Available online at www.sciencedirect.com

SCIENCE DIRECT

Science of the Total Environment 367 (2006) 50 – 57

Science of the Total Environment
An International Journal for Scientific Research into the Environment and its Relationship with Humankind

www.elsevier.com/locate/scitotenv

Willingness to pay for reducing fatal risk by improving air quality: A contingent valuation study in Chongqing, China

Hong Wang [a,*], John Mullahy [b]

[a] Global Health Division, Department of Epidemiology and Public Health, Yale University, 60 College Street, Suite 315, P.O. Box 208034, New Haven, CT 06520-8034, USA

[b] Department of Population Health Science, University of Wisconsin Medical School, 610 N. Walnut Street, Suite 707, Madison, WI 53705-2397, USA

Received 29 September 2005; received in revised form 20 February 2006; accepted 24 February 2006
Available online 3 April 2006

Abstract

In China, 76% of all energy comes from coal consumption, which is the major cause of air pollution. One of the major barriers to developing sound policies for controlling air pollution is the lack of information related to the value of the health consequences of air pollution. We conducted a willingness-to-pay (WTP) study using contingent valuation (CV) methods in Chongqing, China to estimate the economic value of saving one statistical life through improving air quality.

A sample of 500 residents was chosen based on multistage sampling methods. A face-to-face household interview was conducted using a series of hypothetical, open-ended scenarios followed by bidding game questions designed to elicit the respondents' WTP for air pollution reduction. The Two-Part Model was used for estimations.

The results show that 96% of respondents were able to express their WTP. Their mean annual income is $490. Their WTP to save one statistical life is $34,458. Marginal increases for saving one statistical life is $240 with 1 year age increase, $14,434 with 100 yuan monthly income increase, and $1590 with 1 year education increase. Unlike developed country, clean air may still be considered as a "luxury" good in China based on the estimation of income elasticity.

Keywords: Willingness-to-pay; Contingent valuation; Air quality; Environmental health; Economic evaluation; China

1. Introduction

In the past two decades, China has experienced dramatic economic development. The gross domestic product (GDP) per capita at comparable price increased from 441 yuan (53.3 US dollars; 1 US dollar = 8.3 Chinese yuan) in 1980 to 6459 yuan (781 US dollars) in 1998, a more than fourteen-fold increase (National Bureau of Statistics, 1999). Along with this economic growth, the demand for the energy has steadily increased. Total energy consumption increased from 637 million tons of Standard Coal Equivalent (SCE) in 1980 to 1240 million tons of SCE in 1998, a 1.9-fold increase (National Bureau of Statistics, 1999). While people are beginning to use cleaner sources of energy, such as oil, natural gas, and hydropower in order to protect the environment, coal is still the major source of energy. As a percentage of total energy consumption, the

* Corresponding author. Tel.: +1 203 785 6230; fax: +1 203 785 6193.
E-mail address: hong.wang@yale.edu (H. Wang).

0048-9697/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.scitotenv.2006.02.049

share of coal consumption increased slightly from 69.4% in 1980 to 72.0% in 1998 (National Bureau of Statistics, 1999). Coal consumption is still the major source of air pollution. About 62% of total smoke and dust emissions and 95% of sulfur dioxide (SO_2) come from coal combustion (Ni and Sze, 1998). A report released in 1998 by the World Health Organization (WHO) noted that seven of the ten most polluted cities in the world can be found in China (Green Nature, 2004). Controlling air pollution due to coal combustion is one of the major environmental issues in China.

The impact of air pollution on health has been studied in the past 10 years in China (Xu, 1994; Xu et al., 1995; Zhou, 1997; Xu, 1998; Zhang, 1999; Xu et al., 2000). It is estimated that if China met class 2 air quality standards in urban areas, about 178,000 premature deaths, 346,000 respiratory hospital admissions, and 6,779,000 emergency room visits could be avoided each year (The World Bank, 1997). While people realize the biological impact of air pollution on health status, very few studies have attempted to estimate the economic valuation of this impact in China.

There are two major approaches to estimating the value of the health impact of air pollution: the human capital approach and the willingness-to-pay (WTP) approach (The World Bank, 1997). The human capital approach values mortality and morbidity impacts simply as lost productivity as is estimated by discounted lost wages plus medical expenditures (Hara and Stieb, 1995). Based on this approach, the typical value of a statistical life used by Chinese social scientists is about 70,000 yuan (The World Bank, 1997), which is about 8433 US dollars. Although the human capital approach is convenient for estimating, it does not capture the value of health itself.

Contingency valuation (CV), one of WTP approaches, is frequently used and is considered a more appropriate method for evaluating the no-market value of goods such as health status and human life (Hanemann, 1994; Portney, 1994; Boardman et al., 1996). Since no known WTP survey has been carried out in China, the value of a statistical life in China was estimated based on the conversion from the US estimation (about $3,000,000 per statistical life) using the U.S./China rate of purchasing power parity or daily wage. The results of these estimations are about $24,000 to $60,000 per statistical life (Well et al., 1994; The World Bank, 1997).

The immediate objectives of this study are to estimate the WTP for reducing the risk of fatality due to air pollution and the value of a Chinese statistic life by CV methods. This study also examines the associations between WTP and its determinants, and explores the feasibility of the application of CV methods in China. We also expect the results from this study could provide evidence to convince researchers and decision-makers to select better air pollution control projects and programs.

This paper is divided into five sections. Section 2 is devoted to the study design issues, such as sampling, the survey and questionnaires and the analytical models. Section 3 presents the results of the estimation of the value of a statistical life and its determinants. The discussions and policy implications appear in Section 4. The final section contains some concluding remarks.

2. Study design

2.1. Study site description

One of criticism of the CV method is that the respondents may not be familiar with the scenarios described in CV questions, and as such respondents' preferences are not well-defined with the respect to the issues described (Diamond and Hausman, 1994). For this study, we selected one of most polluted cities in China, Chongqing, as our study site.

Chongqing is located in the northeast of Sichuan province. The area of this city is about 23,000 km^2 and the population is about 15 million. As in other parts of China, coal consumption is the major energy source, and accounts for about 62.5% of total energy consumption. It is one of the most polluted cities in China; from 1981 to 1996, SO_2 emissions were about 800,000 tons, and TSP emissions about 200,000 tons per year. The daily concentration of SO_2 reached to 0.26–0.49 mg/m^3, which is 3–7 times higher than the class 2 national standard of air quality (0.06 mg/m^3) (Ni et al., 1998).

2.2. Sampling and data collection

The household interview was conducted in March 1998. We selected 500 residents aged 15 to 80 years old from Chongqing based on multistage sampling methods. Among these residents, half of them were from two highly polluted districts, and others were from two less polluted districts. Two residential streets in each of the four selected districts were identified as the sample areas. Systematic sampling methods were used at the final stage to select households and residents who were at home at the time of the interview. The household interview was arranged in the evening from 6–9 P.M. in order to reduce the number of people who were not at home at the time of the interview. Ten senior students from Chongqing Medical School were recruited as interviewers.

2.3. CV questionnaires

As in many other CV studies, this study included three kinds of questions: the CV questions, the respondent's background questions, and validity checking questions (Portney, 1994).

The method of elicitation used in this study is an open-ended question backed by a bidding game. This method was adopted by Jones-Lee to determine UK citizens' WTP for traffic safety in 1985 (Jones-Lee et al., 1985). The CV questions start with a scenario description that directly asks respondents' WTP for reducing air pollution. This scenario is described as follows:

> Assume that the Chongqing Government is thinking of implementing a new city program to reduce air pollution. It is expected to cut one quarter of premature deaths due to air pollution, i.e. the mortality due to air pollution will be reduced from 20 / 100,000 to 15 / 100,000 per year. The number of non-fatal air pollution related health problems would not be affected by the program. In order to implement this program, the government has to collect a special fee to cover its cost.

A visual card was presented to the respondents by the interviewers when they describe the scenario to the respondents in order to assist the respondents to understand the magnitude of the probability and the change of the probability.

Following the description of the scenario, the respondents were, in the first instance, asked directly and without prompting how much the maximum amount they would like to pay to support this program. If the respondents hesitated to give an amount, the interviewer was instructed to read out a series of figures as the potential of WTP, starting with 1, 2, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 80, 100, 200, 500, 1000, 2000, and so on (yuan). When the respondent stopped the interviewer, the interviewer asked at which number the respondents stop him/her to confirm the amount of WTP.

The background and validity checking questions used in this study are listed in Table 1. These variables include the respondent's demographic characteristics, his/her socio-economic status (SES), his/her health status and health behaviors, the air pollution status of their resident areas from both objective and subjective perspectives, and their understanding to the CV questions.

2.4. Analytical models

The estimation method used in this study is the two-part model utilized by the RAND Cooperation for the RAND Health Insurance Experiments (Duan et al., 1983). The first part of this model estimates the probability of any positive WTP, and the second part estimates the level of WTP of the respondents with positive WTP.

A probit model was used for the estimation of the probability of a person having any positive WTP. Since the bid in biding game questions is not a continuous amount of WTP, and the responses of the respondents

Table 1
Descriptive table for independent variables

Variables	Description	Mean	S.D.
Age	Respondents' current age	48	17
Agesq	Age square	2531	1649
Gender	Male = 1, Female = 0	0.502	0.501
Marriage	Married = 1, Others = 0	0.824	0.382
Fsize	Number of family members lived in same house	3.082	1.386
Education	Number of years of education	9.336	4.789
Income	Income per month per person (100 yuan)	3.422	2.625
Incomesq	Income square	18.69	49.82
Employment	Being employed in the formal sectors = 1, others = 0	0.506	0.494
Chronic disease	Having diagnosed chronic disease = 1, others = 0	0.288	0.453
Visit	Visited clinics or hospitals in last 2 weeks = 1, others = 0	0.222	0.416
Smokers	Smoking more than two packs in a week = 1, others = 0	0.243	0.429
Alcohol consumers	Currently alcohol consumers = 1, others = 0	0.237	0.425
Exercisers	Currently active exerciser = 1, others = 0	0.299	0.457
Location	Living in a severely polluted area = 1, others = 0	0.479	0.500
Pollution	Self-reported living in a severely polluted area = 1, others = 0	0.529	0.496
Questions	Person who answered open-ended question = 1, others = 0	0.625	0.483
P-understand	Understanding probability change in questionnaires = 1, others = 0	0.702	0.454
M-understand	Understanding money contribution in questionnaires = 1, others = 0	0.691	0.460

who entered the bidding game questions are the low boundary of the bided WTP interval, interval regression was used for the estimation of the amount of WTP conditional on having a positive WTP. Total expected WTP is equal to the product of probability of positive WTP and expected WTP conditional on the respondents with positive WTP.

Part I: Prob(WTP > 0) = *f*(Age, Sex, Education, Income, …)
Part II: (WTP | WTP > 0) = *f*(Age, Sex, Education, Income, …)
Total WTP: *E*[WTP] = Prob(WTP > 0) × *E*[WTP | WTP > 0].

After construction of the probability and the amount of WTP models described above, a “recycling” prediction method is used to predict the WTP for saving a statistical life and the marginal effects of selected factors on WTP for saving a statistical life with the assumption of all other variables being fixed (Stata Corporation, 2003).

3. Results

Of the 500 sampled respondents, 482 (96.4%) of them answered WTP questions. 299 out of 482 respondents (62.0%) gave their sum amount of WTP when they faced open-ended question after scenario description. 183 out of 482 respondents (38.0%) hesitated to answer open-ended questions and enter the bidding game questions. Among the respondents who answered the WTP questions, 22.0% of them provided zero value of WTP for the air pollution program. The respondents’ characteristics are listed in Table 1.

3.1. The determinants of WTP

3.1.1. The determinants of the probability of having positive WTP for reducing air pollution

The probabilities of people having a positive WTP were estimated by probit models. A sequence of probit models was estimated in order to observe the effects of endogenous variables. Table 2 presented the results of these calculations.

In the first model, only exogenous variables have been included. The results show that age has a negative relationship with the probability of positive WTP, which means that as age increases, people’s probability of having any WTP on reduction of air pollution decreased. Not surprisingly, income has a positive relationship with the probability of positive WTP. Although education has a positive relationship with the probability of any WTP, it is not statistically significant.

As expected, people who believe that they live in a severely polluted area tend to have a higher probability

Table 2
Probit model for the people who has positive WTP, *N* = 482

Variables	Model 1		Model 2		Model 3	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Age	−0.077	0.033*	−0.090	0.034**	−0.098	0.036**
Agesq	0.001	0.000*	0.001	0.000*	0.001	0.000*
Gender	0.139	0.153	−0.116	0.196	−0.250	0.210
Marriage	0.339	0.217	0.418	0.227	0.521	0.240*
Fsize	−0.153	0.055**	−0.159	0.055**	−0.192	0.057**
Education	0.044	0.023	0.042	0.024	0.031	0.025
Income	0.191	0.158**	0.173	0.171*	0.086	0.190**
Incomesq	0.001	0.021**	0.003	0.023*	0.014	0.026**
Chronic	0.168	0.183	−0.059	0.200	−0.023	0.207
Location	−0.294	0.160	−0.262	0.164	−0.154	0.172
Pollution	0.523	0.159**	0.493	0.163**	0.330	0.172
Questions	−1.333	0.199**	−1.332	0.202**	−1.429	0.222**
Works			−0.049	0.207	−0.076	0.215
Visit			0.726	0.242**	0.732	0.250**
Smokers			0.409	0.225	0.408	0.234
Alcohol consumers			0.154	0.217	0.172	0.223
Exercisers			0.214	0.185	0.158	0.192
P-understand					0.274	0.197
M-understand					0.777	0.189**
Pseudo R^2	0.2643		0.2953		0.3539	

* $P \leq 0.05$.
** $P \leq 0.01$.

of having positive WTP. People who respond to the open-ended questions tend to have a lower probability of having any WTP than the people who enter the bidding game questions. The results also show that the probability of having any WTP was negatively related to family size, with larger family size associated with a lower probability of having positive WTP. In addition, medical care visits displayed a positive relationship with the probability of any WTP, which is also consistent with expectations.

These results were not affected by adding some choice variable as regressors in the second model. These choice variables were considered endogenous variables and may affect the results of the estimations.

In the final probit model, two self-assessed understanding variables were included. While these two variables have relative little impact on the relationship between age, income, education and probability of any WTP, the significant relationship between self-assessed pollution status and the probability of positive WTP disappears when they are included.

3.1.2. The determinants of amount of WTP conditional on the people with positive WTP

As above, a set of interval regressions were calculated to examine the effects of endogenous variables on the results. The results of the first regression indicate that unlike the results of the probability model, age has positive relationship with the amount of WTP, although this relationship is not statistically significant. Education and income display positive relationships with WTP, which means higher educated or higher income people are more willing to contribute for air pollution reduction. The results also showed that people who lived in more polluted areas are willing to pay more for clean air. Unlike the results from the probability analysis, in this model people from a larger family tend to have higher WTP to control air pollution (Table 3).

The results from the second and third regressions showed that the choice variables have little impact on the estimation results from the first regression, although the age effect turned out to be significant, and the education effect turned out to be insignificant after adding the two understanding variables in the third regression.

3.2. The estimation of WTP

Since the distribution of WTP is skewed, we used median estimate to represent the average value of WTP. Bootstrap method with 1000 replications has been used to estimate the confidence interval (Wu, 1986). Table 4 lists the median predicted WTP results based on the two-part model (model 3). The average person's WTP for air pollution control is 14.3 Chinese yuan per person per year. The average WTP for saving a statistical life is 286,000 Chinese yuan, which is about 34,458 US dollars.

Table 3
Interval regression model conditional on people with positive WTP, $N=376$

Variables	Regression 1		Regression 2		Regression 3	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Age	0.066	0.030	0.059	0.031	0.055	0.030*
Agesq	−0.001	0.000	−0.001	0.000	0.000	0.000*
Gender	−0.022	0.141	−0.010	0.179	−0.072	0.177
Marriage	0.295	0.202	0.259	0.203	0.271	0.200
Fsize	0.183	0.068**	0.203	0.069**	0.180	0.068**
Education	0.046	0.021*	0.046	0.021*	0.036	0.021
Income	0.409	0.061**	0.405	0.063**	0.379	0.062**
Incomesq	−0.011	0.003**	−0.011	0.003**	−0.010	0.003**
Chronic	−0.099	0.175	−0.145	0.193	−0.117	0.190
Location	0.409	0.140**	0.438	0.141**	0.502	0.140**
Pollution	0.257	0.142	0.263	0.142	0.217	0.140
Questions	0.777	0.143**	0.759	0.143**	0.780	0.141**
Works			0.166	0.197	0.165	0.194
Visit			0.279	0.182	0.239	0.180
Smokers			0.093	0.191	0.070	0.187
Alcohol consumers			−0.166	0.187	−0.085	0.185
Exercisers			−0.174	0.162	−0.183	0.160
P-understand					0.499	0.185**
M-understand					0.237	0.171

* $P \leq 0.05$.
** $P \leq 0.01$.

Table 4
Prediction results of the WTP for saving a statistical life

Variables	Median	95% CI	
Average WTP per person (Chinese yuan)	14.3	12.7	15.9
Average WTP for saving a statistical life (Chinese yuan)	286,000	254,000	318,000
Average WTP for saving a statistical life (U.S. dollar)	34,458	30,602	38,313

3.3. The marginal effects of WTP

Table 5 lists the results of the marginal effects of some key determinants on WTP on saving a statistical life based on the estimation in model 3. These effects combined the joint effect of indicators on both the probability of having a positive WTP and the level of WTP of those who have a positive WTP. The results show that if age increase by 1 year, the WTP per person will increase 0.1 Chinese yuan. The marginal increase for saving a statistical life is 2000 yuan, which is about 240 US dollars. With an income increase of 100 Chinese yuan per month, the WTP per person will increase 6 Chinese yuan. The marginal increase for saving a statistical life is 119,800 Chinese yuan, which is about 14,434 US dollars. With an education increase of 1 year, the WTP per person increased 0.66 Chinese yuan. The marginal increase for saving a statistical life is 13,200 Chinese yuan, which is about 1590 US dollars.

4. Discussion and conclusion

Contingent valuation (CV) has been in use for over 35 years, and there are now over 2000 papers and studies dealing with the topic (Carson, 2000). However, most of these studies have been carried out in developed countries. Until the last 10 years, many researchers thought that CV could not be done in developing countries since CV methods associated with posing hypothetical questions to low-income, perhaps illiterate respondents were assumed to be so overwhelming that one should not even try (Whittington, 1998).

The results of our study showed that the CV method is feasible in urban China. This study was conducted in Chongqing, one of the largest cities in China. The average annual income in that region is about $490.00 per capita. The average education is about 9 years, which is middle school level. The response rate for the WTP questions was 96.4% (482/500). With the help of a visual card, over 70% respondents felt that they understood the questions about probability and money values.

The validity of the CV method for estimation of WTP is more difficult because there is no “true” value for WTP to compare with. One alternative way of checking the validity is to compare these study results with the results of other studies. The results of this study showed that the WTP for saving a statistical life is about 286,000 Chinese yuan, which is about 34,458 US dollars. This result falls in between of two World Bank studies that estimated the value of a Chinese statistical life compared to a statistical life in the USA. U.S. CV estimations and the U.S./China rate of purchasing power parity and daily wage were considered in these calculations.

Compared to the value of 70,000 Chinese yuan, which derived from the human capital approach, the WTP value from this CV study is 4 times higher. This result is very close to, but lower than, the results of studies carried out in the United States. In the United States, the value of a statistical life estimated by CV methods is typically 5 to 10 times higher than the value of forgone earnings estimated by the human capital approach (World Bank Group, 1998).

Another test of validity is to check whether WTP is significantly related to income (Johannesson et al., 1991); a person’s willingness to pay is clearly limited by his or her ability to pay. The results of this study showed that both the probability of positive WTP and level of WTP are positively related with income levels. Income elasticity is about 1.42. This figure is much larger than that in developed countries (Biddle and Zarkin, 1988; Viscusi and Evens, 1990; Diamond and Hausman, 1994). This result suggests that, unlike developed

Table 5
Marginal effects of selected factors on WTP for saving a statistical life

Variables	Median	95% CI	
Marginal effects on WTP of an individual (Chinese yuan)			
Age (per year)	0.10	0.08	0.12
Income (100 yuan)	5.99	5.43	6.61
Education (per year)	0.66	0.59	0.74
Marginal effects on WTP for saving a statistical life (Chinese yuan)			
Age (per year)	2000	1600	2400
Income (100 yuan)	119,800	108,600	132,200
Education (per year)	13,200	11,800	14,800
Marginal effects on WTP for saving a statistical life (US dollars)			
Age (per year)	241	193	289
Income (100 yuan)	14,434	13,084	15,928
Education (per year)	1590	1422	1783

countries, clean air may still be considered a “luxury” good among the Chinese population.

Although this study demonstrated reasonable results, the findings with respect to WTP should be interpreted with caution. We recognize that our results are based on a relatively small sample. There is potential sample selection bias in the last step of sample selection since respondents who were at home at the time of the home interview might not represent the population that was not at home at the time of the interviews. Anchoring–Adjustment bias could be another issue that influences the results of this study (Stalhammar, 1996; Bosch et al., 1998). Other CV methods, such as discrete-choice methods (Bosch et al., 1998; Smith, 2000), would be alternative approaches to reduce this bias in future studies. Furthermore, we should be aware that the WTP based on CV method might not be the same as actual mean WTP (Boardman et al., 1996; Carlson, 2000).

Investment in air pollution control is expensive. Health improvements are often cited as the major justification for such investments. Consequently, one of the more troublesome problems, both practically and ethically, facing policy makers is that of placing value on the health impacts of pollution. The economic valuation of health impacts from air pollution is a rapidly evolving field that demonstrates the potential for using economic analysis of health outcomes to help identify priority environmental problems, and efficiently target investments in pollution control. This study is the first known CV study that relates to the issue of air pollution in China. More studies with alternative methods should be done in order to confirm the findings of this study for better economic valuation and, therefore, better environmental policy.

Acknowledgements

The authors would like to thank professors Lihua Wang, Ruicong Peng, and James Hammitt who provided timely, insightful comments and suggestions for this research. The authors also wish to acknowledge the cooperation of Dr. Dafang Chen and colleagues from Chongqing Health Prevention Institute for the support on field works.

This study was funded by the V. Kann Rasmussen Foundation, as part of the China Project of the Harvard University Center for the Environment.

References

Biddle JE, Zarkin GA. Worker preferences and market compensation for job risk. Rev Econ Stat 1988;70(4):660–6.

Boardman AE, Green DH, Vining AR, Weimer DL. Contingent valuation: using surveys to elicit information about costs and benefits. In: Boardman AE, Green DH, Vining AR, Weimer DL, editors. Cost–benefit analysis: concepts and practice. Upper Saddle River (NJ): Prentice Hall; 1996. p. 345–76.

Bosch JL, Hammitt JK, Weinstein MC, Hunink MGM. Estimating general-population utilities using one binary-gamble question per respondent. Med Decis Mak 1998;18:381–90.

Carlson JL. Hypothetical surveys versus real commitments: further evidence. Appl Econ Lett 2000;7:447–50.

Carson RT. Contingent valuation: a user’s guide. Environ Sci Technol 2000;34(8):1413–8.

Diamond PA, Hausman JA. Contingent valuation: is some number better than no number. J Econ Perspect 1994;8(4):45–64.

Duan N, Manning WG, et al. A comparison of alternative models for the demand for medical care. J. Bus. Econ. Stat. 1983;1(2):115–26.

Green Nature. Air pollution in China. Green nature; 2004. http://greennature.com/article354.html, Feb. 8.

Hanemann WM. Valuing the environmental through contingent valuation. J Econ Perspect 1994;8(4):19–43.

Hara A. Review of methods for valuing human injury and lost productivity under changes in air quality. Ottawa: Health Canada; 1995.

Johannesson M, Jonsson B, Gorgquist M. Willingness to pay for an antihypertensive therapy – results of a Swedish pilot study. J Health Econ 1991;10:461–74.

Jones-Lee MW, Hammerton M, Philips PR. The value of safety: results of a national sample survey. Econ J 1985;95(377):49–72.

National Bureau of Statistics. China statistical yearbook 1998. Beijing: China Statistics Press; 1999.

Ni W, Sze ND. Energy supply and development in China. In: McElroy MB, Nielson CP, Lydon P, editors. Energizing China: reconciling environmental protection and economic growth. Newton (MA): Harvard University Press; 1998. p. 67–117.

Ni W, Li D, Zheng H. Provincial-level countermeasure research of sulfur dioxide and carbon dioxide mitigation. Beijing: Tsinghua University; 1998.

Portney PR. The contingent valuation debate: why economists should care. J Econ Perspect 1994;8(4):3–17.

Smith RD. The discrete-choice willingness-to-pay question format in health economics: should we adopt environmental guidelines? Med Decis Mak 2000;20(2):194–206.

Stalhammar NO. An empirical note on willingness to pay and starting-point bias. Med Decis Mak 1996;16(3):242–7.

Stata Corporation. Stata base reference manual volume 2, G-M, Release 8.0. College Station (TX): Stata Corporation; 2003. p. 513.

The World Bank. Clear water, blue skies: China’s environment in the new century. Washington (DC): The World Bank; 1997.

Viscusi WK, Evens WN. Utility functions that depend on health status: estimates and economic implications. Am Econ Rev 1990;80(3):353–75.

Well GJ, Xu X, Johnson TM. Valuing the health effects of air pollution: application to industrial energy efficiency projects in China. Washington (DC): The World Bank; 1994.

Whittington D. Administering contingent valuation surveys in developing counties. World Dev 1998;26(1):21–30.

World Bank Group. The effects of pollution on health: the economic toll. Pollution prevention and abatement handbook. Washington (DC): The World Bank; 1998. p. 63–71.

Wu CFJ. Jackknife, bootstrap and other resampling methods in regression analysis. Ann Stat 1986;14(4):1261–95.

Xu X. Air pollution and daily mortality in residential areas of Beijing, China. Arch Environ Health 1994;49(4):216–22.

Xu X. Air pollution and its health effects in urban China. In: McElroy MB, Nielson CP, Lydon P, editors. Energizing China: reconciling environmental protection and economic growth. Newton (MA): Harvard University; 1998. p. 267–85.

Xu X, Li B, Huang H. Air pollution and unscheduled hospital outpatient and emergency room visits. Environ Health Perspect 1995;103(3):286–9.

Xu ZY, Liu YQ, Yu DQ. Air pollution and daily mortality in Shenyang, China. Arch Environ Health 2000;55(2):115–20.

Zhang J. Effects of air pollution on respiratory health of adults in three Chinese cities. Arch Environ Health 1999;54(6):373–82.

Zhou YR. Association between air pollution and hospital admissions in Chongqing. J. Mod Prev Med 1997;24(1):43–5.