

ECONOMIC DEMAND CURVE OF "dB OF SILENCE" AND IT'S RELATION WITH INCOME AND OPINION OF NOISE INFLUENCE IN QUALITY OF LIFE

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ABSTRACT.

In a social study, with a representative sample of the population, it has been quantify the demand of dB's of silence of the city and the willingness to pay for each dB of silence. With this information it has been determined the equation of the demand curve of the amount of less noise needed. Then, the result shows the different "prices" which people are willing to pay and the amount of dB's that they would buy at these prices. This curve is an indicator of the importance of silence in the well-being of the society and quantifies the degree of dissatisfaction in the population for the lack of silence. It has been determined that the willingness to pay is correlated to people's opinion of noise influence in the quality of life. Nevertheless, the amount that people pay is correlated to the income.

INTRODUCTION.

There is not yet a unique economic model to assess the social cost of noise. The most known valuation techniques are the contingent method that inquires the willingness to pay or willingness to accept compensation on a hypothetical situation, the hedonic prices and the avoidance or incurred costs that are based on the direct observation of consumer behavior. It is difficult to transform the knowledge of these studies and incorporate them with easiness to the cost-benefit analyses. Typically, the benefits are defined from the point of view of the damages that are avoided assigning monetary values to them.

In this study there is an effort to value the benefit through the reduction of the actual unsatisfied well-being of silence in people. The one's interviewed in the survey are subjected to a choice, creating in this way a hypothetical market. Indirectly, for each choice there is implicit a cost (with a market price), associated with a compensation or benefit (which does not have a market price).

A comparative value for this study is those obtained in Germany [1] [2] which states the willingness to pay 10 Euro for each dB of improvement per person and per year if the noise level exceeded 43 dB(A) or the equation: Willingness to Pay (Euros) = $0.85 \text{ LeqDN} - 36.6$

RESEARCH METHODOLOGY.

The social survey is indexed with LeqDN measured in the outside of the dwellings. The 115 LeqDN measured values used to make the noise map of the city were used. The measuring points were determined with a grid superimposed aleatorily over the city map, though, these points are uniformly distributed and can also be used in a systematic sampling. The minimum number of questionnaires necessary to obtain a representative sample with a confidence interval of 95% and a significance level of 5% was calculated according to Santos [3]. The minimum sample size is 383 for the considered population. The final sample size obtained was 473 from a set of approximately 700 questionnaires delivered in all the dwellings at a distance not further than 50 m from the measuring point.

It is considered as population of the survey all the people who live in the city and are older than 14 years old.

The questionnaire was administered to only one person of the population in the selected dwelling, chosen at random by them. The questionnaire was left at least two days in the dwelling with the aim to give equal opportunity of participation to all members of the house including those who are not at home when the questionnaire is delivered.

The choice to be selected by the interviewed was presented in two questions. As help for the choice, a dB scale with the corresponding drawings of environmental situations were attached to the questionnaire.

The questions and possible answers are:

Question 1: If the State gives you a housing (without cost for you), with the condition that you must live there at least 10 years before being able to sell it or rent it. Which of the following houses do you choose?

- a) The house valued in US\$ 36,000; surrounded by an extremely noisy environment (80 dB day-night)
- b) The house valued in US\$ 27,000; surrounded by a moderate noise environment (60 dB day-night)
- c) The house valued in US\$ 18,000; surrounded by a silent environment (40 dB day-night).
- d) Do not know.

Question 2: You attend to a finish off (or sale) of houses in an urbanization that has a group of houses in a sector with an extremely noisy environment (80 dB day-night) and a group of houses in a silent sector (40 dB day-night). What extra percentage of price are you willing to pay for a house in the silent sector? Suppose that the houses are the same and there are no other differences. The price of the house in the noise environment is US\$ 55,000.

The choices are: 0%; 1%; 3%; 5%; 10%; 15% and "don't know"

In the first question there is a linear relation between market value of the house and environmental noise. So, the difference of the present value of any two properties was valorized in monthly quotas at a rate of 9% for the 10 years. The relation between this difference and the difference of their environmental noise gives as a result the "price" of US\$ 1 monthly for each dB of less noise.

In the second question there is not a linear relation between the extra percentage to pay and the environmental noise. This means that it has been established, in an indirect way, a set of prices for each dB of less noise. If the extra percentage is paid with a loan at an annual rate of

8% and in 12 years, the ones who are willing to pay 15% extra, are paying US\$ 2.2 monthly for each dB of less noise; 10% pays US\$ 1.47; 5% pays US\$ 0.73; 3% pays US\$ 0.44 and 1% pays US\$ 0.14 monthly for each dB of less noise.

Then, according to the choice, the economic value of the actual monthly unsatisfied well-being of silence UWS, of each person, is calculated by

$$UWS = (LeqDN_M - LeqDN_E) * P \quad (1)$$

Where $LeqDN_M$ = LeqDN measured at the outside of the actual dwelling.

$LeqDN_E$ = LeqDN chosen on the interview.

P = monthly price willing to pay for each dB of less noise.

Also, the questionnaire asked the opinion if noise influences the quality of people's life. We will analyze the relation of this question and the family income with the choices of question 1 and 2.

RESULTS AND DISCUSSION.

The prevalence obtained for the demographic variables are in accordance with the official demographic statistic index of city. For example, the age variable has a triangular distribution with a relatively equal participation of men and women in every range of age. This speaks in favor of the design and strategy used in the survey. The prevalence's of the family's monthly income are shown in figure 1.

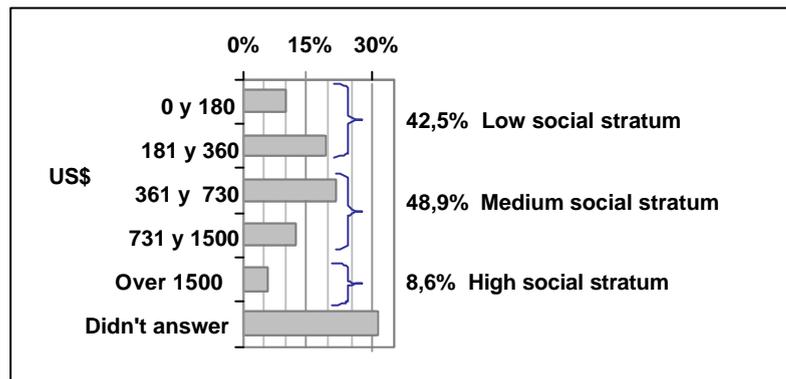


Figure 1. Prevalence's of the family income.

The prevalence of opinion if noise influences the quality of people's life is shown in figure 2. It can be seen that the citizenship assigns a high value of importance to the noise.

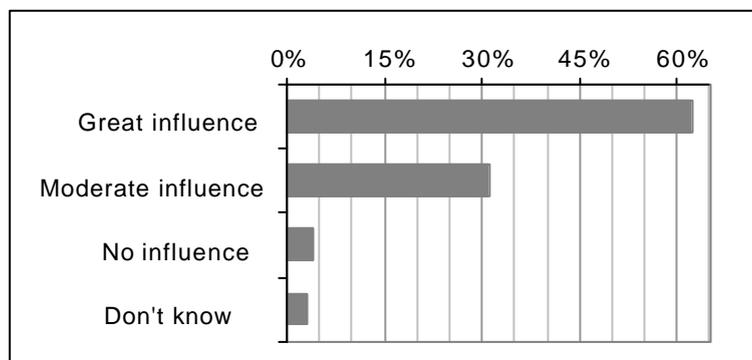


Figure 2. Prevalence of the opinion if noise influences the quality of people's life.

The prevalence's of question 1 and 2 are shown on figure 3.

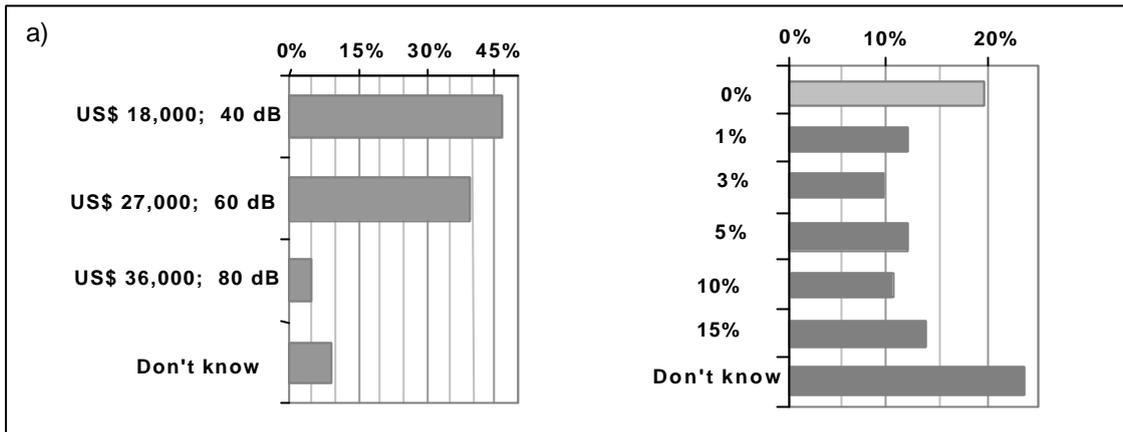


Figure 3. Prevalence's of the choices of: a) question 1; b) question 2.

In question 1, if we apply equation (1) to those interviewed we have that: 46.7% of the sample has a total UWS = US\$ 6,795; 39.3% of the sample has a total UWS = US\$ 2,045; 4.9% of the sample has a total UWS = US\$ 0. If the 9.1% of the interviews who did not answer are subtracted from the total sample only 430 dwellings are left. Then, the number of people that live in these dwelling is 1,806 people (considering the statistical official average of 4.2 persons in each home). Dividing the total UWS of US\$ 8,840 by 1,806 the result is the average of US\$ 4.89 of unsatisfied well-being of silence per person. This also means that at a monthly price of US\$ 1 per dB of less noise, there would be a monthly average demand of 4.89 dB of environmental less noise per person.

In question 2, if we apply equation (1) we have that: for 11.8% of those who are willing to pay US\$ 0.14 monthly per dB of less noise, the improvement with regard to their current situation has a total value of US\$179 monthly, equivalent to 1,279 dB; for 9.3% of those who are willing to pay US\$ 0.44 monthly per dB of less noise, the improvement with regard to their current situation has a total value of US\$ 475 monthly, equivalent to 1,080 dB; for 11.8% of those who are willing to pay US\$ 0.73 monthly per dB of less noise, the improvement with regard to their current situation has a total value of US\$ 964 monthly, equivalent to 1,320 dB; for 10.1% of those who are willing to pay US\$ 1.47 monthly per dB of less noise, the improvement with regard to their current situation has a total value of US\$ 1,691 monthly, equivalent to 1,150 dB; for 13.7% of those who are willing to pay US\$ 2.2 monthly per dB of less noise, the improvement with regard to their current situation has a total value of US\$ 3,077 monthly, equivalent to 1,398 dB.

These values have been extrapolated to the population taking care in subtracting from the total of the sample those who did not answer. The result is shown in table 1.

Table 1. Summary of prevalences, prices and values in US\$ and dB's of less noise.

% extra paid	% of the sample	A = Price (US\$/dB)	Total US\$ of sample	Total dB of sample	Total US\$ of population	Total dB of population	B = \sum dB of population
15%	13.7%	2.2	3,077	1,398	313,854	142,661	142,661
10%	10.1%	1.47	1,691	1,150	172,482	117,335	259,996
5%	11.8%	0.73	964	1,320	98,328	134,696	394,692
3%	9.3%	0.44	479	1,080	48,450	110,114	504,805
1%	11.8%	0.14	179	1,279	18,258	130,414	635,220

Applying regression analysis to columns A and B we obtain the following demand equation:

$$y = 3.3657 - 0.009 x + 0.0000062 x^2 \quad (2)$$

Figure4 shows the demand curve given by the values of column A and B, and by equation (2).

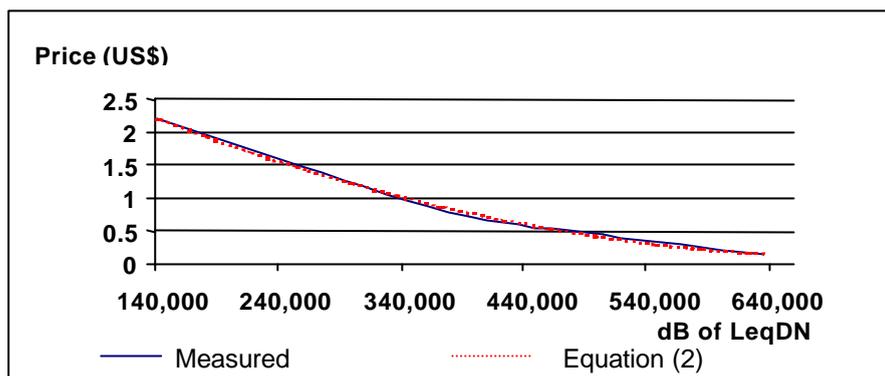


Figure 4. Demand curve given by the values of column A and B of table, and equation (2).

As a global result of the choices of question 2 we have an average of US\$ 4.79 of unsatisfied well-being of silence per person. This corresponds to a monthly average price of US\$ 1.03 per dB of less noise with a monthly average demand of 4.67 dB of environmental less noise per person.

We asked ourselves about the influence of income and the opinion of noise influence in quality of life in these choices. The results of association and correlation analysis between the choices and income, and choices and influence of noise in quality of life are shown on table 2.

Table 2.

Question	Other Variables	Chi Square	df.	Sig.Level	Tau-b	Tau-c	Sig.Level
1	Influence in life quality	42,369	4	0.000	0.189	0.144	0.000
	Income	9,576	8	0.296	0.075	0.072	0.151
2	Influence in life quality	33,961	8	0.000	-0.177	-0.162	0.001
	Income	42,977	16	0.000	0.304	0.294	0.000

We see an association and correlation between question 1 and the people's opinion of noise influence in life quality and a very poor association and correlation between income and noise influence in life quality. Although in this question there is an interesting amount of money at disposition of the one interviewed, the noise influence in quality of life has prevailed in his choice.

For question 2 we observe a stronger association and correlation with income than with people's opinion of noise influence in life quality. This reveals that although people are aware and wants to find a better way out to noise problem, the amount to pay in their willingness depends on their income.

In figure 5 and 6 we observe the prevalence distribution of the categories of noise influence in quality of life and prevalence distribution of categories of incomes with respect to the choices of question 1 and 2.

CONCLUSIONS.

Considering the results obtained in questions 1 and 2 we conclude that in this city there is a monthly average of willingness to pay of approximately US\$ 1 per dB of less noise. With this price the monthly average demand of less noise needed to satisfy the actual necessity of well being of silence is approximately 4.78 dB.

We also conclude that willingness to pay is more correlated to people's opinion of noise influence in life quality than to their income. Nevertheless, the amount of money that people are willing to pay is correlated to the income.

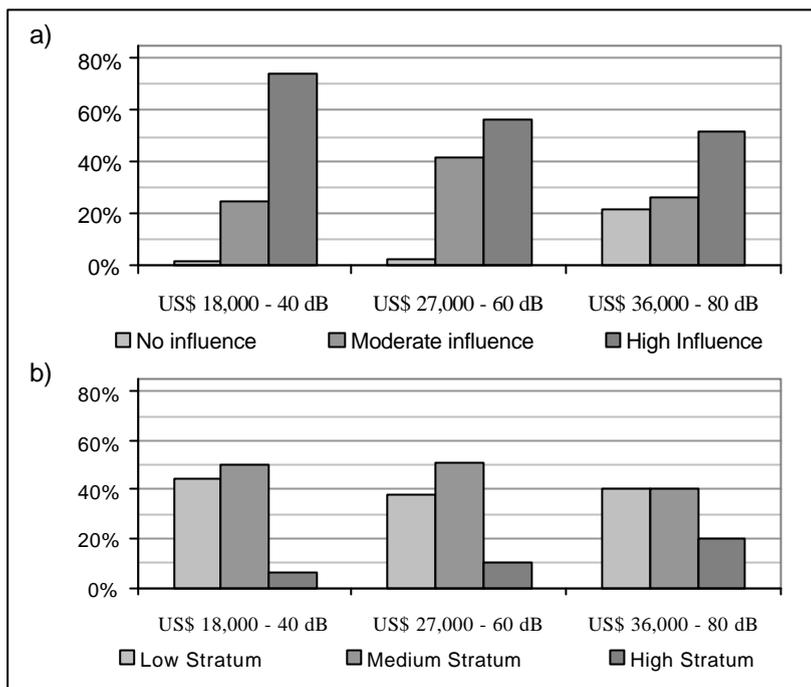


Figure 5. Prevalence's of question1 in relation to: a) Noise influence in quality of life; b) Income.

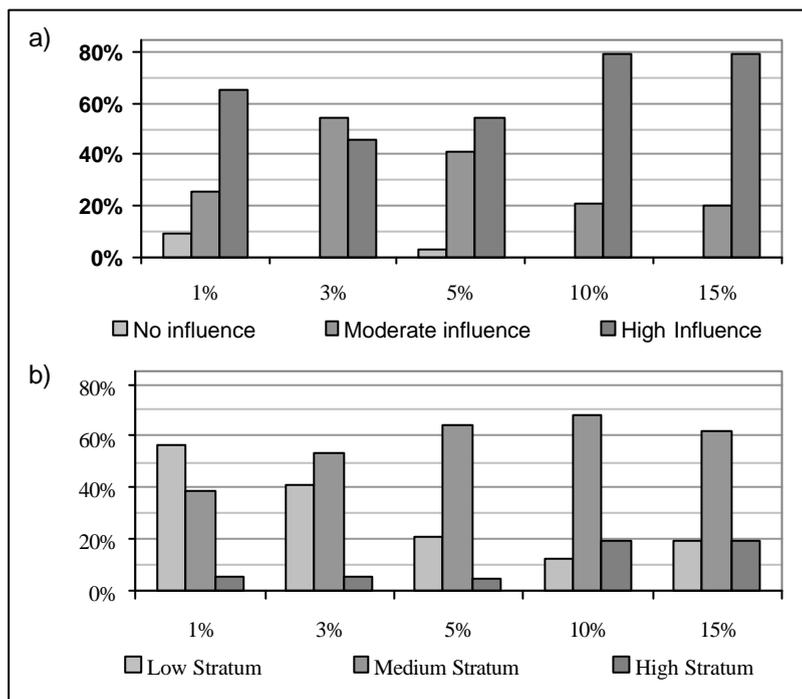


Figure 6. Prevalence's of question2 in relation to: a) Noise influence in quality of life; b) Income.

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