvious question is whether the social benefits of reduced noise can justify these high costs. Thus, we need to know the social costs of noise to find the social optimal level of investments in noise reducing measures. Having an economic estimate of social benefits of reduced noise allows for cost-benefit analysis (CBA) of different noise-reducing measures, which can identify the combination of measures providing highest social benefits per euro of costs from a limited budget for noise-reducing measures, i.e. highest benefit−cost ratios. Realizing the need to estimate the social costs of noise, the Norwegian Ministry of Environment and the State Pollution Control Authority (SFT) financed several projects in the period 1996-2000. This paper reports the results from a recent Contingent Valuation (CV) study aiming at estimating the social benefits of a proposed program to reduce transportation and community noise. The CV study provides an economic estimate of increased well-being among affected households from reduced noise levels due to the program, i.e. reduced annoyance costs. The CV estimate should be interpreted as a conservative estimate of total social benefits for this program, since it does not include benefits from fewer cases of work productivity reductions due to sleep disturbance, communications problems in schools, treatment of health impacts that could be related to noise stress etc.

2 - METHODS FOR VALUING NOISE

There have been many Hedonic Price (HP) studies of noise, but relatively few Contingent Valuation (CV) studies. This is probably due to the difficulties in constructing a good CV survey for valuing noise level reductions. A good CV survey would in general include the following sections: (a) an introductory section that helps set the general context for the decision to be made, (b) a detailed description of the good to be offered to the respondent, (c) the institutional setting in which the good will be provided, (d) the manner in which the good will be paid for, (e) a method by which the survey elicit the respondent's preferences with respect to the good; (f) debriefing questions about why respondents answered certain questions the way they did; and (g) a set of questions regarding characteristics including attitudes, and

demographic information (Mitchell and Carson 1995). Particularly sections (b), (c) and (d) provides problems, i.e. describing the reductions in noise level in a scientifically correct and understandable way, institutional arrangements that makes respondents accept willingness-to-pay (WTP) questions (they easily protest WTP questions, since they think it is unfair that they should pay to reduce noise created by other), and a realistic and fair payment vehicle. However, the stated preference method of CV also has some advantages over the revealed preference method of HP. The HP method uses actual transactions in the housing market and tries to model the factors explaining differences in dwelling prices, including a variable for the noise level. However, the estimated impact of noise is very sensitive to model specification (e.g. if other external effects of. transportation are not accounted for in the model, the estimated impact of noise on property prices could include these impacts as well), estimation procedures, the level of information about the noise level the respondent had when bidding for the dwelling, whether people can perceive marginal changes in the physical noise measure used, and whether there is perfect competition in the housing market and other strict assumptions (which often are not fulfilled).
CV surveys of noise also run the risk of estimating WTP for a more comprehensive good than noise. If the respondents assume that the reduced transportation noise also leads to reduced air pollution, reduced well-being from soiling, accident risks, they would give state their WTP to avoid all these impacts. Thus, it is essential to construct a CV scenario that focuses on noise only, and have debriefing questions (both in pilot tests and the main survey) that check whether respondents understood the scenario the way we meant them to understand it.
To my knowledge, Vainio (1995) represents the only combined CV and HP study of the same population of respondents, i.e. the CV study was done among the buyers of apartments. Even though the aim of this study was to value traffic externalities in general, the noise level was found to be a good metric for all externalities. (This again shows the main problem in using HP to value noise). The study found the values from the CV survey to be 2-3 times higher than the HP estimate. Thus, even under favorable conditions for a comparative study, the two independent methods produce quite different results. Vainio (1995) argues that the results are reasonably close, but discusses several reasons for the CV estimate to be biased (mainly upwards), e.g. the aggregation from the stated monthly amounts to a lump sum. The HP values could also be biased (mainly downwards), if the prospective buyers only experienced the lower traffic levels on Sundays when most dwelling units are shown, when bidding for the dwelling.

3 - THE CONTINGENT VALUATION SURVEY

The CV survey reported in this paper adheres closely to the NOAA Panel guidelines for good practise in CV surveys (Arrow et al 1993), and combines the latest advances in CV methodology with the lessons learned from previous CV studies on noise. The CV survey was developed in close cooperation with experts in noise annoyance surveys and the environmental authorities, and thoroughly pre-tested. Only households subjected to noise levels that could be annoying were selected, based on available data on noise levels (measured as dbA) from different noise sources. Data on how annoyed the individuals felt by noise both indoors and outdoors from different noise sources (using a standard scale for noise annoyance, i.e. categories: very, somewhat, slightly or not annoyed) were collected as part of the survey. Thus, the economic estimates from the CV survey can be linked both with the dbA level and a standard measure of annoyance. Annoyance costs of households affected by both single and multiple noise sources can also be estimated.
The CV survey was conducted in June and July 1999 as in-person interviews of a random sample of households subjected to transportation and community noise. A randomly selected person above 17 was interviewed in each household. 406 persons with outdoor road traffic noise levels above 60 dbA in the community of Oslo, and 204 persons subjected to one or more noise sources (road traffic, railway, aircraft and rifle range noise) in the nearby community of Ullensaker (where the new Oslo Airport is situated) were interviewed by a professional opinion poll agency. The interviewers' evaluation of the respondents' performance showed that the respondents were well informed, took the interview very seriously and few had problems in answering the WTP questions (7.2 and 12.0 % of the respondents in Oslo and Ullensaker, respectively). Only 5.2 and 2.7 % of the respondents in Oslo and Ullensaker, respectively, did not think seriously about the WTP question before answering. When the respondents gave their evaluation of the WTP questions, only 8.5 and 6.5 % in Oslo and Ullensaker, respectively, stated that the WTP questions were difficult to answer. All responses were used in the data analysis. On average each interview lasted 27 minutes. To avoid a focusing effect on noise (and respondents valuing noise as an indicator of a more comprehensive good of e.g. transportation externalities), all respondents were told that the survey was about their local environment.
The CV survey consisted of seven parts: (i) introduction, asking how many years they had lived in

their dwelling and what characteristics of their local environment (e.g. location, standard of dwelling, view, access to recreational areas communications, community services traffic safety, noise, pollution, social conditions/crime rate) they liked and disliked; and whether they had plans to move; (ii) Level of annoyance from: a) noise indoor and outdoor their dwelling, separately for each of the possible transportation and community noise sources, b) vibrations and smell/soiling from road traffic; c) noise in the residential area, and d) noise in the large nearby recreational forest area of Oslomarka; (iii) CV scenario, including description of the program of noise reducing measures and its impacts, WTP questions and debriefing questions, (iv) Respondents' evaluation of the program and payment vehicle used in the WTP question (i.e. increased community taxes), (v) Respondents' demographics (e.g. income. age, education, sex, household size) and other characteristics (e.g. hearing disorders, renting or owning dwelling), existing noise reducing measures inside and outside the dwelling, and other variables expected to explain level of annoyance and WTP; and (vi) interviewers' evaluation of respondents' performance.
The CV scenario (part (iii)) consisted of: (a) description of the program of noise reducing measures, its impacts on noise levels and the reduced well-being from noise, (b) the institutional setting (i.e. households have to pay part of the costs) and payment mechanism (increase in community taxes), and (c) an elicitation method using a closed-ended format which better reveal protest behavior, based on Blamey et al (1999), followed by an open-ended WTP questions and debriefing questions to further explore protest behavior (i.e. respondents' protest one or more aspects of the CV scenario and does not reveal his/her true preference
The program included measures to reduce noise from road traffic, aircrafts, industry, construction activities, rifle ranges, railways, trams, and noise in recreational areas. The authorities were said to consider whether to implement the program or not. If implemented, the program would eliminate the noise annoyance indoor all affected dwellings, and the noise annoyance outside the dwellings would be halved. This would eliminate discomfort from noise due to: sleep and concentration problems; disturbances of conversations, TV and radio listening and homework; tension and sleeplessness; reduced use of outdoor areas and reduced possibilities of airing the dwelling. In addition the noise annoyance in the northern and eastern part of the Oslomarka forest recreation area will be eliminated, while other parts of Oslomarka will keep the present noise level. Respondents were then told that some of the costs would be covered over existing governmental budgets (affecting the construction of roads and community services as schools and health care), while a large part of the costs would have to be covered by industry, businesses and households through increased community taxes. An amount X (100, 300, 500, 1000 or 3000 NOK) is then assigned randomly to each respondent, who are told that the program costs each household X NOK annually in increased community taxes to implement. They are then reminded to consider what it is worth to them to get rid of the noise annoyance, and their budget constraint ("Remember that if you pay for the program you have less money to use on other things").
Then they are asked the closed-ended WTP question about whether they support the program at a cost of X NOK annually, and asked to tell which of the four statements best describes their answer (which is a procedure based on the approach in Blamey et al 1999): 1) I support the program and the tax of X NOK, 2) I support the program and use of a tax, but it is not worth X NOK to me, 3) I support the program, but not if it means increased tax, irrespective of the size of it, 4) I do not support the program, even if it would cost me nothing, and 5) "I do not know". Then the respondents are told that the costs of the program are uncertain, and asked about the most their households would pay as increased annual community tax to get the program implemented. This open-ended WTP question is used for the closed-ended WTP question to identify respondents with zero WTP (and a follow-up question is asked to reveal "protest" zero answers), but it is also used to calculate separate WTP estimates from an open-ended WTP question. If respondents chose statement 3) and 4) in the closed-ended WTP question, they were asked separate follow-up questions to determine whether they have a "true" zero or a "protest" zero WTP Those that chose statements 1) and 2) are also asked to state what motivates their positive WTP.

4 - RESULTS AND DISCUSSION

Table 1 shows the results from the closed-ended WTP question. It clearly shows a larger degree of support for the program, and hence acceptance of the CV scenario, in Oslo than in Ullensaker.
This could be due to the fact that road traffic noise by far is the most important noise source in Oslo (and people accept paying the damage they themselves create), while the aircraft noise and road traffic noise due to transport to and from the new Oslo airport in Ullensaker is largely seen as a problem those using the airport should pay to eliminate.

WTP statement	Oslo (N= 402)	Ullensaker (N=184)
1. Support program and tax of X NOK	60.4	41.8
2. Support program and tax, but not worth X NOK to me	14.4	10.3
3. Support program, but not the tax, irrespective of size	19.4	40.8
4. Do not support program, even at no cost to me	5.0	6.0
5. Do not know	0.8	1.1

Table 1: Percent of respondents choosing different statements in the closed-ended WTP question.

The follow-up question to statement 3 revealed that more than 80 % of the respondents would not have paid the amount even if another payment vehicle had been used. Thus, the majority of those that chose statement 3 should be treated as "real" no-answers to the program at the stated cost of X NOK. Statement 4 is a "No"-answer to supporting the plan, and the follow-up question showed that the majority of the respondents choosing this statement did so because they were not annoyed by noise (i.e. true zero answer), and did not think the program would have the impacts described in the CV scenario (i.e. protest answer).
The most important motivation for supporting the program and paying something (as a tax), i.e. statements 1 and 2 was that the respondent was annoyed by noise. Other important modivations include: avoiding others being annoyed by noise and a general interest in environmental protection.

Sample	Mean WTP	Median WTP	Std. Error	Percentage WTP = 0	Minimum WTP	Maximum WTP
Oslo	1002	500	1127	0.7	0	10,000
Ullensaker	1002	500	1259	1.1	0	9,000

Table 2: Willingness-to-pay (WTP) per household annually for the program of noise reducing measures; results from the open-ended WTP question, separately for the samples in Oslo (N=404) and Ullensaker (N=185); 1 Norwegian kroner (NOK) = 8.20 euro.

Multiple logit models were used to estimate WTP from the closed-ended questions. Two different interpretations of the choice of statements and follow-up questions resulted in mean WTP/household/year of 1320-2200 NOK and 2000-3320 NOK in Oslo and Ullensaker, respectively. Table 2 shows that this is 1.3 − 3.3 times higher that the estimate from the open-ended WTP question, which was about 1000 NOK in both Oslo and Ullensaker. Overall the logit models resulted in more significant independent variables and improved explanatory power compared to regressions with open-ended WTP. The probability of supporting the program and pay increased community tax in Oslo significantly (at the 5 % level): i) decrease when increasing the stated cost of the program (which supports the validity of closed-ended WTP questions and permits estimation of mean and median WTP), ii) decrease with reduced education level, iii) increase with household income, iv) decrease with increasing age, v) increase with increased level of annoyance from indoor noise. In the Ullensaker sample only i), ii) and iv) were significant. The explanatory power of the models was largest in Oslo. Maddala R [2] of 16-20 % and 69-73 % correct predictions is acceptable in such cross section surveys.
Multiple regressions with WTP from the open-ended question as the dependent variable showed a significant, positive effect of household income and the stated cost of the program (X NOK), used in the closed-ended WTP, which was asked just before the open-ended WTP question. Thus, the open-ended WTP answers could be biased by the stated cost of the program. However this potential impact have produced lower rather than higher estimates of WTP compared to the closed-ended WTP question. We have taken the conservative approach, and recommend using the estimates from the open-ended WTP question.
The Ullensaker sample was constructed to test for the impact of combined noise sources. In terms of mean WTP from the open-ended WTP questions there is no clear pattern. This could be due to the small sample size for the combinations of noise sources. However the combination aircraft and rifle range noise seems to give the highest WTP (1374 NOK/household/ year), while the combinations aircraft and road traffic noise and the addition of railroad noise provides the lowest WTP (about 685 NOK/household/year). Separate regressions for Ullensaker and Oslo shows no significant increase in WTP for the program with increasing number of noise sources, but a regressions of both samples combined do. Thus, there is some evidence that combined noise sources increase WTP to avoid noise annoyance.

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