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A Framework to Estimate the Willingness to Pay of Household for Airquality Improvement: A Case Study in Klang Valley, Malaysia

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Abstract
The main objective of this study is to estimate the willingness to pay (WTP) of the household for improving the air quality in Klang Valley, Malaysia as a result of implementation of two types of transport hypothetical policy options. Survey method will be conducted to estimate how much the household in Klang Valley would value lowering the health risks associated with poor air quality. The popular method, contingent valuation method (CVM) has been used to estimate WTP for avoiding the ill health episodes due to air pollution or to improve the air quality in Klang Valley. The survey results will be analyzed using Binary Logit Model. This study is expected to minimize the problem of mismatch in terms of services that can be supplied by government and what the public really wants and is willing to pay for.

Keywords: Air quality improvement, Contingent valuation, Willingness to pay.

Application of Choice Experimental Design to Estimate the Willingness to Pay of Household for Reducing Air Pollution from Transport Sector in Klang Valley, Malaysia

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Abstract
The rapid increase in motor vehicles in Klang Valley, Malaysia would trim down the air quality in urban areas. Thus, it is critically important to reduce the air pollution due to its adverse human health effects. The present study aims to estimate the willingness to pay of the household for reducing the air pollution in Klang Valley, Malaysia as a result of implementation of two types of hypothetical policy options. Choice Experimental Design was used to estimate the willingness to pay of household for avoiding the ill health risks related with air pollution in Klang Valley. The survey result was analyzed using Conditional Logit Model. Three variables; air pollution index, medical expenditure and sick days are significantly influencing on willingness to pay of households in Klang Valley, Malaysia. The household respondents are willing to pay on average between RM 0.32- RM 0.82 per liter of transport intended fuel for reducing the air pollution in Klang valley, Malaysia. The findings obtained from this study hope to provide important insights for policy-makers to develop programs to increase public's participation for air quality improvement projects.

Key words- Air Pollution, Choice Experimental Design, Conditional Logit Model, Willingness to Pay

Introduction

Klang Valley is the most polluted region in Malaysia. It was given a serious concern after recognizing as it has a high potential of air pollution due to its inherent topography (Sham, 1979). According to department of environment (2012), the main four local sources of air pollution in Malaysia in 2011 were vehicular emissions, power plants, industrial processes, and open burning at solid waste dumpsites. For the past years the mobile sources is remaining at the first place in causing the air pollution, which is averagely more than 70% of the total air pollution in Malaysia (Malaysia Air Quality Reports, 1999-2012).The motor vehicles are contributing 95% of CO; 28% of NO_2; 16.62% of PM; 7.23% of SO_2 in 2011 (Malaysia Air Quality Reports, 2009). Rapid increase in private cars and motorbikes are emitting more air pollutants among other vehicle types. The reasons for increasing the private vehicles are degree of freedom, accessibility, passion for car and driving, comfort or at times, late bus arrival, increase in travel time and travel cost (Kamba *et al*., 2007; Nurdden *et al*., 2008; Steg., 2005; Beirao and Cabral., 2007) and negative perception on public transport. Furthermore, the modern public transportation facilities with lacks of service quality (Almselati et al., 2011), use of public transport may place them in between traffic and thus waste their time. Moreover, establishments of Malaysian automotive company ownership of Proton in 1981 as well Perodua in 1993 would extremely increase the percentage of car sold in Malaysia. The rapid increase in motor vehicles would trim down the air quality in urban areas in Klang Valley, Malaysia.

This condition would be affecting human health in this area. Thus, there is a need to have effective control of pollutant emissions in Klang Valley. The major concerns for human health from exposure to particulate matter is given more emphasise by the existing researches. Respiratory diseases are among the highest ranked diseases suffered by Malaysian citizens. In Klang Valley, approximately 49% of diseases are air-pollution-related, such as allergy to dust or pollen (20%), asthma (14%), heart disease (12%) and Chronic Bronchitis (3%) (Afroz, 2004). It can be predicted that the emission load from vehicles in 2015 will be increased between 2 and 3 times higher than emission loads in 2005[1] (ERIA Research Project Report, 2008). The elderly and the children are the most victims of the effects of the particulate matter (Environmental Protection Agency, 1996; WHO, 2009). However, consideration of the human health effects is giving more emphasis to dominate discussion of policy towards air quality in particular and the environment in general. As a result, local and national governments increasingly require information of costs and benefits associated with ambient levels of pollution to support them in improving standards and imposing pollution control measures.

This study intends to estimate the willingness to pay of household from two air quality improved alternative hypothetical options. The experimental design in this study is constructed based on the Hiksian compensating surplus (CS) welfare measure. It estimates the change in income that would make an individual indifferent between the initial (status quo) and proposed situation (improved air quality) assuming the individual has the right to choose the initial utility level. This change in income reflects the individual's WTP to obtain an improvement in air quality. WTP extra money is being paid by the household for having improved air quality in Klang Valley, Malaysia. Further, it would try to identify the factors influencing the probability of WTP.

Literature Review

CM was originally employed in the marketing and the transport studies, then it extended its usage towards other areas like health research, environmental valuation such as valuing remnant native vegetation, environmental attributes of rivers, recreation demand for rock climbing, predicting user fees at public recreation sites, preservation of tropical rainforest protection of aboriginal cultural heritage sites and valuing cultural goods, heritage and monuments and solid waste management, (Morrison et al., 2002; Hanley et al., 2002; Schroeder and Louviere., 1999; Rolfe et al., 2000; Rolfe et al, 2001., Navrud and Ready, 2002., Othman, 2002).

Choice modelling represents a range of state preference techniques which carries the same move toward to valuing non-market goods (Bennett & Blamey, 2001). Choice Modelling (CM) and Contingent valuation Method (CVM) analysis are the taken place in the same manner for estimating the stated preferences of individual for the hypothetical market, but the design of WTP scenario. CVM is unable to produce multiple value estimates from a single sample split as in CM, which allows for the valuation of all the options within a sample split. CM has the ability to offer information regarding the relative contribution made by the attributes enables some of the questions surrounding CVM application to be answered. Any goods' attributes and their levels could be explained by choice modelling techniques and it focuses the changes of attributes levels which is result of different 'good' being produced and the value of such changes of attributes. CM can capture some factors such as unemployment impacts and the subsequent estimation of implicit prices through the attributes. CM estimation is seemed more appropriate in terms of rich in data set, framing, scoping, problem identification and incentive compatibility than CVM. Choice modelling is useful to value the attributes and capture the marginal changes of attributes. It is preferred over the contingent valuation method where it is potential for the valuation of the individual attributes for the number of scenarios in one study but it is limited in contingent valuation method (Bennett and Adamowicz, 2001).

Theoretical Framework and Model Specification for Air Pollution Reduction in Klang Valley, Malaysia

A common theoretical framework: the Random Utility Model (RUM) is being applied to value the non- market goods (Thurstone, 1927; McFadden, 1974).The stated preference method CM is built based on hypothetical scenarios and ask the respondents to value the non- market goods. The respondents' problem in this framework is to maximize their utility level by choosing the most preferred combination between the market and the non-market good and services subject to budget constraint and the price of goods. The utility level depends on respondents' income, socio-economic characteristics and consumption of market and non-market goods. Air quality improvement is being treated as non-market good in this study.

[1] Since the emission levels are estimated from the energy consumption, the author predicted the emission level approximately from the projected energy demand using the date form ERIA Research Project Report, 2008.

The indirect utility function under the random utility modal can be illustrated into two elements as, observable (*Vij*) and unobservable (*εij*) components on individual choice (Verbeek, 2004; Mogas et al., 2006). Assume utility for an option *i* depends on environmental attributes (Z) and socio-economic characteristics (S).

$$U_{ij} = V_{ij} (Z_{ij} , S_j) + \varepsilon_{ij} (Z_{ij} , S_j) \quad (1)$$

In Choice Modeling, the probability of any individual respondent prefers the option *j*, in the choice set to any alternative option *k*. The probability that the utility related with j exceeds that related with all other options in the choices can be expressed as follows;

$$P_{ij} = P \{V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}; \forall K \in C\}, \text{ for } j \neq k \quad (2)$$

Where C stands for all possible alternatives choice set, assuming a Type I Extreme Value distribution for the error terms, the probability of choosing the alternative *j* by an individual respondent *i*, is being shown as;

$$P_{ij} = \frac{\exp(V_{ij})}{\sum_{q=1} \exp(V_{iq})} \quad (3)$$

The parameters can be estimated by maximising the likelihood given in equation (3a), where y_{ij} is an indicator variable which takes the value of one if respondent *j* chose option *i* and zero otherwise.

$$\log L = \sum_{i=1}^{N} \sum_{j=1}^{3} y_{ij} \log \left[\frac{\exp(V_{ij})}{\sum_{j=1} \exp(V_{iq})} \right] \quad (3a)$$

An individual expected utility is modeled with the characteristics of the alternatives and the attributes of the individuals which is known as conditional logit model (McFadden, 1974). In this study conditional logit model was utilized to estimate the WTP.

The individual indirect utility function as shown in equation (4) can take different models. The easiest model is the linear model without an intercept (Haan et al. 2008). Where V is indirect utility, SD refers sick days, mitigating activities are referred by M, PM represents concentration of PM10 and C is the cost. Therefore, the simple model is as follows;

$$V_i = \beta_1 SD + \beta_2 M + \beta_3 PM + \beta_4 C + \varepsilon \quad (4)$$

Using the best model estimators obtained from the conditional logit model, has been used to estimate the implicit price (marginal rate of substitution) for each attributes and the trade-off among those attributes, and the CS by employing following equations (5) and (6) respectively (Bennett and Adamowicz, 2001, p.63; Hanley and Spash, 1993, p.76).

$$\text{Implicit price} = -\frac{\beta_k}{\beta_c} \quad (5)$$

Where, β*k stands* for the coefficient of the attribute in question and βc stands for the coefficient of the monetary attribute (Rolfe et al., 2000, p.295).

Using the results from the conditional logit, the CS can be estimated by employing the following equation (Adamowicz et al. 1994).

$$CS = -1/(\beta_M)\{\ln(\Sigma_i \exp^{V0}) - \ln(\Sigma_i \exp^{V1})\} \quad (6)$$

Since this study considers only one side, the above equation which is for considering the valuation of multiple sites is simplified, Boxall et al. (1996) and Morrison et al. (1998), as follow;

$$CS = \{-1/(|\beta_M|)\}(V_0 - V_1) \quad (7)$$

where β_M is the coefficient of the monetary attribute and is known as the marginal utility of income, and V_0 and V_1 represent current and improved state, respectively.

Experimental Design

In CM, respondents was offered with multiple choice sets, where each choice set contains common attributes with different levels. Respondents were solicited to select their preferred option from each choice set. The combination of attribute levels for each option in each choice set was designed using experimental design techniques. Before the choice sets were offered to the respondents, explanation of the study site, the research matters, the planned policy change were given to the respondents.

An orthogonal experimental design is used in this study to develop the combination of attribute level for the choice sets. The orthogonal design choice sets used in this study are constructed using the L^{MN} approach (Street et al., 2005); L is level of attributes, M is number of alternatives and N is number of attributes. The arrangement of all possible combination is called the "full factorial". For instance, the design has 8 attributes (four for each policy option and four attributes have two levels. The total of(2^{2x4}) would build up full factorial. Using SPSS software 20.0, the final choice sets were determined from the full factorial. Therefore, each respondent was given choice sets according to the number of choice blocks. Table 1 described an Illustration of a choice set which was presented in the Focus Group Analysis.

The attributes and the levels of these attributes were recognized from the literature, the focus groups discussions and discussions with experts on the area of environmental studies. This is helpful to establish the appropriate choice sets format and the levels of price tags for each choice set. It is important for the success of a CM practice. The three focus groups were selected from the general households (lower income, middle income and higher income) and each group had 5 members, and the pilat study has been done from 60 respondents in Gombak, an international university town within the Klang Valley municipality.

Proposed Alternative Options and Payment Vehicle

The service attributes and levels that it takes for the two proposed alternative options are as follows:

- Sick Days per month (Number of Days): 2 levels; Baseline (5 days), improved options (5 days, and 4 days)
- Mitigation expenditures per moonth (MYR): 2 levels; Base line (MYR 50) and improved options [RM40 (5%) reduction, and RM30 (10%) reduction]
- Air Pollution Index (API): 2 levels; Base line (unhealthy) and improved options (moderate air and good air reduction)
- Increase in fuel price(MYR) per liter annualy: Base Line (based on current house price) and improved options (0.1% increase, and 0.2% increase).

The baseline option considers the baseline levels only while the other two options can take on any orthogonal mix of levels including the baseline level. It has been found that sick days in Kuala Lumpur Malaysia is 5 days per month (Afroz et al., 2004) and mitigation expenditure is MYR 50 per month (MOH-Ministry of Health, 2010). Currently, the API in Klang Valley is unhealthy averagely half of the year for last ten years (Department of Environment, 2012). Fuel price was used as the payment vehicle for the air quality improves options. In most countries the fuel price is increased on fuels which are intended for transportation. Fuels used to power agricultural vehicles, and/or home heating oil similar to diesel is priced at a different, usually lower, rate. In this study we assume the fuel price is increased on sale which is intended for transportation. The more drive would be releasing the more pollutants. Thus, it would cost more those who drives more in the form of fuel price.

The respondent has the option to agree or not to agree the proposed alternative options. The preference towards the proposed option over the baseline scenario was pointed out, if the respondent agrees to WTP for the improved options. Otherwise the baseline scenario was selected for not to agree the proposed scenario. The respondents were presented the CM design. Thus, the respondents require comparing each choice set with the same baseline plan one at a time. In brief, this approach has the benefit of a CV in terms of easiness of response obtain and the capacity of a CM in modelling different levels of resource allocation alternatives.

Questionnaire as a Tool of Survey

The household respondents were given the description of the current air quality in Klang Valley, the health impact of air pollution, medical expenditures and the policies to improve the air quality in Klang Valley, before the CM questions presented to the respondents. The improved option plan was then presented. The respondents were asked clearly that if they decide to vote for the improved plan, they have to pay the increase in fuel price directly to the government from their pocket for the certain period. Respondents who voted for the improved plan were further asked to reveal their maximum monthly WTP to obtain the improvement. Suppose, if the above two air quality management options are the only available options, each household respondent was asked to select the prefereble option for improving the air quality in Malaysia as shown in Table 2.

The questionnaire has seven components. In part one, the impact of air pollution was described to the respondent, and the respondents were asked about their experiences of air pollution in the Klang Valley and asked to rank attributes from the most to the least dangerous. In part two, the respondents were asked whether they experience any ill health episodes related to air pollution such as cough, sneezing, fever, running nose, eye irritation, and the daily length of time spent outdoors during the last three months. Then, they were presented the health impact of air pollution, part three was about the causes of ill health episodes, and part four was about the policies to be implemented as a remedy for reducing those causes to the respondents using three show cards. The households who selected for the current management project were not asked any WTP question. In part five, the households who decided to vote for the improved project, they were asked to reveal their WTP to obtain the improvement. In part six, some questions were asked to the respondent to validate their answer. In part seven, the respondents' socio-economic gathered such as their occupation, level of education, monthly household consumption, ethnic, and number of children and smoking habits.

Survey and Sampling Design

The structured questionnaire interview was utilized in Klang Valley and 300 respondents were selected from three urban areas; Shah Alam, Petaling Jaya and Batu Muda. They are highly, medium and low air polluted areas within Klang Valley region. The reasons for selecting the above mentioned metropolitan cities are, its economic development is extremely growing fast at 11.2% per annum and are recognized as unhealthy air quality region by the department of environment (DOE, 2012). The interview was done among the households rather than the individuals as response unit in WTP questions to avoid the over estimation of aggregate willingness to pay (Lindhjem and Navrud, 2009). The interview was administered by means of a 10-15-minutes face-to-face interview, which was taken place at the respondent's area.

Findings

This section presents the results from simple conditional logit model for air pollution reduction in Klang Valley, Malaysia. The estimated coefficients, standard error and t-value are presented in Table 3. A likelihood ratio test of joint significance of the included variables rejects the null hypothesis that the marginal effects ($ß_s$) are jointly zero with a likelihood ratio statistic value of 103.352 with the critical chi-squared value 0.0000 at 1 percent level of significant and 5 degree of freedom.

Three variables, air pollution index (API), medical expenditure (ME) and sick days (SD) are significant at 1 percent level. Positive relationship between air pollution index and sick days were with more utility relative to air pollution reduction in Klang Valley, Malaysia. The highest utility increment was due to air pollution index (coefficient= 0.54317) followed by medical expenditure (coefficient = 0.259567), and sick days (coefficient = 0.21685). The negative relationship between price and the utility of the product (air quality) reflects as in the theory. In other words, increase in price decreases the combined utility level provided by the choice. The willingness to pay for this model is presented as the marginal value for the attributes. It was calculated on the basis of marginal rate of substitution (MRS) between all the attributes and monetary attributes using WALD procedure in the LIMDEP 3.0 and 4.0.

The household respondents were willing to pay on average between RM 0.32- RM 0.82 for the presents of attributes. The respondents are more concerned about the air pollution index, for that, they are willing to pay more for the air pollution index which is RM 0.82. Moreover, on average the household respondents are willing to pay RM 0.32 for sick days and RM 0.39 for medical expenditure, keep other factors constant.

The finding that household respondents were willing to pay more for air pollution index is consistent with the finding of Farber et at. (1993). Farber et at. (1993) found that statistically significant association between the API and the resident of the respondent's WTP to improve the air quality. The household respondent who is staying in a heavy polluted area is WTP more than less polluted area household respondents.

Number of sick days is a crucial factor for which consumers seemed willing to pay. The finding of Amalia (2010) suggested that number of sick leave days is positively influence on household respondent's willingness to pay. On average the household respondents are willing to pay RM 0.15 for sick days in the current study.

Medical expenditure on the respiratory sickness is significantly effects on WTP for reducing the air pollution in Klang Valley, Malaysia.The finding of this study is similar with the finding of Wang & Zhang (2008). According to Wang & Zhang (2008), medical expenditure on the respiratory diseases treatment variable had a significant relationship with the probability of having a positive WTP. People without respiratory symptoms were more willing to pay for air quality improvement than those who had symptoms.

Conclusion

The air pollution is given more stress the policy makers, due to their greatest impacts on health and agriculture, visibility, global weather, and man-made material. Mobiles sources are the major root for air pollution in Malaysia. The increasing importance given to the valuation of intangible good during last decades has given rise to the development of numerous valuation methods to place the monetary value for environmental goods. The CM method has become increasingly popular in recent years to estimate the value of non-market goods among others. However, time, resources constrain and the lacks of expert bodies in the environmental valuation methods are the main barriers in developing countries. It is potential for designing and identifying influencing factors on economic evaluation methods to develop the theoretical framework. Moreover, the household respondent's readiness to willing to pay for reducing the air pollution would help the policy makers to come out with the agenda to upgrade the public transport sector in Klang Valley, Malaysia. The finding of this result could be used by the policy makers to shift the polluted cities towards green cities such as Johor Baru green city in Malaysia.

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Table 1. An Illustration of the Choice Set

Attributes	Base line	Option 1	Option 2
Sick Days(Number of Days) per month	5	4	3
Mitigation expenditures(RM) per month	50	40	30
Air Pollution Index (API)	Unhealthy air	Moderate air	Good air
Fuel Price (RM)	RM 1.90 per litrer	2.00	2.10

Table 2. Othogonal Design for Eight Attributes with Two Levels

Block1	Status Quo	Management Option 1	Management Option 2
Sick days	5 days per month	3 days per month	4 days per month
Medical Expenditure	50 RM	30RM	30RM
Air pollution Index (API)	Unhealthy Air	Moderate Air	Good Air
Cost	1.90 RM per litter	2.0 RM per litter	2.10 RM per litter
	☐	☐	☐

Table 3. Results from the Simple Conditional Logit Model

Variables	Coeff(B)	Std.Error	t-Value	P-Value
Sickdays (B_1)	0.216857	0.0755857	2.86902	0.00411743
Medical Expenditure (B_2)	0.259567	0.0879319	2.95191	0.00315819
Air Pollution Index (B_3)	0.543167	0.10238	5.30538	1.12441
Price (B4)	-6.586	0.64134	-10.2691	2.88658e
Marginal Value for Attributes – $B_{ij/}$ $B_{ik=P}$				
Sickdays	.329270066	.10452692	3.150	.0016
Medical Expenditure	.3941192232	.11973758	3.292	.0010
Air Pollution Index	.8247302488	.12465998	6.616	.0000