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Abstract

This paper has described the first application of SP experiment to value environmental benefits from reduced air pollution and noise in Korea. SP is a survey tool which makes respondents face with a hypothetical choice or set of choices and their choices are used to estimate monetary values through the establishing utility functions.

The SP survey was conducted in Seoul. The choice of the residential location was used for the experimental context for valuing air pollution reduction and noise reduction. Binary logit models were estimated with the air pollution data and with traffic noise data. Model segmentations were done by the level of family income and by the house ownership. The WTPs per household for environmental benefits from 1% air pollution reduction is 0.36% of the rent and the WTP from 1% car emission reduction is 0.31% of the rent. The WTP per household for 1% noise reduction is 0.33% of the rent. The WTPs for air pollution and noise reduction increase as the level of income increase. The WTP per household for 1% air pollution reduction is 28.2 thousand won per year and the WTP per household for 1% air pollution reduction from car emission is 24.0 thousand won per year. The WTP per household for 1% noise reduction is 37.8 thousand won per year. Landlords are more sensible to the air pollution and noise reduction than tenants.

These results will be useful data for considering environmental factors in evaluating the transport and environmental appraisals as well as in establishing environmental related policies in Korea.

APPLICATION OF SP TO VALUE ENVIRONMENTAL BENEFITS RELATED TO ROAD TRAFFIC

Kang-Soo Kim & Hye-Jin Cho

External effects of road traffic have become important as transport systems has developed and it is increasingly realized that the valuation of the effects should be incorporated in the process of the transport project evaluation. However, in Korea, the number of studies on the valuation of the external effects related to road traffic is few and the valuation of the external effects has been ignored in the transport project evaluation.

In this paper, willingness to pay (WTP) for environmental benefits from reduced air pollution and traffic noise in Seoul is investigated using Stated Preference (SP) method. The SP methods have been widely used in travel behavior research to identify the behavioral responses to choice situations, which are not clearly revealed in the market (see Hensher (1)). Thus they appear to be a promissory tool in assessing monetary values for improvement to the environment. In particular, for the valuation of air pollution only related to urban traffic, the contribution of car emissions in the air pollution is considered.

This paper is organized as follows. Following this introductory section the next section describes the survey design including environmental attributes and their levels. Data collection is briefly summarized including the number of observations and the way the sample were drawn. The next section reports model estimation results including model segmentations and willingness to pay for the environmental benefits. The final section summarizes the empirical findings and draws overall conclusions and further studies for this paper.

STATED PREFERENCE METHOD

Traditionally estimating willingness to pay for the environmental benefits has been based on the Contingent Valuation(CV) method which asks people how much they are willing to pay for the benefit. However, the international literature has been divided into two groups: one who support the CV method such as Navrud(2), Braden and Kolstad(3) and Mitchell and Carsen(4), and the other who are very critical of CV such as Hausman(5). McFadden and Leonard(6), Kemp and Maxwell(7) and Arrow et al.(8) also recommended the use of SP as an alternative method to CV for assessment of environmental benefits. Adamowicz *et al.* (9) applied the SP method to environmental management problem for recreational use of rivers. Hanley et al. (10) researched environmental management benefits from the landscape and wildlife protection in Scotland using the SP method. In SP, respondents are faced with a hypothetical choice or set of choices, which in turn are used to estimate monetary values through the establishing utility function while CV method asks respondents directly to provide a monetary evaluation for the environmental benefits,

The SP is a survey tool which obtains information about people's preferences or possible action in response to different hypothetical choice situations. Each respondent is provided with alternative hypothetical situations with different combinations of attributes. The SP responses were analysed to quantitative a measure of the relative importance of each of the attributes presented. One of the main advantages of the SP method is that choice alternatives can be completely controlled by designers, so more interesting ranges of trade-offs than in real choice situations provide sufficient variation in the data to examine the variables of interest. Furthermore, SP method asks each respondent to make several choices rather than just one per person as is the case of revealed preference (RP) method. This makes it possible to investigate how a respondent responds to different trade-offs and to carry out SP analysis with much smaller sample sizes than for RP (Pearmain and Kroes (11)).

SURVEY DESIGN

The design of the main SP survey is based on experience with a pilot survey. The pilot survey was conducted in late 2000 in Seoul Metropolitan area. The questionnaire included questions about household characteristics, commuting time, house price, noise, and air pollution levels. Also, willingness to pay for better residential location in terms of air pollution and noise was asked using CV method and SP method. The main SP design for the survey was clarified and revised from the pilot results. The results of the willingness to pay for the environmental benefits from the pilot survey were used for the main SP design. The results from the pilot survey showed that the walking time variables from home to subway station had a positive sign indicating counterintuitive. So, the variable was excluded from the main SP design.

To make hypothetical choice situations as realistic as possible, the choice of the residential location is used instead of the choice of the transport context where route choice or mode choices has usually been used. The reason for this is that the effect of environmental benefits from reduction of air pollution and noise is more clearly shown as a result of the residential location choice rather than on the route or mode choice. It has been known that environmental factors become important in the residential location choice (Hunt *et al.* (12)).

Respondents are asked to make a choice between two hypothetical alternative residential locations, each of which is described in terms of travel time to work, rent and noise (or air pollution) levels. In SP experimental design, an orthogonal method was applied, which means that there is zero correlation between the explanatory variables. The attributes presented to respondents are varied independently from one another. The environmental factors affecting choices are presented in relative percentage value (%) based on current situation because it is difficult to define the "air quality (or noise)" and difficult for respondents to understand the actual levels of air pollution or noise. The basic level for environmental factors is the present level experienced today. The detailed information on the level of air pollution and noise was obtained from the Department of Environment records and give to the respondents prior to the interview. The basic level for the rent cost means present rent level. The

basic level for the travel time to work means each respondent's travel time to work experienced today. Tables 1 and 2 show the attributes and their levels in the SP experiment.

TABLE 1. Attributes and Their Level in SP experiment (Air Pollution Survey)

TABLE 2. Attributes and Their Level in SP experiment (Noise Survey)

In order to give background information on environmental problems caused by road traffic, before the interviews, the respondents were given newspaper articles about the actual damages caused by air pollution and noise. Then they were reminded that any money for environmental improvements would have to be paid out of their own pocket.

Questionnaire consists of two parts: the first part for general questions and attitude questions about environment and the second part for SP questions. For the SP questions the full set of options combined with different levels of variables has too many questions for the survey. So we used fractional factorial SP experimental designs which show respondents only a subset of the full set of options. The total number of combinations was usually defined by the number of attributes and levels included in SP design (Permain and Kroes (11)). The catalogues of design presented in Kocur *et al.* (13) was applied to the SP design and in this survey, each respondent was asked to respond to ten SP questions. An example of the SP questions is shown in Figure 1.

FIGURE 1 An example of the SP questions

DATA COLLECTION

Surveys were carried out in the summer of 2001 in Seoul. SP survey sites were total 39 sites in Seoul which have been continuously monitored by Department of Environment every year. The 26 sites for the air pollution monitoring are Guro-dong, Gueuo-dong, Kileum-dong, Namgazua-dong, Daechi-dong, Mapo-Gu, Munmok-dong, Munrae-dong, Banpo-dong, Bangeyu-dong, Bun-dong, Bulkwhang-dong, Sadang-dong, Sangkyue-dong, Sungsu-dong, Sihyung-dong, Sinshul-dong, Sinlim-dong, Sinjung-dong, Ssangmun-dong, Oryu-dong, Euhwa-dong, Janshil-dong, Chunho-dong, Hannam-dong, and Hwagok-dong. The 13 sites for the traffic noise monitoring in Seoul are Eutaewon-dong, Hyugui-dong, Bulkwhang-dong, Pukahyun-dong, Sungbuk-dong, Jongam-dong, Myung-dong, Sindolim-dong, Daechi-dong, Banpo-dong, Apkyujung-dong, Euoeuido-dong, and Sungsu-dong. The dong is an administrative district in Korea and there are 330 dongs in Seoul.

The sample was drawn in the survey sites at random with careful consideration. Interviewers visited individual household and interviewed face-to-face. A total number of observations was 2255 respondents including 1537 households for the air pollution and 718 households for the traffic noise. The characteristics of the sample was compared with those of whole population in Seoul and seems to well represent the characteristics of Seoul's whole population with respect to income and the price of

houses.

MODELLING

Prior to modeling, data were cleaned. Responses which were not completed for any of the questions about household characteristics, residential characteristics and willingness to pay were excluded from the analysis. Responses which did not make choice exercises as carefully as required were excluded because a dominant pair of options in the SP exercises was included. The lexicographic responses, which were always consistent with preferring options with the highest level of a single attribute, were also excluded. As a result of these tests, 444 households for air pollution survey and 183 households for traffic noise survey were eliminated.

We estimated binary residential location choice models. Based on the assumptions that all choices are independent from irrelevant alternatives (IIA) and the errors (the random and unobserved part of the indirect utility) are Gumbel-distributed, the choice data are analysed by means of logit models; see McFadden (7).

$$\Pr(y_n = 1) = \frac{e^{V_{na}}}{e^{V_{na}} + e^{V_{nb}}} = \frac{1}{1 + e^{-(V_{na} - V_{nb})}} \quad (1)$$

In equation (1), y_n is individual n 's choice between the two alternatives i , $i = A, B$ (A is set equal to 1 and B is set equal to 0). The systematic (observable) part of the (indirect) utility, V , of the alternative chosen, i , can be stated as

$$V_{ni} = \beta_0 + \beta_1 X_{ni1} + \dots + \beta_K X_{niK} \quad (2)$$

where β_k , $k = 0, \dots, K$, are the $K+1$ unknown parameters to be estimated and X_k , $k = 1, \dots, K$, are the K explanatory variables such as rent, time to work and air pollution in the model. The rent variable was initially designed to the relative percentage(%). Four models were estimated using whole sample : two with percentage rent variable and two with monetary rent variables each of which was using either air pollution survey or noise survey data.

Willingness to pay for the environmental benefits from reduction of air pollution and noise is derived using equation (3). That is WTP for environmental benefits from reductions in air pollution and traffic noise of Seoul was calculated using the relative size of parameters of air pollution (noise) and rent.

$$\frac{\partial V_i / \partial X_p}{\partial V_i / \partial X_n} = \frac{\beta_n}{\beta_p} \quad (3)$$

MODELS WITH PERCENTAGE RENT VARIABLE

Whole Sample Model Estimates

The estimated coefficients from the logit models are given in Table 3. As it can be seen, the model estimates are satisfactory; the values of rho-squared are reasonably high; all parameters have intuitive signs; and all parameters are significant. The signs of all parameters indicate that utilities of respondents are decreasing as the increasing of travel time to work, rent and air pollution (or noise). Rent has more influence on residential choice than any variable unit given. Next to the rent, travel time to work has more influence than environment variables on residential choice.

TABLE 3. Model Estimation with Rent (%) Variable

Willingness to pay (WTP) for environmental benefits for reductions in air pollution and traffic noise of Seoul was calculated using the relative size of parameters of air pollution (noise) and rent. It is found that the WTPs per household for 1% reduction in the air pollution are 0.36% of the rent, while the WTP per household for 1% reduction in the noise is 0.33% of the rent. To consider the WTP related to urban traffic only, the WTP is multiplied by the contribution of car emissions among the urban air pollution. The 2001 National Environment Reports reported that the total amount of air pollution in Seoul in 2000 was 325,000 ton consisting of 277,000 ton from car emission, 41,000 ton from heating, 5,000 ton from industries and 1,000 ton from the others. In other words, the air pollution in Seoul was caused by car emission(85.2 %), heating(12.6%), industries(1.5%), and the others(0.3%). In order to estimate the value of the air pollution, we assumed that 85% of the willingness to pay for the improvements of air quality is the willingness to pay for the reduction of car emission. Therefore, the WTP per household for 1% reduction of car emission is 0.31% of the rent.

Segmented Models by Income Levels

To look at the influence of socio-economic household characteristics in the valuation of the various attributes, segmented models are estimated. Considering the small sample size, it appeared more sensible to estimate the stratified model according to family income levels. Four income groups were considered; Income 1 (low family income: less than a million won per month), Income 2 (medium family income: from 1.1 million won to two million won per month), Income 3 (medium family income 2 : from 2.1 million won to 3.5 million won per month) and Income 4 (high family income : more than 3.5 million won per month).

Table 4 presents air pollution models estimated by four different levels of income. The overall results of model estimates are satisfactory. For all models, rent has more influence on choice

than any given units of variables. The Air pollution parameter indicates that those who have higher level of income are more sensitive to the air pollution increase in terms of residential location choice. The Travel time parameter also indicates that travel time increases influence more on residential choice as the level of income increases. The Rent parameter indicates that as the level of income increases, the rent has slightly more effect on residential choice except income group 3.

WTPs for environmental benefits from air pollution reduction are calculated according to the income groups. It is found that the WTPs per household for 1% reduction in the air pollution are 0.35% of the rent for the income group 1, 0.32% of the rent for the income group 2, 0.40% of the rent for the income group 3 and 0.49% of the rent for the income group 4. The WTPs per household for 1% air pollution reduction from car emission are 0.30% of the rent for the income group 1, 0.27% of the rent for the income group 2, 0.34% of the rent for the income group 3 and 0.42% of the rent for the income group 4. As level of income increases, The WTPs for air pollution reduction and the WTPs for air pollution reduction from car emission increase.

TABLE 4. Segmented Models by Levels of Income : Air Pollution Data

Table 5 present segmented models by four different levels of income. The overall results of model estimates are satisfactory. For all models, rent has more influence on choice than any given units of variables. WTPs for environmental benefits from traffic noise reduction in Seoul are calculated according to the income groups. The WTPs per household for 1% traffic noise reduction are 0.29% of the rent for the income group 1, 31% of the rent for the income group 2, 0.36% of the rent for the income group 3, 0.40% of the rent for the income group 4. Overall, those who have a high level of income have a higher WTP for traffic noise reduction.

TABLE 5. Segmented Models by Levels of Income : Noise Data

MODELS WITH MONETARY RENT VARIABLE

The previous section describes the model with the percentage rent variable which only show the willingness to pay for the environmental benefits in relative terms. For the monetary value of willingness to pay for the benefits we estimated monetary valuation models. To do this, the percentage(%) rent variable was transformed to monetary values using the following procedure. For house price for landlords, present house prices are multiplied by saving account interest rate (0.05), and then average ratio of rent and house price (0.63%). For tenants, house prices are obtained by multiplying present rent price by saving account interest rate (0.05%).

Whole Sample Model Estimates

We estimated two binary choice logit models with air pollution survey data and noise survey data, shown in Table 6. As can be seen, the estimates of both models are satisfactory. The signs of all parameters indicate that utilities of respondents are decreasing with the increase of travel time to work, rent and air pollution (or noise). The WTPs for environmental benefits from air pollution reductions and traffic noise reduction in Seoul were calculated using the relative size of air pollution (noise) and rent parameters. The WTP per household for 1% air pollution reduction is 28.2 thousand won per year and the WTP per household for 1% air pollution reduction from car emission is 24.0 thousand won per year. The WTP per household for 1% traffic noise reduction is 37.8 thousand won per year.

TABLE 6. Model Estimation with Monetary Rent Variable

Segmented Models by House Ownership

The WTPs for environmental benefits from air pollution and traffic noise reduction in residential location choice seems to depend on his/her house ownership. Therefore In this section we investigate the extent to which the house location choice related to environmental benefits was influenced by house ownership by house ownership segmentation. Among the air pollution sample, the number of landlord observations was 4430 and that of tenant observations was 2800. Table 7 presents two segmented models. The overall results of model estimates are satisfactory. In order to investigate whether there is significant difference between models between landlord and tenants we did log-likelihood test and the results, $-2(L_R-L_U)$ was 36.1044 which is higher than critical values 7.81 for the 95% significance with 3 degree of freedom. Therefore we reject the null hypothesis and the results indicate that the two models are statistically significantly different from each other.

The Rent parameter indicates that the tenants were more sensitive to the rent i.e. housing cost than landlords. According to air pollution and travel time parameters, however, landlords were more sensitive to the air pollution increase and travel time increase than tenants. These results indicate that landlords consider not only house price but also more factors including environments and commuting time when they choose their house location than tenants do. The WTPs per household for 1% air pollution reduction are 32.7 thousand won per household for the landlord and 18.5 thousand won for the tenants. That is the landlords are willing to pay for air pollution reduction 1.77 times more than the tenants.

TABLE 7. Segmented Models by House Ownership : Air Pollution Data

With noise survey data, the number of landlord observations was 3090 and that of tenants was 1890. Table 8 presents two segmented models. To test the significant difference between segmented models, we did log-likelihood test. The results, $-2(L_R-L_U)$ was 45.707 for the 95%

significance indicating that the two models are statistically significantly different from each other.

The Rent parameter indicates that the tenants were much more sensitive to the rent i.e. housing cost than landlords. The noise parameter indicates that landlords were slightly sensitive to the noise increase. The travel time parameter shows that landlords are influenced by travel time increase slightly more than tenants. The WTPs per household for 1% noise reduction are 44.8 thousand won for the landlord and 18.1 thousand won for the tenants. In other words, the landlords are willing to pay for noise reduction 2.5 times more than the tenants.

According to the air pollution survey and the noise survey, overall those who own their houses consider the environmental issues more than tenants do. Tenants are more concerned about the rents than environmental situation.

TABLE 8. Segmented Models by House Ownership : Noise Data

CONCLUSIONS AND FURTHER STUDIES

This paper has described the first application of SP experiment to value environmental benefits from reduced air pollution and noise in Korea. SP is a survey tool which does not ask respondents directly about the monetary evaluation for the environmental benefits but make them face with a hypothetical choice or set of choices. These choices in turn are used to estimate monetary values through the establishing utility functions.

The SP survey was conducted in Seoul and 2255 responses were collected. Binary residential location choice models were estimated with the air pollution data and traffic noise data. Model segmentations were done by the level of family income and by the house ownership. It was found that the choice of the residential location was an appropriate experimental context for valuing air pollution reduction and noise reduction.

According to the estimation results with percentage rent variable, the WTP per household for environmental benefits from 1% air pollution reduction is 0.36% of the rent and the WTP from 1% car emission reduction is 0.31% of the rent. The WTP per household for 1% reduction in the noise is 0.33% of the rent. Model segmentations by family income levels show that the WTPs for the air pollution and noise reduction increase as the level of income increase.

Model estimation with monetary rent variable show that the WTP per household for 1% air pollution reduction is 28.2 thousand won per year and the WTP per household for 1% air pollution reduction from car emission is 24.0 thousand won per year. The WTP per household for 1% traffic noise reduction is 37.8 thousand won per year. According to the model segmentations by the house ownership that the landlords are willing to pay for noise reduction 2.5 times more than the tenants. Overall, those who own their houses consider the environmental issues more than tenants do.

These results will be useful data for considering environmental factors in evaluating the transport and environmental appraisals. Existing appraisals of transport projects and project

evaluation has excluded the environmental factors in Korea. One of the main reasons for that is lack of researches dealing with quantifying the environment damages from transport. The travel time saving researches were the only related quantified researches and they have been mainly used for the evaluation. These results are also valuable data for establishing environmental related policies in Korea.

For the further studies it is recommendable to design SP questions which enable objectives to be achieved and bias of responses to be reduced. It is also very important to conduct consistency and lexicographic response testing before analyzing data. Furthermore it is also recommended to investigate traffic volume changes due to transport investments and traffic management and their effects on traffic noise and air pollution.

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FIGURE 1 An example of the SP questions

TABLE 1. Attributes and Their Level in SP experiment (Air Pollution Survey)

| Attributes | Levels | | |
|-------------------------|---|---------------------------------------|---|
| | Level1 | Level 2 | Level 3 |
| Rent (%) | Present rent | 10% increase of the present rent | 25% increase of the present rent |
| Air pollution (%) | 10 % increase of the present level * | 40% reduction of the present level* | 90% reduction of the present level* |
| Travel time to Work (%) | 25% decrease of travel time to work experienced today | Travel time to work experienced today | 25% increase of travel time to work experienced today |

*Present air pollution level was obtained from the Department of Environment.

TABLE 2. Attributes and Their Level in SP experiment (Noise Survey)

| Factors | Levels | | |
|-------------------------|---|---------------------------------------|---|
| | Level1 | Level 2 | Level 3 |
| Rent (%) | Present Rent | 10% increase of the present rent | 20% increase of the present rent |
| Noise (%) | 20% increase of the present level * | 20% reduction of the present level * | 60% reduction of the present level * |
| Travel time to Work (%) | 25% decrease of travel time to work experienced today | Travel time to work experienced today | 25% increase of travel time to work experienced today |

*Present noise level was obtained from the Department of Environment.

TABLE 3. Model Estimation with Rent (%) Variable

| Variables | Air Pollution Model | | Noise Model | |
|----------------------------------|------------------------------------|----------------|------------------------------------|----------------|
| | Coeff. (β) | t-value | Coeff. (β) | t-value |
| Rent (%) | -0.0742 | -29.2 | -0.08129 | -21.6 |
| Air Pollution (Noise) (%) | -0.02655 | -38.7 | -0.02744 | -27.6 |
| Travel time to Work (%) | -0.03405 | -27.1 | -0.03260 | -18.1 |
| L (β) | -7576.0987 | | -3708.3374 | |
| Rho-Squared(c) | 0.1950 | | 0.2052 | |
| No. of Obs. | 10930 | | 5350 | |

TABLE 4. Segmented Models by Levels of Income : Air Pollution Data

| Variables | Income 1 | Income 2 | Income 3 | Income 4 |
|------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| | Coeff. (t-values) | Coeff. (t-values) | Coeff. (t-values) | Coeff. (t-values) |
| Rent (%) | -0.06937 (-8.8) | -0.07648 (-20.5) | -0.07620 (-16.4) | -0.07756 (-7.8) |
| Air Pollution (%) | -0.02397 (-11.7) | -0.02444 (-25.6) | -0.03031 (-22.7) | -0.03782 (-11.3) |
| Travel time (%) | -0.02887 (-7.6) | -0.03246 (-18.2) | -0.03791 (-16.0) | -0.04989 (-8.6) |
| L(β) | -588.65 | -2798.1 | -1951.7 | -446.11 |
| Rho-Squared(c) | 0.1768 | 0.1867 | .02219 | 0.2652 |
| No. of Observation | 1040 | 4961 | 3629 | 890 |

TABLE 5. Segmented Models by Levels of Income : Noise Data

| Variables | Income 1 | Income 2 | Income 3 | Income 4 |
|------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| | Coeff. (t-values) | Coeff. (t-values) | Coeff. (t-values) | Coeff. (t-values) |
| Rent (%) | -0.07461 (-5.9) | -0.09647 (-14.5) | -0.08217 (-13.0) | -0.05161 (-5.7) |
| Noise (%) | -0.02153 (-7.0) | -0.02998 (-17.3) | -0.02986 (-17.0) | -0.02066 (-9.0) |
| Travel time (%) | -0.02981 (-5.0) | -0.03741 (-11.9) | -0.03358 (-10.9) | -0.02451 (-5.6) |
| L(β) | -231.03 | -1039.35 | -1067.03 | -393.38 |
| Rho-Squared(c) | 0.1564 | 0.2319 | 0.2207 | 0.1462 |
| No. of Observation | 400 | 1960 | 1990 | 670 |

TABLE 6. Model Estimation with Monetary Rent Variable

| Variables | Air Pollution Model | | Noise Model | |
|---------------------------------|---------------------|---------|--------------------|---------|
| | Coeff. (β) | t-value | Coeff. (β) | t-value |
| Rent (million won /year) | -0.006487 | -15.1 | -0.004897 | -13.7 |
| Air Pollution (%) | -0.01830 | -32.2 | | |
| Noise (%) | | | -0.01853 | -13.0 |
| Travel time to Work (%) | -0.04162 | -17.1 | -0.03777 | -12.9 |
| L (β) | -4226.0489 | | -2893.9937 | |
| Rho-Squared(c) | 0.1515 | | 0.1565 | |
| No. of Obs. | 7230 | | 4980 | |

TABLE 7. Segmented Models by House Ownership : Air Pollution Data

| | Landlord | | Tenant | |
|------------------------------|------------|----------|------------|----------|
| | Coeff | T-values | Coeff | T-values |
| Rent(million won) | -0.006224 | -12.3 | -0.008644 | -9.3 |
| Air Pollution (%) | -0.02033 | -26.2 | -0.01602 | -18.6 |
| Travel time (min) | -0.04393 | -14.0 | -0.04093 | -10.2 |
| L(β) | -2520.6962 | | -1687.3005 | |
| Rho-Squared(c) | 0.1732 | | 0.1264 | |
| No. of Obs. | 4430 | | 2800 | |

TABLE 8. Segmented Models by House Ownership : Noise Data

| | Landlord | | Tenant | |
|------------------------------|-----------------|-----------------|---------------|-----------------|
| | Coeff | T-values | Coeff | T-values |
| Rent (million won) | -0.004527 | -11.6 | -0.00966 | -8.8 |
| Noise (%) | -0.02029 | -21.7 | -0.01745 | -16.0 |
| Travel time (%) | -0.03900 | -10.4 | -0.04156 | -8.5 |
| L(β) | -1761.5950 | | -1109.5452 | |
| Rho-Squared(c) | 0.1775 | | 0.1539 | |
| No. of Obs. | 3090 | | 1890 | |

FIGURE 1 An example of the SP questions



| Option 1 | | Option 2 |
|--|----------------------------|--|
| 10% increase of the present rent | Rent | Present rent |
| 60% reduction of the present level* | Noise | 20% reduction of the present level* |
| 25% decrease of travel time to work experienced today | Travel time to work | Travel time to work experienced today |
| | Your choice ? | |