

## Environmental Policy and Willingness to Pay for Clean Air: A Survey in Hong Kong

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### Abstract

Similar to other large cities in China, the sources of pollution, in Hong Kong, come from both local emissions and emissions from nearby cities in Mainland China. As the public becomes more aware of the issue of air pollution, they are willing to put more effort into protecting the environment. In this paper, the focus is on investigating the correlation between the public willingness to pay and the methods to pay for clean air. Empirical results using data from a survey conducted on randomly selected citizens in Hong Kong cover four main points. Firstly, data revealed that high levels of education and/or household income are associated with high levels of willingness to pay (WTP). Secondly, the more severe the problem of air pollution, the more respondents would be willing to pay electricity companies for clean air. In the third instance, respondents believe that if Government puts a lot of effort into protecting the environment, they would be willing to pay for clean air in the form of a tax. Fourthly, people in Hong Kong felt that the problem of air pollution is severe and that the Government is not putting enough effort in protecting the environment.

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**Keywords:** environmental valuation, air pollution, econometric analysis

### Introduction

The World Bank estimates that China is home to 20 of the world's 30 most polluted cities. In fact the environmental problem in China is a global issue. Similar to other large cities in China, the sources of pollution in Hong Kong come from both local emissions and emissions from nearby cities in Mainland China.

As the public becomes more aware of the issue of air pollution, they are willing to put more effort into protecting the environment. For those who control the allocation of resources, the main concern is the question of how much and in what way the public would be willing to pay for clean air. In this paper, the focus is on investigating the determinants of the public's willingness to pay for clean air under environmental policies of using buses with fewer emissions, ways of producing electricity with less air pollution and buy discharge permits from electricity companies in Mainland China.

Recently, there is a growing literature that relates the willingness to pay (WTP) to environmental issues. For example, Duroy (2005) investigates the determinants of environmental values across countries. Hersch and Viscusi (2005) examine age variations in relation to support for environmental protection policies using WTP data obtained from a sample of over 14,000 respondents to a 1999 Eurobarometer survey. They find that there is a positive WTP to improve the environmental quality in the fishing industry in France. Bulte, Gerking, List and de Zeeuw (2005) find evidence supporting the hypothesis that people are willing to pay significantly more to correct problems caused by humans than those caused by nature.

Dupont (2004) studies the role played in a household by children on choice behaviour related to a household's WTP for environmental goods improvements.

In China as well as in Hong Kong environmental studies dealing with WTP and environmental issues have recently been receiving attention. Hammitt and Zhou (2006) use WTP methods to estimate the economic value of preventing adverse health effects related to air pollution. This is estimated using contingent valuation in three different locations in China. Deng (2006) uses WTP methods to evaluate the magnitude of air pollution from motor vehicles in Beijing. Barnes (1997) investigates the changing environmental values in Hong Kong. Yeung; Smith and McGheea (2003) examine the WTP and the size of health benefits.

The remaining sections of this paper are organised as follows: Section 2 describes the survey employed to collect the empirical data. Section 3 discusses the construction of the empirical models. Section 4 describes and evaluates the empirical results, and Section 5 presents the conclusion.

### **Survey and Statistical Summary**

Data was collected by means of a survey conducted by "Economics and Well-being Research" of Hong Kong Shue Yan University<sup>1</sup> during the first two weeks of October 2006. Three thousand and fifty-five randomly selected respondents were successfully interviewed. The margin of sampling error was estimated to be  $\pm 1.81\%$  at a 95% confidence level.

Since the majority of Hong Kong's population is Chinese speaking, the original questionnaire was written in Chinese.

The questionnaire consisted of two main parts and all answers were ranked on an ordinal scale. The first part collected personal information on the respondents such as gender, marital status, education level, age, and household income. Table 1 reports the distribution of the respondents.

The second part of the questionnaire set a clean air target and asked respondents to indicate their WTP in order to reach this target under different environmental policy scenarios. The clean air target is to reduce by 30% the number of days that roadside air monitoring stations report air pollution indexes (API) of "very high".<sup>2</sup> Questions 1 and 2, of the second part, aimed at finding which methods of payment are preferred by respondents.<sup>3</sup>

The first question asked was "What percentage increase in bus ticket fares would you be willing to pay if bus companies changed to buses that were more environmentally friendly in order to fulfil the clean air target?"

The second question was, "How much sales tax in terms of the percentage of your consumption expenditure would you be willing to pay if the Government subsidized bus companies to change buses to more environmentally-friendly buses in order to fulfil the clean air target?"

Gender		Age		Education		Monthly Household Income	
Male	48.6%	18-24	34.6%	Primary	12.9%	Below \$10,000	24.2%
Female	51.4%	25-34	19.5%	Secondary	31.9%	\$10,000-\$14,999	19.6%
Marital Status		35-44	15.6%	Post-Secondary school or equivalent	14.1%	\$15,000-\$19,999	17.3%
Single	53.4%	45-55	16.5%	University or above	41.1%	\$20,000-\$29,999	18.8%
Married	46.6%	55-65	8.4%			\$30,000 or above	20.1%
		65 or above	5.4%				

Table1: Distribution of the respondents

Table 2 shows that 32.96% of the respondents are not willing to pay a sales tax to fulfill the clean air target, but only 19.84% of the respondents are not willing to pay for a direct increase in bus ticket for the clean air target. Moreover, 4.68% of the respondents are willing to pay for a direct increase in bus ticket of 10% or

above, but only 1.11% of the respondents are willing to pay for a 10% or above of sales tax in terms of the percentage of your consumption expenditure to fulfill the clear air target. It seems that respondents are more willing to pay for a direct increase in bus ticket fares than a sales tax to fulfill the clean air target.

Q1) What percentage increase in bus ticket fares would you be willing to pay if bus companies changed to more environmentally friendly buses in order to fulfil the clean air target?				
1=Not Willing to pay	2=Willing to pay 3% or below	3=Willing to pay 4-6%	4=Willing to pay 7-9%	5=Willing to pay 10% or above
19.84%	44.30%	25.41%	5.76%	4.68%

  

Q2) How much sales tax in terms of the percentage of your consumption expenditure would you be willing to pay if the government subsidized bus companies to change to more environmentally friendly buses in order to fulfil the clean air target?				
1=Not Willing to pay	2=Willing to pay 3% or below	3=Willing to pay 4-6%	4=Willing to pay 7-9%	5=Willing to pay 10% or above
32.96%	44.94%	18.33%	2.65%	1.11%

Table 2 Willingness to pay for bus companies to change to environmentally friendly buses

Questions 3, 4, and 5 of part two intended to determine which method of payment respondents would prefer. They had a choice of a sales tax, buying discharge permits, or a direct raise in electricity fees, if electric power companies were to install more desulfuration devices, or increase the usage of natural gas and wind power.

Consistent with the statistical result reported in Table 2, the result in Table 3 shows that respondents would be more willing to pay for a direct increase in electricity fees rather than the other two options of sales tax or buying discharge permits from nearby cities in order to pay for clean air.

Q3) What percentage increase in electricity fees would you be willing to pay if electric power companies installed more desulfuration devices or increased usage of natural gas and wind power in order to fulfil the clean air target?				
1=Not Willing to pay	2=Willing to pay 3% or below	3=Willing to pay 4-6%	4=Willing to pay 7-9%	5=Willing to pay 10% or above
28.1%	44.4%	22.3%	3.4%	1.8%
Q4) How much would you be willing to pay in terms of the percentage of your consumption expenditure if electric power companies buy discharge permits from electric companies in nearby cities in order to fulfil the clean air target?				
1=Not Willing to pay	2=Willing to pay 3% or below	3=Willing to pay 4-6%	4=Willing to pay 7-9%	5=Willing to pay 10% or above
34.2%	42.9%	18.1%	3.4%	1.4%
Q5) What percentage of sales tax would you be willing to pay in terms of your consumption expenditure if the government subsidized electric power companies to become more environmental friendly in order to fulfil the clean air target?				
1=Not Willing to pay	2=Willing to pay 3% or below	3=Willing to pay 4-6%	4=Willing to pay 7-9%	5=Willing to pay 10% or above
37.6%	43.8%	14.7%	2.8%	1.1%

Table 3: Willingness to pay for electric companies to produce less emissions

Question 6 of part two reviewed the severity of air pollution. The respondents were asked to indicate the severity of air pollution on a scale from 1 to 10, where 1 stands for the least severe, 5 stands for normal, and 10 stands for the most severe level. Table 4 reports the statistical summary. Table 4 shows that the public feels that air pollution is a severe problem with 88.9% of respondents giving a grade of 6 or above in relation

to the severity of air pollution.

Finally, question 7 of part two asked respondents to rate the efforts of the Hong Kong SAR Government in protecting the environment. Table 5 reports the statistical summary and shows that 89.5% of respondents felt that the SAR Government has not done enough or has certainly not done enough to protect the environment.

Grade	1 (least severe)	2	3	4	5 (normal level)	6	7	8	9	10 (most severe)
Severity of Air Pollution	0.49%	0.46%	1.67%	1.83%	6.61%	8.35%	20.20%	27.59%	16.07%	16.73%
Average grade: 7.71 (S.E. =1.73)										

Table 4: Grading the severity of air pollution

	1= Certainly not enough	2=Not enough	3=Enough	4=More than enough
Q7) Do you think the SAR Government has done enough to protect the environment?	22.7%	66.8%	10.0%	0.6%

Table 5: Respondents perception of the efforts of the SAR Government in protecting the environment

The statistical result shows that people in Hong Kong felt that the problem of air pollution is severe and that the government is not putting enough effort into protecting the environment. In terms of willingness to pay, the public tends to be willing to pay directly for increases in fees rather than indirectly through an emission tax or transferable discharge permits. The next task consisted in an investigation of the WTP under different environmental policies.

## The Models

### The ordered probit model

This paper uses the commonly used ordered probit model in order to handle the ordinal scale dependent and independent variables. Berrens, Bohara, Jenkins-Smith and Silva (2003) used the probit model to examine the effect of environmental disclosure requirements on the WTP for residential properties in a borderlands community.

Laplante, Meisner and Wang (2005) examined the Armenian Diaspora's WTP in order to protect Armenia's lakes by using ordered probit models. The general ordered probit model used in this paper is as follows:

$$WTP_{pi} = X_i \beta' + \varepsilon_i \quad (1)$$

Here the dependent variables  $WTP_{pi}$  are the self-reported willingness to pay of individual  $i$  under the mentioned five alternative methods of payment for the clear air target.  $X$  stands for the vector of the determinants,  $\beta$  a vector of the coefficients to be estimated, and  $\varepsilon$  represent independent and identically distributed random variable. Table 6 summarizes the descriptions and notation of the variables.

<b>Dependent Variables (Five methods of payment for the clean air target)</b>	
Variables	Description
$WTPB_{tax}$	the self-reported willingness to pay sales tax to the government in order to subsidize bus companies to become more environmentally friendly
$WTPB_{fee}$	the self-reported willingness to pay higher ticket fares in order for bus companies to become more environmentally friendly
$WTPE_{tax}$	the self-reported willingness to pay sales tax in order for the government to subsidize the electric companies to become more environmentally friendly
$WTPE_{tdp}$	the self-reported willingness to pay for electric companies to buy discharge permits from electric companies in cities near Hong Kong
$WTPE_{fee}$	the self-reported willingness to pay higher electricity fees in order for the electric companies to become more environmentally friendly
<b>Independent variables (Determinants)</b>	
Variables	Description
AIR	grade of air pollution in Hong Kong,
GOV	perception of the SAR Government's efforts to protect the environment,
GENDER	gender,
MARITAL	marital status,
EDU	education,
AGE	Age
INCOME	Monthly household income

Table 6: Notation and Description of the variables

As seen in Miyata (2003) and Greene (2000), the log likelihood function to be maximized is:

$$l(\beta, \gamma) = \sum_i^n \sum_j^5 \log(\Pr(WTP_{Pi}|X_i, \beta, \gamma)) \cdot l(WTP_{Pi} = j) \quad (2)$$

Where  $\gamma$  represents the limits of the dependent variables. It is worth mentioning that the magnitude of the coefficient  $\beta$  does not reveal the direct effect of the independent variables  $X'_i$  on the dependent variable. The estimated coefficients  $\beta$  only influence the conditional probability that a certain value of the dependent variable will appear. A positive estimated coefficient indicates that an increase in the ordinal scale of the independent variable influences the dependent variable in such a way that the conditional probability of the dependent variable falling into a higher ordinal scale increases while the opposite happens in the case of a negative estimated coefficient (See Boccaletti and Moro, 2000, Rivera, 2001).

## Empirical Results

Table 7 reports the determinants that are significantly different from zero at a 5% significance level. The variables education and household income appear to be determinants of all self-reported WTP independent variables for clean air. The positive coefficients show that high levels of education and/or household income are associated with high levels of WTP. In addition, education exhibits the largest coefficients in all models (1.1 to 2.3) in comparison to the coefficients of other determinants. This implies that education exhibits the highest influence on the independent variable of WTP for clean air in the form of increasing bus fares in comparison to other methods of paying for clean air. In Table 7, models 1.1 and 1.2 summarize the empirical result for the willingness to pay for using buses with less emission. Model 1.1 shows that, apart from education and monthly household income, the level of WTP in terms of increasing bus fares also depends on gender.

Models	1.1	1.2	2.1	2.2	2.3
Dependent Variable	<i>WTPBfee</i>	<i>WTPBtax</i>	<i>WTPEfee</i>	<i>WTPEtdp</i>	<i>WTPEtax</i>
Determinants	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
AGE	-	-	-	-	-0.0545** (0.0159)
AIR	-	-	0.0353** (0.0117)	0.0240** (0.0117)	0.0279** (0.0122)
EDU	0.2064** (0.0186)	0.1374** (0.0214)	0.2098** (0.0191)	0.1890** (0.0192)	0.1339** (0.0229)
GENDER	-0.0831** (0.0389)	-	-	-	-
GOV	-	-	-	-	0.0706** (0.0358)
INCOME	0.0668** (0.0074)	0.0616** (0.0077)	0.0573** (0.0075)	0.0471** (0.0076)	0.0545** (0.0077)
MARITAL	-	-0.1953** (0.0411)	-	-	-

Note:

1. \*\* means significantly different from zero at a 5% significance level
2. ( ) presents the standard error

Table 7: Determinants of the self-reported willingness to pay under the five methods of payment for the clean air target

The negative coefficient of the determinant gender implies that females are less willing to pay for clean air in comparison to males. Model 1.2 shows that, apart from education and household income, marital status exhibits a significant coefficient. The negative coefficient for marital status implies that married respondents are less willing to pay for clean air in the form of sale tax for the government to subsidize more environmentally friendly bus companies.

Table 7, models 2.1 to 2.3, summarize the empirical results of the willingness to pay for the electricity companies to reduce emissions. Apart from education and household income, the grading of air pollution is also significantly different from zero at all conventionally significant levels in models 2.1 to 2.3. This implies that when the respondents consider paying the electricity company for clean air, they also consider the seriousness of air pollution. The positive coefficient indicates that the higher the grading given to air pollution, the more respondents are willing to pay to electricity companies for clean air. Model 2.2 exhibits similar results to those of model 2.1, using education, household income, and air pollution grades as determinants, however, all coefficients in model 2.2 are smaller than those present in model 2.1. This implies that the influence of the determinants on WTP in the case of increasing electricity fees is larger than that of the WTP in electricity companies to buy emissions discharge permits from electric companies in Mainland China cities near Hong Kong. Model 2.3 shows that apart from education, household income, and air pollution grade, age, and perception of the SAR Government's efforts to protect the environment also exhibit significant coefficients. The negative significant coefficient for the variable age indicates that, the conditional probability for elder respondents to be willing to pay for clean air in the form of a sales tax to subsidize the electricity companies reduces. Moreover, the positive significant coefficient of the government's efforts to protect the environment indicates that if the respondents believe that the government has put a lot of effort into protecting the environment, they will be willing to pay for clean air in the form of an emission tax.

## Conclusion

This paper focuses on an investigation into the determinants of the willingness to pay for clean air under the environmental policies of using buses with less emissions and methods of producing electricity with less air pollution. Education and household income of respondents appear to be determinants of all self-reported WTP independent variables for clean air. The positive coefficients show that high levels of education and/or household income are associated with high levels of WTP. In addition, education exhibits the highest influence on the independent variable willingness to pay for clean air in all form of environmental policies. It is predicted, on these empirical results, that as the income level of Hong Kong increases and the population attains higher levels of education, the people of Hong Kong will be willing to pay more for clean air in the future. Since the major population group in Hong Kong is Chinese, the empirical results indicate that as the income level of major cities in China catches up with Hong Kong and as China's education levels also increase, people in major cities in China will be willing to pay more for clean air. In addition, Hong Kong is a wealthy place, the empirical results also indicate that the public in other wealthy countries would be willing to pay to buy discharge permits in China.

The grading of air pollution is significant for all environmental policies involving electricity companies. Therefore, as the problem of air pollution increases in importance we can predict that the public in Hong Kong, perhaps the same for other wealthy countries, will be willing to pay more to obtain clean electricity. In addition, the empirical results show that if the Government puts more effort in protecting the environment, people in Hong Kong will be willing to pay for clean air in the form of an emission tax. Similar predictions can apply to major cities in China given that by the time the public perceives the severity of air pollution and/or the Government contributes more to protect the environment, the people in major cities in China will also be willing to pay more for clean air.

## Notes

1. "Economic and Well-being Research" project is a study of the views of the general public concerning the economic well-being of Hong Kong. Surveys are undertaken each year with the help of students of Hong Kong Shue Yan University.
2. The health implications of the "very high" air pollution index are "people with existing heart or respiratory illnesses may notice mild aggravation of their health conditions. Generally healthy individuals may also notice some discomfort". (Sources: Environmental Protection Department, API and You)
3. In Hong Kong, there is no sales tax, but the government is calling for a consultation of the public to launch a general sales tax (GST). To promote the GST, the government imposes the aspects of using the GST to finance environmental protection projects, such as projects to reduce air pollution.

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