Residents' Preferred Measures and Willingness-To-Pay for Improving Air Quality in Ha Noi City, Viet Nam

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Abstract

Air pollution has been a major concern for people around the world, especially in urban areas of developing countries, such as Ha Noi city. This paper presents estimates of residents' willingness-to-pay (WTP) for measures to improve air quality of Ha Noi. Hanoi residents expressed their strong preferences for three measures for air quality improvements, including: (1) Increase of green spaces; (2) Use of less polluting fuels; (3) Expansion of public transportation. The mean WTP for the implementation of those measures with the aim of improving air quality is 148,000 - 282,000VND, equivalent to 0.09 - 0.16% of household income. Multivariate probit and linear regression models was used to identify determinants of respondents' choices of measures and WTP. The respondents' choices appear to be consistent with their characteristics and needs, such as financial affordability, time on roads and their perceived impacts of air pollution. WTP was found to increase in perception of air pollution impacts, time on roads, education and income; but was lower for older people. The information on residents' preferred measures and WTP for improving air quality would be useful for policy makers in identifying prioritized measures and investing effectively in controlling air pollution given the budget limitation.

Keywords: Air pollution, Contingent Valuation Method, Ha Noi

1. Introduction

Air pollution is one of the most serious problems in the world. According to World Health Organization (WHO), more than 80% of people in urban areas are living in an atmosphere with quality levels not satisfying the WHO recommended limits. Recent estimates by WHO show that ambient air pollution accounts for an estimated 4.2 million deaths per year. While ambient air pollution affects developed and developing countries alike, low- and middle-income countries experience the highest burden, with the greatest toll in the WHO Western Pacific and South-East Asia regions.

In Vietnam, particulate matter (PM) is a major environmental problem in major cities (MONRE, 2017). Air pollution in Ha Noi, the capital of Vietnam, is considered to be more serious when compared with other big cities in Vietnam (Luong et al., 2017). The WHO Global Ambient Air Quality Database (update 2018) shows that PM concentration in Ha Noi are usually higher than in other cities of Vietnam, such as Ho Chi Minh City, Da Nang and Ha Long. The annual concentration of PM2.5 (monitored by the Vietnam's U.S. Embassy at 7 Lang Ha Street, Ha Noi) in 2016 reached 50.5 μg/m3, and in 2017 was 42.6 μg/m3 nearly twice as compared to the Vietnamese standard (25 μg/m3) and five times as recommended by WHO (10μg/m3) (GreenID, 2017, 2018). According to the Department of Natural Resources and Environment of Ha Noi city, 70% of air emissions are caused by traffic activities. Emissions from more than 4 million vehicles account for 85% of CO2 emissions and 95% of volatile organic compounds (Box 2.1, MONRE (2017))

The health effects of air pollution to Hanoi citizens are considered to be serious. Hieu et al. (2013) estimated the number of deaths due to PM10 pollution from traffic in 2009 was 3200 people, greater than the number of deaths from traffic accidents. Luong et al. (2017) showed that in the period of 2010-2011, if the PM10, PM2.5 concentration increased to 10μg/m3, the number of children hospitalizations related to the respiratory diseases in Hanoi increased by 1.4% and 2.2%, respectively.

To cope with this situation, the Government of Viet Nam in June 2016 has issued the National Action Plan on Air Quality Management until 2020 with the main goal of strengthening air quality management based on controlling emission sources and monitoring ambient air quality. In recent years, Hanoi's Government also has made efforts to implement measures for improving air quality such as cleaning dust on trucks before entering the city, installing additional air monitoring stations, planting one million trees in the period of 2016-2020. However, air pollution is still a major concern of the Hanoi citizens, demanding for more effective solutions to improve air quality.

The aim of this paper is to quantify individual willingness-to-pay (WTP) for improvements in air quality in Ha Noi by using the contingent valuation method (CVM). This paper also examines Hanoi residents' preferences for measures to improve air quality. Such information is important for policy makers when determining public investments and policy instruments in order to effectively improve air quality in Ha Noi city.

2. Study design and implementation

Air quality is a non-market commodity, we cannot use market prices to measure users' WTP. Instead, non-market valuation method – measuring the monetary value of changes in

individual welfare associated with the change in environmental quality – should be applied. CVM, a non- market valuation method, asks individuals directly their WTP in a hypothetical survey to assess non-market goods or services. The application of CVM for improvements air quality has been considered in many previous studies (Alberini and Krupnick, 2000; Carlsson and Johansson-Stenman, 2000; Carlsson and Martinsson, 2001; Ami et al., 2014)

The importance of well-informed respondents is often emphasized in a CVM exercise. However, the effects of air pollution on human and environment are very diversified and difficult to predict. Given different datasets and applied methodologies, scientific information often provides widely varying views. Hence, there is a question that whether practitioners should try to provide respondents with some 'facts' formulated based on some kind of average of these views, or whether the whole issue should be presented given some levels of genuine uncertainty, where respondents would judge the air pollution using information from various sources (Carlsson and Johansson-Stenman, 2000). The latter strategy was chosen to design this CVM study. Instead of quantifying a specific scenario, this CVM survey was considered as an exercise where respondents have their own subjective views about the harmfulness of air pollution.

The survey started with questions about respondents' perception of air pollution in Ha Noi. The overview of the Government's plans on improving air quality was presented to respondents. A list of relevant measures to improve air quality was also presented to respondents, who then were requested to make choices of three most preferred measures. Benefits of implementing those measures were discussed with respondents, and they also were requested to choose three types of benefits which are most relevant to their situations. After being aware of benefits of improvements in air quality, respondents were asked for their maximum WTP to contribute to the implementation of the measures to improve air quality. Their payment would be a one-off payment via household electricity bill. Follow up-questions were included to identify anomalies in the responses, such as reasons for zero bids, hypothetical bias (respondents may agree to pay because the payment is hypothetical). The final part of the questionnaire collects respondents' socio-economic and attitudinal information to analyse the factors affecting the WTP for improvements in air quality in Ha Noi.

For the WTP question, an open-ended question format was applied in this CVM exercise. As is well known, this type of question has often been criticized in the CVM literature; and referendum type questions are usually recommended, since this type is considered to be more similar to everyday consumption decisions, i.e. where you either buy or do not buy the good at a certain level of price. However, the open-ended format also has obvious advantages such as a much more efficient use and processing of the data and absence of starting-point and yea-saying bias (Carlsson and Johansson-Stenman, 2000). Since open-ended format could reduce yea-saying, this type of questions generally tends to give lower mean WTP compared to questions of referendum type. Therefore, one could also claim that open-ended format provides a conservative design (Carlsson and Johansson-Stenman, 2000).

The research designs were initially checked and adjusted through a pilot online survey with 191 responses of differing socio-economic circumstances to ensure that its approach was reasonable and that participants could understand the information provided.

In May and June 2018, face-to-face survey was conducted with households living near traffic roads. Criteria for selection of traffic roads are near the monitoring stations showing high

concentrations of air pollutants (such as the monitoring station at 7 Lang Ha) and roads with dense traffic. Households living near traffic roads were the main target of the survey, since they are the most affected group due to emissions from traffic activities that are main source of air pollution in urban areas like Ha Noi city. The survey was completed by 212 household representatives, so the total sample for analysis was 212. Table 1 presents a summary of the socio-economic characteristics of the sample in our CVM exercise.

Table 1: Socio-economic characteristics of the surveyed sample

Socio-economic characteristics	Mean	Standard Deviation
Perception of air pollution levels[a]	4.292	0.978
Perception of air pollution impacts[a]	4.165	0.712
Households with children under 5 years old (%)	37.74	0.485
Time on roads per day (hours)	2.155	0.969
Male (% male)	57.54	0.495
Age (years)	38.405	13.462
Years of education	15.433	2.207
Income (monthly mill.VND per household)	14.433	5.639
Sample size	212	

3. Residents' preferred choices of measures to improve air quality in Hanoi city

In our survey, respondents were presented a list of measures, which were designed based on a rigorous review of international experiences and the Government's plans on controlling air emission sources in order to improve urban air quality. Then, we asked respondents to choose their three preferred measures that should be implemented at high priority to improve air quality of Hanoi city. Table 2 presents results of respondents' choices of measures. The three most preferred measures include: (1) Increase of green spaces; (2) Use of less polluting fuels; (3) Expansion of public transportation.

Table 2: Respondents' ranking of measures for air quality improvement

Rank	Measures	Rate of choice
1	Increase of green spaces	76.9%
2	Use of less polluting fuels	43.9%
3	Expansion of public transportation	42.5%
4	Development of advanced monitoring system	36.3%
5	Application of strict emission standard for traffic vehicles	25.9%
6	Application of traffic management strategies (e.g. speed control, congestion charges)	12.7%

To have better understanding of the respondents' choices of measures, our analysis continues to examine determinants of their choices. Dependent variables in this examination have two possible outcomes (1 if a respondent chose a given measure, 0 if otherwise). The three most preferred measures are included in the analysis, and a respondent could choose one or more measures in this set of three measures. This implies that there are correlations between the three dependent variables representing the three measures. Following Carlsson et al. (2010) and Nguyen et al. (2015), multivariate probit models were applied to take into account the correlations between the dependent variables. A constant is included in a multivariate probit model to represent unobserved factors (i.e. the part is not represented by the covariates) affecting the likelihood that a respondent belongs to each group of measures.

In the multivariate probit models, perception variables, time on road, age, years of education and household income were modelled as continuous variables, while households with children and gender were treated as dummy variables. Statistically significant covariates, included in the multivariate probit models, show factors determining the respondents' choices of measures to improve air quality. The multivariate probit models were estimated with 500 draws using the GHK simulator provided in the NLOGIT 5.0 package. Table 3 reports the results of the models.

Inspection of table 3 reveals that the variable of household income is significant in all three models and have expected signs. Respondents having higher household income are more likely to choose the measures of increasing green spaces and using cleaner fuels, while they are less likely to support the measure of expanding public transportation system. This is reasonable because respondents with higher income might have higher demand for green and clean environment, and they also have better financial ability to accept higher price of cleaner fuels. Respondents having higher income might also prefer more comfortable private vehicles to the public transports.

Table 3: Multivariate probit models by groups of respondents choosing each measure

Variables	**Green spaces**	**Cleaner fuels**	**Public transportation**
Constant	-3.829**	-2.988***	3.722***
	(1.607)	(1.069)	(1.158)
Perception of air pollution levels	0.03961	0.148	-0.079
	(0.139)	(0.111)	(0.102)
Perception of air pollution impacts	-0.236	0.438***	-0.497***
	(0.176)	(0.139)	(0.148)
Households with children under 5 years old	-0.138	-0.249	-0.040
	(0.273)	(0.205)	(0.209)
Time on roads per day	0.426**	-0.119	0.070
	(0.196)	(0.103)	(0.103)
Male	0.272	-0.087	-0.167
	(0.257)	(0.194)	(0.192)
Age	0.005	-0.010	0.010
	(0.014)	(0.007)	(0.008)

Variables	Green spaces	Cleaner fuels	Public transportation
Years of education	0.085	0.003	-0.019
	(0.081)	(0.045)	(0.047)
Household income -Ln(Income)	1.195***	0.432*	-0.638***
	(0.319)	(0.248)	(0.225)
Number of observations	212		
Correlation matrix			
Green spaces		-0.615***	-0.200
Cleaner fuels			-0.263**

Standard errors are in parentheses; ***, **, * = Significance at 1%, 5%, 10% level

The *perception of impact* variable is significant in the models of cleaner fuels and public transportation. The signs are opposite in those models, so that the perception of air pollution impacts has positive effects on the likelihood of choosing the measure of cleaner fuels, but has negative effects on the propensity to choose the measure of public transportation. A reason here may be related to the respondents' financial ability (income). Respondents with perception of more serious impacts would be willing to pay more for cleaner fuels at higher prices; and given their financial ability, they would not prefer the public transports.

The variable of *time on roads* is significant in the group of respondents choosing the measure of increase of green spaces. This is immediately intuitive, as people who have to spend more time on roads would prefer the shadow created by trees nearby the roads. Hence, they are more likely to choose the measure of increasing green spaces.

Examination of the model results indicates that the respondents' choices seem to be reasonable, and to be consistent with their characteristics and needs, such as financial affordability, time on roads and their perceived severity of consequences of air pollution.

4. Willingness-To-Pay for improving air quality in Hanoi city

The design of this CVM exercise would give respondents an opportunity to 'purchase' the improvements in air quality by paying for the measures that they preferred to be implemented in order to improve air quality. Figure 1 presents frequencies of WTP amount. Of 212 respondents, 118 respondents (~ 56%) were willing to pay for improving air quality of Ha Noi city. Among those respondents, 64 respondents (~30%) were willing to pay an amount of less than 250 thousand VND; 48 respondents (~23%) had an WTP amount in the range of 250 - 650 thousand VND; only 6 respondents (~3%) were willing to pay from 650 thousand to 1 million VND. This is consistent with the economic theory of decreasing demand curve.

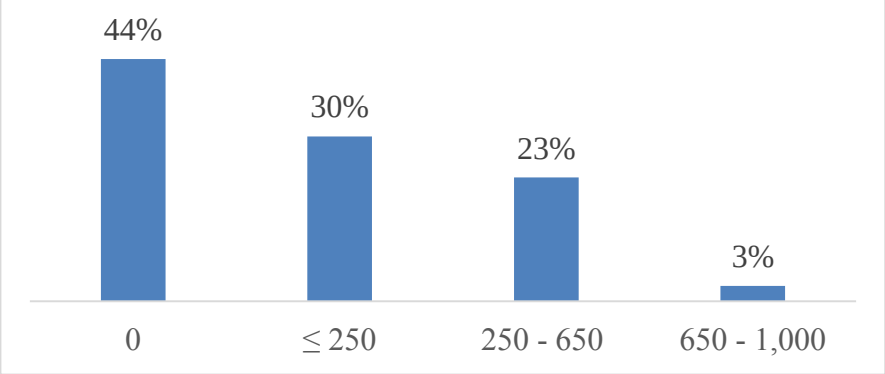

Figure 1: Frequencies of the WTP amounts in thousands VND

In our CVM survey, 94 respondents, accounting for 44% of the full sample, had a zero WTP. A follow-up question was included in the questionnaire to understand reasons for the zero WTP. The follow-up question requested respondents to select their reasons for stating zero WTP among a list of five statements. Of the zero WTP respondents, the top reason was that they did not really believe that the collected money would be spent correctly, and the second most frequently chosen reason was that the Government had to pay the costs of the improvements (Table 4).

Table 4: Reasons for zero willingness-to-pay

No.	Reasons	Frequency
1	I support the improvements, I do not really believe that the collected money would be spent correctly on improving air quality	78%
2	I support the improvements, but the Government is responsible to pay all costs of the improvements	50%
3	I support the improvements, but I do not agree with paying the fee through electricity bill	14%
4	I support the improvements, but cannot afford a payment of any amount	10%
5	The improvements do not have any benefits to me	4%

One concern with stated preference (SP) surveys (i.e. CVM survey) is hypothetical bias, which leads to differences between actual and hypothetical WTP. Since payment in a typical SP survey is hypothetical, it is likely that hypothetical bias generates WTP estimates that exceed those elicited in a real market or actual payment experiment (Murphy et al., 2005; Loomis, 2011). By comparing hypothetical and real payment experiments, a number of contingent valuation (CV) studies have found that WTP with a hypothetical payment exceeds WTP with a real payment (Champ et al., 1997; Blumenschein et al., 1998; Johannesson et al., 1999; Blumenschein et al., 2001; Champ and Bishop, 2001; Blumenschein et al., 2008; Blomquist et al., 2009; Morrison and Brown, 2009). Possible reasons for the hypothetical bias include an attempt to please the survey interviewers or the expectation that by overstating their WTP, the good or service being valued will be provided and respondents would be able to buy the good in the future (Naald and Cameron, 2011).

To minimize the hypothetical bias, certainty scales have been proposed in the literature on SP methods. In a SP survey, respondents might be uncertain over their choices or their preferences. A reason may be that respondents do not have perfect knowledge about the characteristics of the goods and how the goods would be provided (Li and Mattsson, 1995; Loomis and Ekstrand, 1998). Another possible reason is that respondents may not have sufficient time to evaluate and optimise over their preferences (Cook et al., 2011). The certainty calibration approach suggests including a follow-up question asking respondents how certain they are of their stated answers. In social psychology, it has been shown in experiments that if an individual holding a certain attitude is more certain, it will be more likely that this attitude will translate to behaviour (Fishbein, 1963; Sample and Warland, 1973; Fazio and Zanna, 1978; Fujii and Gärling, 2003). This is consistent with the finding in SP surveys that respondents who voted 'Yes' in the hypothetical setting but had lower stated certainty were more likely to switch to the 'No' option in the real payment setting (Ready et al., 2010). The change in choices of uncertain respondents indicates that respondent uncertainty is related to hypothetical bias. A body of literature has shown that the use of follow-up certainty scales to treat uncertain 'Yes' as 'No' can be effective at eliminating the difference between actual and hypothetical WTP (Champ et al., 1997; Blumenschein et al., 1998; Blumenschein et al., 2001; Champ and Bishop, 2001; Blumenschein et al., 2008; Blomquist et al., 2009; Morrison and Brown, 2009; Ready et al., 2010).

To adjust for the presence of hypothetical bias, this study applied certainty scales allowing respondents to indicate how sure they are that they would actually pay the amount they had indicated. Respondents could express how sure they were by answering to 5-point Likert scale with 1 labelled “very uncertain” and 5 labelled “very certain”. The certainty scale responses were used to switch the uncertain positive WTP to zero WTP. Thus, all positive WTP with the certainty answers of “very uncertain” and “uncertain” were changed to zero WTP. The changes in WTP values could result in the generation of more conservative measures of WTP. With the revision in WTP values, the mean value of the WTP (including zero bids) is about 148,000 VND (~0.09% of annual household income); and the mean value of the WTP (excluding zero bids) is about 282,000 VND (~0.16% of annual household income) (Table 5). Our WTP estimates is similar to the WTP estimates of 0.15% of household income for improving air quality in Ho Chi Minh city (the biggest city of Vietnam) (Ngoc et al., 2015).

Table 5: Willingness-to-pay for improving air quality of Ha Noi city

	Mean	**95% Confidence Interval**
WTP including zero bids (100,000 VND)	1.476	1.196 – 1.756
WTP excluding zero bids (100,000 VND)	2.819	2.425 - 3.213
Ln(WTP)	0.743	0.588 - 0.898

Determinants of WTP estimates were also explored in this study. This examination focused on the positive WTP values of 111 respondents who were certain about their WTP, since the zero bids in this CVM exercise are very likely protest zero bids given the reasons for zero bids reported in Table 4. The dependent variable in our regression model is the logarithmic function of WTP (i.e. lnWTP), because it is expected that the logarithmic transformation would help to convert the WTP data to a normal distribution form.

The model results in Table 6 indicate that *perception of air pollution impacts*, *time on roads*, *education levels* and *household income* have positive effects on respondents’ WTP. It is intuitive that higher levels of impact, which could be related to respondents’ time on roads and be

reflected in respondents' perception, could motivate higher levels of WTP. Higher levels of education and income could indicate better financial ability, which ensure ability of respondents to offer higher levels of payment. The *age* variable has negative effects on respondents' WTP, such that older respondents had lower levels of WTP. The constant is significant and R^2 is about 0.2; this might suggest that there are significant effects of other unobserved variables.

Table 6: Linear regression model for determinants of WTP values

Variables	Coefficient	Standard Error	P-value
Constant	-2.157***	0.715	0.003
Perception of air pollution levels	-0.010	0.081	0.901
Perception of air pollution impacts	0.224**	0.102	0.030
Households with children under 5 years old	0.131	0.161	0.416
Time on roads per day	0.189**	0.080	0.020
Male	0.104	0.149	0.486
Age	-0.011**	0.005	0.039
Years of education	0.065*	0.032	0.050
Household income -Ln(Income)	0.378**	0.166	0.025
Number of observations	111		
R^2	0.214		

5. Conclusions

In this paper, residents' WTP for measures to improve air quality of Ha Noi was estimated. Hanoi residents expressed their strong preferences for three measures for air quality improvements, including: (1) Increase of green spaces; (2) Use of less polluting fuels; (3) Expansion of public transportation. The mean WTP for the implementation of those measures with the aim of improving air quality is 148,000 VND (if including zero bids) and 282,000 VND (if excluding zero bids). These amounts of WTP estimates account for about 0.09 - 0.16% of annual household income, which is of the same order of magnitude as the previous CVM study in Ho Chi Minh city.

In the econometric analysis for determinants of respondents' choices of measures and WTP, most parameters had the expected sign. The respondents' choices appear to be consistent with their characteristics and needs, such as financial affordability, time on roads and their perceived impacts of air pollution. WTP was found to increase in *perception of air pollution impacts, time on roads, education* and *income*. But it was lower for older people. There still appears to be considerable uncertainty causing the zero bids, since most of zero-bid respondents did not believe that the collected money would not be used correctly for reducing air pollution in Ha Noi city. However, the information on residents' preferred measures and WTP for improving air quality would be useful for policy makers in identifying prioritized measures and investing effectively in controlling air pollution given the budget limitation. The match-up of residents needs and well-informed plans will be an important key to success.

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