CONTINGENT VALUATON AND THE ECONOMIC VALUE OF AIR-POLLUTION-RELATED HEALTH RISKS IN CHINA

Xiaoqi Guo

Department of Agricultural, Environmental and Development Economics, Ohio State University. Ag. Admin. Bldg., 2120 Fyffe Road, Columbus, OH 43210 USA. Tel: 614-292-9346. E-mail: guo.63@osu.edu

Timothy C. Haab

Department of Agricultural, Environmental and Development Economics, Ohio State University. Ag. Admin. Bldg., 2120 Fyffe Road, Columbus, OH 43210 USA

James K. Hammitt

Harvard University, Center for Risk Analysis, 718 Huntington Avenue, Boston, MA 02115 USA.

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The Contingent Valuation (CV) method uses survey questions to ask respondents to directly value the good or service of interest in a hypothetical market. A CV survey usually has three main parts. The first part is a detailed description of the good being valued and the hypothetical market in which the good is provided to the respondents. The second part is the core part in a CV survey: the Willingness-to-Pay (WTP) or Willingness-to-Accept (WTA) question. The third part usually asks demographic questions and debriefing questions to respondents.

The CV method is very flexible as researchers can construct a hypothetical market with a desired provision structure and payment vehicle for a very wide range of public or private goods. The goods that have been valued by the CV method include environmental amenities, resources, new private commodities and health risks. The limitation of the CV method is the hypothetical nature of the CV survey; people's stated preferences may deviate from their true preferences because of the hypothetical scenario. Therefore, despite its apparent simplicity, CV requires the researcher to make multiple decisions to ensure valid and reliable responses from survey subjects.

In this article, a CV survey study conducted in China to elicit people's WTP for health risk reductions of asthma and mortality is reported. Two important issues of the stated valuation method are discussed: (1) the potential impact of the provision mechanisms of the good to be valued-private provision mechanism and public provision mechanism-to people's WTP. Since health care could be either privately provided or publicly provided, it is important for researchers to know whether the provision mechanisms would affect people's WTP for the same health risk reduction; (2) the

scope/scale effects of the CV survey are discussed and tested empirically. At last, the value of a statistical life (VSL) and the value of a statistical case of asthma are estimated.

Literature Review

Tolley, Kenkel and Fabian (eds., 1994) reviewed some applications of the CV method to health symptoms related to air pollution including the following studies. Loehman et al. (1979) used a mail questionnaire to ask Florida residents their WTP for symptoms associated with sulfur oxides including shortness of breath, chest pain, coughing, sneezing, head congestion, etc. Respondents were asked to value various days of symptom relief. Rowe and Chestnut (1984) estimated the value of a reduction in asthma symptoms, using personal interviews of a group of individuals suffering asthma. They found a mean bid for a 50% reduction (19 days in average) in bad asthma days of $401 per year, with a standard deviation of $85. Viscusi, Magat and Huber (1991) estimated the value of reductions in the risk of chronic bronchitis using a sample from the general population. To communicate the chronic disease effects to potential sufferers, they used an interactive personal-computer program. They found that the mean WTP for one statistical case of chronic bronchitis is about $883,000, with a standard error of $114,000. Similar to this study, my study also value health risk reduction based on a sample from the general population.

Hammitt and Zhou (2006) valued colds, chronic bronchitis and mortality related to air pollution in China using a three-location CV survey for the general population. They asked people's WTP for risk reductions of getting the health effects. They estimated

that the value of a statistical case of cold ranged between $3 and $6, the value of a statistical case of chronic bronchitis ranged between $500 and $1,000, and the value per statistical life ranged between $4200 and $16,900. This study is known as the first well-organized and peer-reviewed CV study on health effects in China. Our study is based on Hammitt and Zhou by using similar WTP question for health risk reduction.

Hypotheses

This section describes three hypotheses to test within this CV study. The first hypothesis to test is on the effect of the private and public provision mechanisms to WTP in the CV survey. The second and third hypotheses are about the scope/scale effect of WTP.

The Private and Public Provision Mechanisms of Health Risk Reduction

Hypothesis 1: the private or public provision mechanism of health risk reduction has no significant effect to people's WTP.

Health risk reduction could be either privately provided as a market good or publicly provided as a government public project/service. In the literature of health risks valuation, CV surveys have asked people's WTP for medicines, treatments, private water line filter installment, automobile safety equipment and other goods aiming to reduce health risks. Health risks can also be valued as public goods in CV surveys, such as medicines to treat infectious diseases, and government projects to reduce health risks. In the real world, health care is an important part of the public provision of private goods in both developed and developing countries. An interesting and important question thus is

whether the different provision mechanisms would affect people's valuation of health risk reduction differently. This question is important because the difference of valuation may result different cost-benefit analysis conclusion and thus result different policy implication. Some theories such as the altruism theory and Andreoni's warm-glow theory suggest that public and private provision mechanisms may result different valuation of people for the same good. However, very few empirical studies have been done to test whether the difference exists. If this difference exists empirically, researchers must be cautious when they use CV survey to reveal people's WTP for certain goods. If the good can be either privately or publicly provided, researchers must make a decision on which provision should be used for the WTP question in the survey. If the difference is not significant, it suggests that the theories predicting the difference may be not consistent with the empiric. In this article, we test empirically whether there are different effects between the private and the public provision mechanisms to people's WTP responses to the same health risk reduction in the CV survey.

According to the traditional theory on stated preference to public goods, it is in the selfish interest of each person to give false signals, to pretend to have less interest in a given collective activity than he really has (Samuelson 1954). However, experiments and real-life evidence are usually against the selfishness assumption. In order to explain the evidence, alternative theories have been proposed. One stream of the theories is the theory of altruism. In economics, altruism means that people gain welfare from utility of others or consumption undertaken by others. An example of empirical studies to investigate the existence of altruistic preferences is Hudson and Jones (1995). They

presented respondents with alternative policies and then asked them which policy they favored, which policy they thought would be in their self-interest, and which policy they considered to be in the public interest. They found the public interest answer was about twice as highly correlated with the favored policy as the self-interest answer. Andreoni and Miller (2002) implemented experiments and categorized subjects' utility into three forms of utility functions-selfish, Leontief and perfect substitutes, where the last two types are altruistic utility functions: both subject's self payoff and other people's payoff enter the utility function. They found that about 47.2% of the subjects behaved strong or weak selfish, about 30.4% of the subjects behaved consistently with strong or weak Leontief preferences, and about 22.4% behaved consistently with strong or week perfect substitutes preferences[1]. From these results, they concluded, first, that it is indeed possible to capture altruistic choices with quasi-concave utility functions for individuals, implying that altruistic choices are consistent with the axioms of revealed preference; secondly, individuals are heterogeneous with a range from selfish preferences to altruistic preferences, and there is not one notion of fairness or inequality-aversion that all people follow. Theoretical studies on altruism include different models of altruism (for example, see Johansson 1997) and the implications of altruism to CV study (Quiggin 1998), to optimal taxes on externality (Johansson 1997) and to cost-benefit analysis (McConnell 1997).

[1] 'Strong' here means that, in the experiment, the individual allocates the token exactly as the selfish, Leontief or the perfect substitute utility function predicts. 'Weak' means that the allocation of the individual has the minimal distance to the choices from one of the three utility functions predicted.

Another theory to explain the absence of free-riding is Andreoni's 'warm glow' theory (1988, 1990). The key point of the 'warm glow' theory is that the amount of an individual's voluntary contribution to a public good enters his utility function twice, once as part of the total amount of the public good to be consumed, and again as a private good. This special form of utility function is arranged to capture the author's explanation to voluntary contribution: it is motivated by the desire for the 'warm glow' of believing that one has done a good deed.

Implied by the altruism theory and the 'warm glow' theory, people might have different valuations to the same good when it is provided as a private good and when it is provided as a public good or quasi-public good; specifically, the public provision may induce higher WTP than the private provision would. Lower WTP to the public provision may also be resulted, if free-riding is not excluded. In the health care case, the private provision offers the reduction of health risk as a private good to the individual himself, whereas the public provision offers the reduction of health risk to everybody impacted by the public health policy. An individual who has altruistic or 'warm glow' incentive thus might be willing to pay more for the publicly provided health risk reduction than the privately provided same risk reduction.

This prediction of different valuation has been seldom tested empirically by experiments or surveys. Crenson (1971) compared community political support for air pollution programs in the 1960s and found that political parties in communities characterized by a 'private-regarding ethos' tended to ignore pollution issues, whereas in communities where a 'public-regarding ethos' prevailed, such issues were likely to reach

an agenda. Mitchell and Carson (1986) observed that, in a pretest of their drinking water risks study, the same respondents gave lower amounts when asked how much they would pay to have a pollution control device installed and maintained in their homes by the city water company than when asked how much they would pay in higher water bills to have the town's water plant install and maintain new equipment that would achieve the same risk reduction, but for everyone in the community. These respondents valued the latter program more because they perceived that it protected others besides themselves. Jones-Lee, Hammerton and Philips (1985) implemented a national CV survey on the value of different morbidity risks. They ask people's WTP on reduction of the risk of car accident by traveling with a safer coach firm, by purchasing additional safety features for private car, and by paying for a public project of road improvement. They found the resulted VSL from the first two questions are much larger than the VSL computed from the last WTP question. However, as they indicated, their public project question introduced unintended ambiguities by failing to clarify the period of validity of the project and the type people's payment (once for all, or repeated annually). Another flaw of this study is that all of these three questions use open-ended formats instead of binary choice format, which might introduce incentive incompatibility.

Besides the theories that imply people's possibly different responses to public and private goods or provision mechanisms, the perceived effectiveness of each provision mechanism is also a very important factor. Respondents may perceive that either the private provision is more effective than the public provision of the health risk reduction, or the public provision is more effective. This perception may be caused by respondents

trust or distrust to the private provider-hospitals and the public provider-municipal government. Respondents thus may have higher WTP to the provision mechanism with higher perceived effectiveness.

Hypothesis 1: the private or public provision mechanism of health risk reduction has no significant effect to people's WTP.To test this hypothesis, in the CV survey, the sample is randomly divided into four sub-samples. For each sub-sample, respondents were told about two same treatments, which would reduce health risks of asthma and mortality respectively. For the first sub-sample, these treatments are described as private goods that respondents can pay to participate in hospitals. Respondents were asked whether they would be willing to pay certain prices for these treatments. For the second sub-sample, respondents were told that the municipal government was planning to organize all residents to participate in these treatments and collect a one-time fee from every resident if the majority of the residents support this program and agree to pay. Respondents were then asked whether they would be willing to pay this fee for this program. For the third sub-sample, respondents were asked the WTP question first with the private provision mechanism and then with the public provision mechanism. For the fourth sub-sample, the order of the WTP questions was reversed to control for the possible ordering effect. The WTP questions are in binary choice/referendum format to rule out free riding. Pooling the responses to the first questions of the third and fourth sub-samples with the first and second sub-samples constructs a between-group test, while comparing each individual's valuation in the third and fourth sub-samples constructs a within-group test. The expected/median WTP of the public provision version might be

greater than, equal to or less than the expected/median WTP of the private provision version. The null hypothesis is that there is no significant difference between them. If this is not rejected, it implies that people's preferences on health risks are stable; altruistic motivation, warm glow or other factors do not have significant impacts on people's valuation. Thus, researchers may choose to value health risks either as publicly provided or privately provided. It also implies that the altruism or the 'warm glow' theories may not be consistent with people's behavior, at least in this case. If Hypothesis 1 is rejected, and the WTP of the public provision is greater than the WTP of the private provision, it implies that altruistic motive, warm glow or perceived higher effectiveness of the public provision has a great impact to people's valuation. If the expected/median WTP of the private provision is greater than the WTP of the public provision, higher perceived effectiveness of the private provision may be the reason. In these cases, researchers need to be careful when they decide whether to value health risks as private goods or public goods, because it may make a large difference of the resulted total amount of valuation, thus change the result of cost-benefit analysis. Debriefing question about the perceived efficiency of the public provision is asked in the end of the survey. Answers to this question are used to test if perceived or expected efficiency affects WTP. In the questionnaire for the third and fourth sub-samples, we also ask each respondent which provision mechanisms they prefer if the cost is the same and why. From the answers to this debriefing question, we may see if altruistic motive, warm glow or perceived effectiveness is a major concern when people decide their WTP answers.

Scope/Scale Effect of the Contingent Valuation Method

Hypothesis 2: WTP is sensitive to the change of the magnitude of health risk reduction.

Insensitivity of the CV WTP result to the scope or scale of the good to be valued is a problem faced by CV economists. There are different factors or explanations about what cause the insensitivity of CV valuing public goods. A unique possible cause of scope insensitivity of CV on health risks is the misunderstanding of probability. Possible causes for publicly provided goods and the misunderstanding of probability in health risks CV studies are discussed in this section; and hypothesis 2 about the scope/scale effect of CV survey is explained.

Scope/Scale effect was a key issue in the debate on validity of the CV method and is still a very important and fundamental problem in current theory and practice of the CV method. Opponents of CV claim that insensitive scope/scale effect of CV contradicts economic theory, thus CV is not a valid preference elicitation method; while proponents view no contradiction between CV results and the economics theory. Scope/scale effect is that the WTP from CV survey varies with changes in the scale or scope of the item being valued (Hanemann 1994). For example, a heavily cited study by both opponents and proponents of CV is the study of Desvousges (1993), which obtained roughly the same WTPs for saving 2000, 20,000 and 200,000 birds. Evidence on the other side also exists. Carson (1997) reviewed 35 CV studies since 1984, where 31 of them reject the scope *insensitivity* hypothesis.

The difference between opinions of proponents and opponents of CV method focuses on what derives individual's utility from environmental amenities. Opponents of

CV claim that individual's utility should merely depend on the level of resources, but not the action of preserving or destroying the resources, because "preferences over acts do not provide the consistency that is necessary for consistent economic theory" (Diamond and Hausman 1994). They conclude the cause of lack of sensitivity to scope to be "warm glow": the responses to WTP questions represent only general support of respondents for environmental protection, which might be raised by altruistic motives, sense of duty or moral obligation, but not (merely) by their personal economic motives. Proponents of CV state that the standard view in economics is that decisions about what people value should be left to them (Hanemann 1994). Thus, there is no theory saying that WTP should be more than, less than or exact proportionate to the scope or scale change of environmental amenities, though theory does tell us that WTP should be increasing with the increase of environmental amenities. They regard the insensitivity of CV results as caused by flaws of questionnaire design and survey implementation, especially the information about the public good given in the questionnaire.

In the field of public health, scope/scale effect of CV has the problem that WTP is not sensitive to the changes of the reduction of health risk probability. In health risk CV surveys, respondents are often asked to value a medicine or treatment, which could reduce health risk by a certain amount. For example, a split-sample survey result may have almost the same amounts of mean/median WTP to 1/1000 and 5/1000 reduction of mortality probability.

First of all, there are some implications about how much WTP should change with the change of reduction of mortality risk. Hammitt (2000) derives nearly proportionate

change of WTP to the change of reductions from expected state-dependent utility assumption, whenever the 'dead anyway' effect and the production of income elasticity and WTP are small. Hammitt's derivation does not depend on the expected utility maximization assumption, but only depend on local linearity of utility in probabilities, which is satisfied by most alternative theories of decision making under uncertainty, except the prospect theory.

Hammitt and Graham (1999) reviewed 25 CV studies on health risks from 1980 to 1999. Out of them, 14 studies provided information to test the sensitivity of WTP to the magnitude of risk reduction. Among them eight studies were about fatality risks. Of those six studies show significant association between WTP and the magnitude of fatality risks. But all of these studies show less proportionate relationship, instead of near proportion.

In health risk CV surveys, respondents are often asked to value a medicine or treatment, which can reduce health risks by a certain amount. In these cases, the object valued in fact is a private good, instead of public or quasi-public good usually valued in environment and resource CV surveys, if the health problem or the disease is not infectious. Therefore, the so-called 'warm glow' problem should not exist here. Researchers then realize that a possible reason for non-proportionality is that respondents may not be able to report WTP according to the probabilities offered in the survey. One possibility is that the meaning of small probabilities could not be understood by respondents. Another possibility is that respondents build up a subjective probability instead of taking the numbers offered in the survey, which is a case of 'scenario rejection'

proposed by Mitchell and Carson (1989). Respondents may not trust the baseline risk provided by investigator. Often this baseline risk is an average risk; while respondents may have a prior perception about how likely they would be in the risk of mortality or developing a disease. Respondent may also have an estimate about the effectiveness of the stated intervention, which may not be the same as stated in the questionnaire. Combing these perceived risks, respondents will have a perceived posterior baseline risk and after intervention risk. A respondent's WTP depends on both perceived baseline risk and risk reduction. Respondents with higher perceived baseline risk may be willing to pay more than those with lower perceived baseline risk. (Although, theory implies the baseline effect should be small when the baseline risk is small). Respondents who think the intervention would be effective (meaning large reduction of health risks in this case) may be willing to pay more than those with lower perceived effectiveness of the medicine/treatment.

With regard to the first possible reason: miscommunication of probability, there are evidences that people have limited appreciation for small probabilities (Hammitt and Graham 1999). To improve probability communication, researchers have developed a number of tools of visual aids and verbal analogies to assist respondents in comprehending the magnitude of risk reductions[2]. Hammitt and Zhou (2006) used the visual aid of array of 10,000 dots in their CV survey on colds, chronic bronchitis and mortality risks in three areas in China. Results showed no significant positive relationship

[2] For examples, Kunreuther et al. (1978), Mitchell and Carson (1986), Hammitt (1986, 1990), Smith and Desvousges (1987), Hammitt and Graham (1999, 2001).

between risk reductions and WTP. A tool may be more useful to help Chinese respondents is the 'community analogies' (Calman and Royston 1997), which, for example, could compare a 1 in 10,000 risk with 100 expected death per year in a medium city with a population of 1,000,000. This analogy might be more understandable and acceptable to Chinese respondents because it is widely used in news report and other media in China. This tool is included into my questionnaire to improve probability communication.

As to the second possible cause of scenario rejection: perceived prior health risk and posterior risk reduction, researchers could try to reveal perceived health risk reduction. In my survey, effort is done to approach to the perceived baseline risk of respondents. The technique we use is: first, respondents are told the average risk of developing asthma in Chengdu city, and then they are asked to think about whether they are more likely, less likely or as likely as the average risk to develop asthma in Chengdu city. In the debriefing part of the survey, we ask respondents whether they believe the assumption that there were the stated treatments that would reduce the risk of asthma and mortality respectively. This question differentiates those respondents who have scenario rejection of the WTP question. By this way, we could test if the perceived baseline risk and the possible scenario rejection have significant effects to the magnitude and the scope/scale sensitivity of WTP.

Hypothesis 2: WTP is sensitive to the change of the magnitude of health risk reduction. To test this hypothesis, one of two different amounts of risk reduction of getting asthma 1/1000 and 3/1000 from the original risk (5/1000) is provided randomly to

respondents. For mortality risk reduction, one of three different magnitudes 3/10,000, 5/10,000 and 10/10,000 are provided randomly to respondents. By using the (log of) risk reduction amount as an independent variable, we test whether the estimated coefficient of this variable is positive and significant. If yes, hypothesis 2 is not rejected, meaning that the CV elicitation of people's valuation on asthma and mortality risks is sensitive to the magnitude change of the risk reduction. If hypothesis 2 is rejected, misunderstanding of probability, perceived prior and posterior risk and warm-glow to the public provision, may be the possible causes of the insensitivity.

Scope/Scale Sensitivity of the different Provision Mechanisms

Hypothesis 3: the scope sensitivities of the WTP of the private provision version and the public provision version of health risk reduction are not significantly different.

To do this test, an interaction term of the risk reduction and a dummy variable for the public provision is used in the regression estimating WTP. If the estimated coefficient of this variable is not significant, it suggests that hypothesis 3 cannot be rejected. If it is significantly positive (negative), it suggests that the WTP of the public provision is more (less) sensitive to the scale change of risk reduction than the WTP of the private provision.

Survey Instrument

To estimate the value of health risks caused by air pollution, a CV survey is designed and implemented. This section describes the survey design.

The CV survey is designed to elicit respondent's individual WTP for treatments with different provision mechanisms to reduce health risks. The health end points we choose to value are asthma and mortality. The value of mortality risk or the value of a statistical life is the most important and significant part of value of the health risks caused by air pollution from the existing studies of US (Portnety and Stavins 2000) and China (World Bank 1997). Asthma is an important respiratory disease related to air pollution. The health risk of asthma has not been valued in China before.

WTP Question Format

In 1993, the NOAA Blue Ribbon Panel set forth guidelines on the practical implementation of CV, which suggested CV questions be framed in a referendum format in which respondents are asked to vote on contributions to a fund for the good of interest. It also has been demonstrated by many studies that dichotomous/referendum format is incentive compatible. Thus, dichotomous choice question format is used for the health risks reduction in the survey.

To remedy the information loss by DC question, a follow-up DC question and a follow-up OE question are also asked. The follow-up DC question asks a higher bid if the respondent answered yes to the first DC question, a lower bid if the respondents answered no. If the answers of a respondent are no-no, he is then asked why he would not be willing to pay the amount, and an OE question is asked 'what is the maximum amount you would be willing to pay?' If he answered 'zero' or 'I would not pay for the treatment', he is asked whether he would participate in the treatment if it were free. If the respondent would not participate in the treatment even it is free, he is asked why he

would not. The answers to these open-ended questions asking why they would not pay for the treatment are used to analyze how respondents decide their WTP.

There are potential bias raised by using follow-up DC question and OE question. An easy way to check if the second answer is biased is to use only the first answers to estimate WTP and then use only the second answers to estimate it again and compare if two estimates are significantly different.

Sub-Sample Design

For the asthma WTP question, there are 3 pairs of treatments in the questionnaire design: (1) private provision versus public provision mechanism, (2) high risk reduction amount versus low risk reduction amount, (3) light symptom description versus severe symptom description. Design of these 3 pairs of treatments in the questionnaire is shown in Table 1. Version 1, 2, 3 and 4 are corresponding to the provision mechanisms of private, public, first private plus second public, and first public plus second private. Version 1 was assigned with the high risk reduction amount (3/1000). Half of the sub-sample of version 1 was assigned with the light symptom description, while the other half was assigned with the severe symptom description. Sub-sample of version 2 was assigned with the high risk reduction amount and the severe symptom description. Sub-samples of version 3 and 4 were assigned with the low risk reduction amount (1/1000) and the severe symptom description. Considering all the variation of three pairs of treatments, there are totally 5 different questionnaire designs as shown in Table 1. The targeted ratio of observations among these five groups was 3:3:2:2:2. Each respondent was assigned to one of these groups randomly.

For the mortality WTP question, there are two sets of treatments of the questionnaire design: (1) provision mechanism and (2) three levels of risk reduction amount 3/10,000, 5/10,000 and 10/10,000. The mortality WTP question has the same provision mechanism as for the asthma WTP question in each questionnaire. The three levels of risk reduction amount was assigned randomly to each respondent.

Bid Design

To design the initial bid values for the double-bounded binary WTP questions, result from Hammitt and Zhou (2006) is referred. The four-point bid design targets on 20%, 40%, 60% and 80% of the probability mass of WTP distribution. The four-point bid is designed as (5, 15, 40, 100) for 1/1000 or 3/1000 risk reduction of asthma and for 3/10,000, 5/10,000 or 10/10,000 risk reduction of mortality. For the second round bid points, it is half to the first bid, if the respondent answers 'No', and double to the first bid if the respondent answers 'Yes' to the first round bid.

Private and Public Provision Mechanisms and the WTP Question

To ask people's WTP for health risk reduction, researchers need to choose a hypothetical physical good to represent the health risk reduction. It will be difficult to ask respondents their WTP for 'a 1 in 1000 reduction of probability of developing asthma' directly, because it will be too abstract and not very understandable to respondents. Instead, respondents are often asked to value a proxy good, which could reduce their health risk. A criterion of choosing a candidate of the good is that ideally, respondents have preferences *not* to this good itself, but only to the health risk reduction, i.e., the good

should be 'neutral' to respondents. In practice, it is not easy to find a proper and neutral good to be valued. Pill, treatment, shot and vaccination are widely used proxy goods as to risk reduction of diseases[3]. In the questionnaire, it is stated clearly that these interventions do not have any side effect. In this study, considering it is more neutral to Chinese respondents than pill, 'treatment' is used as the proxy good in the WTP question for asthma and mortality risk reduction.

The asthma WTP question with the private provision mechanism is as the following:

'Assume that you could participate in a preventive treatment that would reduce your chance of developing asthma. Nearby accredited hospitals to your home could provide this treatment. But you have to pay to take part in it. Your health insurance would not cover it. This treatment would have no side effects. It would be for adults only; and it would be effective for one year. It will decrease your chance of developing asthma from 5 out of 1000 to 4 out 1000, which is a decrease of 1 out of 1000. In another word, Chengdu has about 4 million adult residents, in very year, about 20 thousand of them would get asthma; if all the adult residents in Chengdu take part in this treatment, there would be 4000 less people get asthma in the next year. If the cost of the treatment is X yuan, would you participate in this treatment?'

In the public provision version, the referendum format question is used:

'Assume that you could participate in a preventive treatment that would reduce your chance of developing asthma. Nearby accredited hospitals to your home could provide this treatment. But you have to pay to take part in it. Your health insurance would not cover it. This treatment would have no side effects. It would be for adults only; and it would be effective for one year. It will decrease your chance of developing asthma from 5 out of 1000 to 4 out 1000, which is a decrease of 1 out of 1000. In another word, Chengdu has about 4 million adult residents, in very year, about 20 thousand of them would get asthma; if all the adult residents in Chengdu take part in this treatment, there would be 4000 less people get asthma in the next year.

Now suppose to reduce the risk of developing asthma of residents in Chengdu, as a public health policy, the municipal government considered to ask every adult resident to participate in this treatment in nearby accredited hospitals, and ask every adult resident to pay a fee for the treatment, including you and your adult family members. If the majority

[3] See example studies of Hammitt and Zhou (2006), Hammitt (2004), Viscusi, Magat and Huber (1991).

of the residents would support this policy and pay the fee, the government would implement this policy. This fee would not be covered by health insurance. If the fee was X yuan per adult, would you be willing to pay it?'

Survey Mode

Chinese populations are not very familiar with survey research in general. Because CV surveys involve hypothetic scenarios that will be especially novel, the face-to-face interview in respondent's home is used, so that interviewers can provide context and explain the questionnaire to interviewees.

Survey Questions

The core question of the CV survey will be the WTP of the respondent on a given scale of reduced health risks. The asthma WTP question was asked to every respondent who does not have asthma. If a respondent does have asthma, he/she is asked about the symptoms of his/her asthma, the severity, the related expenditure spent for asthma, and his/her WTP for a treatment that would provide him/her a symptom-free year without any side effect. Similar questions about chronic bronchitis were also asked to respondents who answered yes to the question 'do you have chronic bronchitis?' The mortality WTP question was asked to every respondent.

Socio-economic questions about the respondent household include age, gender, income, education, occupation, number of people in the household, are asked. Current health conditions of respondent are also important variables in the survey. General questions about respondent's perception about environment, air pollution and health risks are also asked. Questions to test if respondents understand the survey content are asked at the end of the survey to ensure the validity of the answers.

Population and Sampling

The population of this survey is the residential population living in the official urban area of Chengdu city for at least one year. The official urban area of Chengdu, primarily within the outer ring road, has a size of about 600 square kilometers and 1,168,712 households (estimated by Research Center for Contemporary China). By the spatial sampling method implemented by Research Center for Contemporary China (Landry and Shen 2003), the sample includes both registered and non-registered residents. The geo-spatial sampling method with aid of GPS data is used to provide a random sample with much less coverage bias than the traditional method based resident's registration list in China (Landry and Shen 2003).

About 1400 respondents were sampled by multi-stage, stratified random sampling with probabilities proportional to size. Chengdu was divided into 769 primary sampling units (PSU); each unit has the size of half minute of longitude by half minute of latitude. Forty PSUs were sampled with probabilities proportional to the estimated population density of each PSU. Each sampled PSU then was divided into 80 secondary sampling units (SSU) with the size of 90 meters by 90 meters. One SSU was sampled randomly in each chosen PSU. Investigators were sent to each chosen SSU to count and record the total addresses (households) in each SSU. The second ring road of Chengdu is traditionally considered as the boundary between the developed urban area and the under-developed suburban area. To include more urban residents in our sample, stratification was implemented: within the second ring road (urban), if the total number of addresses in each SSU is greater than 74, then 74 addresses were sampled randomly from the list of

addresses investigator recorded; if the total number of addresses was less than 74, then all addresses are chosen. Out of the second ring road (suburban), the threshold number of addresses was 20 instead of 74. Interviewers entered the selected households and sampled one respondent from all qualified residents[4] from 18 to 70 years old by using Kish Grid. Kish Grid is a widely used simple procedure to select one adult from each dwelling, considering the gender and age of each adult (Kish 1965, pp398-400). In-person interviews of 997 people were conducted.

Survey Implementation

Two pretests were done with 25 respondents totally. Wording of the questionnaire were modified according to the pretest findings. Seventy-seven interviewers were recruited from students of Sichuan University, with help from faculty members. Implementation is supervised by the staff of China Project, Harvard University Center for the Environment and the Research Center for Contemporary China, Peking University.

Sample Descriptive Statistics

The important characteristic variables of the sample are defined in Table 2. The characteristics of the sample are as the following. The average age of respondents is 39 years. 46% of the respondents are male. The average education year is about 11 years. About 57% of the respondents are covered by public health insurance, with either full or partial coverage. About 76% of the total sample was assigned with the severe symptom description of asthma. About 54% of the respondents think they are very familiar or

[4] Qualified respondents are individuals who are 18 to 70 years old and have been living in Chengdu for at least one year.

somewhat familiar with asthma. About 21% of the respondents think their chance of developing asthma is above the average chance of 5 in 1000. About 70% of the respondents believe that the stated scenario of the asthma preventive treatment was realistic, whereas 59% of them think the stated scenario of the mortality preventive treatment was realistic. The average household size is 3. The average household income is about 23,100 yuan (US$2888[5]) annually. 35% of the respondents were assigned with the public provision mechanism in the first WTP question (questionnaire version 2 and 4). Among the respondents asked the WTP question with the public provision, 43% of them think that the government provision of the preventive treatment would be effective; this is 22% of the whole sample. These are the un-weighted statistics of the sample; the weighted statistics are also reported in Table 2.

WTP to Reduce the Current Risk of Developing Asthma

Assuming exponential WTP model: $WTP(X_i, \varepsilon_i) = \exp(\beta X_i + \varepsilon_i)$, with normal distributed error term, a *Binary Probit* model is regressed. The dependent variable is the yes-no response to the first bid price for each respondent. Regression using the follow-up response only shows significantly different estimated coefficients and lower mean/median WTP than the results using the first round responses, which means that the responses of respondents to the follow-up question might be strategic. Therefore, the double-bounded WTP model is not used.

Respondents who stated that they currently have asthma are deleted from the sample. Observations with missing values of independent variables are also deleted from

[5] The exchange rate used in this article is US$1=8 yuan.

the sample. we also found very strong interviewer effect from two interviewers by using interviewer dummy variables. Thus, 59 respondents who were interviewed by these two interviewers are then also deleted from the sample. It results a sample with 726 respondents in the asthma WTP regression. The un-weighted and weighted statistics of observations used in the regression are reported in Table 3. Table 4 shows the un-weighted and weighted yes rate of this sample to reduce the risk of asthma.

The parameter estimates of WTP to reduce the risk of developing asthma are presented in Table 5. In this regression, only the first valuation question from each respondent is used, although in the version 3 and 4 of the questionnaire, each respondent was asked two sets of WTP question with both the private provision and the public/government provision mechanisms. Regression using both of these two sets of WTP responses is also done and discussed later. The regression is weighted with the sampling weight of each respondent to represent the whole population. The result in Table 5 shows that the probability of the yes-response is decreasing with the log of the bid price value. Respondents who believe in the stated scenario of the preventive treatment have significantly higher WTP. Education year also has a positive and significant effect to WTP. The household income is negative but insignificant. The estimated coefficient of the dummy of the public provision is positive but insignificant. The coefficient of the interaction term of household income and the public provision is negative and significant at 5%, showing that respondents with higher household income are less likely to say yes to the public provision version of the WTP question. The dummy variable for those who are familiar with asthma and the household size have

positive but insignificant effects to WTP. The dummy variable for those who think that they have higher than average risk of developing asthma and the dummy variable for those who think the government provision would be effective have negative but insignificant effects to the WTP.

Scope/Scale Effect of the Asthma WTP

In Table 5, the estimate of the log of the asthma risk reduction is not significant. But the estimated coefficient of the interaction term of household income and the log of the risk reduction is positive and significant at 9%, which means that the scale sensitivity of respondents to the risk reduction magnitude is increasing with the household income. The possible reason is that respondents with higher income may have better capability of understanding on the health risk probabilities described in the questionnaire, therefore, their WTP are more sensitive to the risk magnitude. In other words, the income could be seen as a proxy of the capability of respondents understanding the questionnaire.

To answer the question whether the change of WTP is proportionate to the change of risk reduction, we need to test whether the estimated coefficient of the log of the risk reduction is equal to 1. The scale sensitivity is increasing with household income as shown in Table 5, which suggests that respondents with low income have no or less than proportionate scale sensitivity, whereas respondents with high income may have proportionate or even more than proportionate WTP change to the risk reduction change. We computed the regression results using respondents with household income greater than 30,000 yuan only. The coefficient of the log of risk reduction is estimated as 1.19 with 1% significance. Wald test shows that this estimate is not significantly different to 1.

Similarly the regression result using respondents with household income greater than 40,000 yuan only shows scale coefficient is 1.79 with 1% significance, where the Wald test still cannot reject that it is equal to 1. Regressions using respondents with even higher income cannot be done because of small sample size. From these results, we can conclude that the scale sensitivity of the WTP for the risk reduction of asthma is increasing with the household income; at certain point, the proportionality hypothesis holds. However, it is difficult to conclude whether respondents with even higher income may have WTP change more than proportionate to the risk reduction change.

To answer the question whether the public provision would decrease the scale sensitivity of WTP to the risk reduction magnitude, an interaction term of the dummy of public provision with the log of risk reduction and an interaction term of public provision with the household income, and with the log of risk reduction are added into the model. The parameter estimates are reported in Table 6. The estimated coefficients of these two interaction terms are negative but insignificance, meaning that the hypothesis that the public provision mechanism has no effect to the scale sensitivity of WTP cannot be rejected.

Within-group Regression on Provision Mechanisms

In Table 5 and 6, the dummy variable of the public provision is always positive but insignificant, so that the hypothesis that the public provision has no significant impact to people's WTP cannot be rejected. This result is a between-group comparison result, since every individual in the sample responded to either the public provision or the private provision, but not both. Referring to Table 1 on the sub-sample design of the

questionnaire, in version 3 and 4, each respondent actually responded to both the public and the private provision WTP questions with different order. Thus, pooling version 3 and version 4 together and using the both WTP responses of each respondent, a within-group comparison is done. The regression result is reported in Table 7. Here, the public provision dummy variable is positive and significance. Different than the between-group comparison result, this result rejects the null hypothesis. A possible reason for the difference is that when respondents are comparing the private provision with the public provision mechanisms directly, it is easier for them to see the advantages and disadvantages of each mechanism, thus, the positive effect of the public provision is more significant. The reason of this effect is discussed later. The variable 'Ordering Effect' is a dummy for the second WTP question of each respondent; there is a negative ordering effect at 6% significance.

Estimated WTP and the Value of a Statistical Case of Asthma

The mean and median WTP for asthma risk reduction are computed from the parameter estimates reported in Table 5 and the weighted mean of the independent variables. The estimated expected WTP is 475.39 yuan (US$59), and the estimated median WTP is 27.93 yuan (US$3.5). The estimated expected WTP of the sub-sample offered with the high risk reduction is 468.43 yuan (US$58.6); the estimated median WTP is 27.52 yuan (US$3.44). The estimated expected WTP of the sub-sample offered with the low risk reduction is 488.55 yuan (US$61.07); the estimated median WTP is

28.70 yuan (US$3.59)[6]. The WTP estimates of the sub-sample offered with the high risk reduction is even slightly lower than the estimates of the sub-sample with the low risk reduction because each sub-sample has different means of the independent variables, although the assignment of risk reduction is random.

The large difference between the expected WTP and the median WTP is caused by the flaw of the design of the bid prices in the questionnaire. The designed bid prices were not able to make the upper tail of the distraction of the WTP well defined. Referring to Table 4, 27% of the respondents answered no the lowest bid, and 32% answered yes to the highest bid. These un-defined tails enables the expected WTP to be sensitive to the functional form assumption of the WTP (Haab and McConnell, 2002, pp106).

As Haab and McConnell (2002) states, when there are concerns about the distribution of response data, a conservative approach is to calculate the sample mean using the Turnbull lower bound and then estimate the exponential willingness to pay function and calculate its median. The Turnbull lower bound (Haab and McConnell 2002, pp75) of the expected WTP (weighted) is 44.55 yuan (US$5.6). The estimated lower bound of the expected WTP for the sub-sample with the high risk reduction is 47.55 yuan (US$5.94); the lower bound estimate for the sub-sample with the low risk reduction is 19.35 yuan (US$2.42).

The value of a case of asthma is computed by dividing the estimated WTP by the weighted mean of the risk reduction amount. Using the median WTP from the

[6] The estimates of each sub-sample are computed using the estimated coefficients reported in Table 3.6 and the means of the independent variables of each sub-sample.

exponential model, the estimated median value for the sub-sample with high risk reduction is 9173 yuan (US$1147), the value for the sub-sample with low risk reduction is 28702 yuan (US$3588); the average of these two estimates is 18,940 yuan (US$2368). Using the lower bound of the expected WTP for the high risk sub-sample, the value of a statistical case of asthma is 15,850 yuan (US$1981), the value for the low risk sub-sample is 19,350 yuan (US$2419); the average of these two estimates is 17,600 yuan (US$2200).

Analysis on Why Respondents Answer No to the Asthma WTP Question

To the respondents who answer no-no to both the initial bid and the follow-up WTP question, we asked why they would not be willing to pay to the bid prices and what would be the maximum amount that the respondent would be willing to pay for the treatment. There are totally 318 in 879 respondents (the original sample deleting the observations with strong interviewer effect) asked these questions. Asked why they would not pay the bid price, 51 respondents (6%) answered that their income is too low or the bid price is too high for them; 197 respondents (20%) answered that they do not think the treatment is necessary for them because they are in very good health condition or with no specific reasons; 19 respondents (2%) answered they do not want to take time or effort to participate in this treatment; 17 respondents (2%) answered that they exercise, or have health insurance, or have other ways to protect themselves; 12 respondents (1%) think that the government should pay for the treatment, but not themselves; 10 respondents (1 %) answered that they have suspicion or distrust to the stated treatment; other respondents had other miscellaneous reasons or missed this question.

When asked on the maximum WTP, 289 in 318 respondents (33%) answered 'zero' or 'I would not pay for the treatment'; 27 respondents answered greater than zero WTP from 2 yuan to 30 yuan. Then, the 289 respondents who answered zero were asked whether they would participate in the treatment if it were free to them. Among them, 182 said yes, 107 respondents answered no. Then, these 107 respondents (12% of all respondents) were asked why they would not participate in this asthma preventive treatment even if it were free. 13 respondents of them (1%) answered that did not trust or believe in the hypothetical treatment is effective to prevent asthma. This 1% of the respondents has obvious scenario rejection to the WTP question. 59 respondents (7%) answered that they think it is not necessary for them to participate in this treatment, because they are in very good health, or they perceive they would have very low chance of developing asthma, or with no specific reason; 24 (3%) respondents answered that it would be time consuming or troublesome to participate in the treatment; 4 (0.5%) respondents answered that they have health insurance or other methods to prevent the disease; these 10.5% respondents may also have various levels of scenario rejection, but expressed it in an indirect way. Other respondents had other miscellaneous reasons or missed this question. From these statistics, the major reason for respondents answering no is that they think the treatment is not necessary for them.

Analysis on the Stated Preference of Respondents to Different Provision Mechanisms

In the version 3 and 4 of the questionnaire, respondents were asked their WTP for the health risks reductions with both the private provision and the public/government provision. They were also asked directly on which mechanism they prefer if the cost is

the same and why. Table 8 reports the number and percent of respondents with different preferences to the private provision and the public/government provision. There are 42.27% respondents stated that they prefer the government provision, whereas 23.71% stated they prefer the private provision, and 31.96% stated that the two provision mechanisms are indifferent to them. The percentage prefers the public/government provision is significantly greater than the percentage prefers the private provision. This is consistent with the estimated coefficient of the public provision dummy variable in the within-group regression in Table 7.

Asked why they prefer the public/government provision, 82 in the total 291 respondents (28%) answered that the government provision would be more trustworthy or more effective; 8 respondents (2.7%) answered that the government provision would induce themselves or others more incentive to participate in the treatment; 4 (1.4%) respondents thought that they would be subsidized by the government or their employer if the treatment is provided by the government. On the other side, among those who prefer the private provision, 29 respondents (10%) answered that they have distrust to the government; 40 respondents (14%) answered that they would have more freedom to choose the hospitals or the time to participate in the treatment if it was privately provided. It can be seen that there are more respondents trust the government than those who distrust the government. It also can be seen that the preference to the government provision of people is mainly caused by their trust to the government or perceived high effectiveness of the government, but not the altruistic incentive.

WTP to Reduce the Risk of Mortality

Similarly to the asthma WTP model, probit regressions have been done to estimate the WTP to reduce the risk of mortality. The un-weighted and weighted descriptive statistics of the observations used in the regression are reported in Table 9. Table 10 shows the un-weighted and weighted yes rate of the sample to reduce the risk of mortality.

The parameter estimates are shown in Table 11. This result shows that, similar to the asthma result, respondents who believe in the stated treatment have significantly higher WTP. Different to the asthma case, the coefficient of the public provision dummy is negative and significant, suggesting that the public provision yields lower WTP for the mortality risk reduction. A possible reason is that for the respondents, it is relatively easy to understand that the government could supply public health service to prevent certain disease like asthma; but the government provision of mortality risk reduction might be too abstract to them. Answering to a debriefing question in the questionnaire, 59% of the respondents think that it is possible that the government would provide the public health service to prevent asthma, whereas only 54% of the respondents think it is possible for the mortality risk reduction. Respondents may thus answer no because they think that the government is less likely to supply this treatment to reduce mortality risk.

In Table 11, the perceived government effectiveness is positive and significant. The interaction term of the dummy of the rural registration status with the public provision is negative and significant, meaning that the respondents with rural registration status are more likely to answer no to the public provision mechanism. The reason is that

residents with the rural registration are generally not covered in any public health insurance system in China[7], thus respondents with rural registration may perceive that they would not be covered in the public provision mechanism either.

The public health insurance dummy and the household size are positive but insignificant; the household income has a negative but insignificant coefficient. The interaction term of household income with public provision in the asthma regressions is deleted from the mortality regression, since it was not significant.

Scope/Scale Effect of the Mortality WTP

The estimated coefficient of the log of the risk reduction shows that the scope sensitivity of WTP to the magnitude of risk is not significant. Different to the asthma result, the interaction term of the household income with the log of the mortality risk reduction is positive but not significant, indicating that the scale sensitivity of WTP is not significantly increasing with the income. A possible cause of the lack of sensitivity is that the magnitude of the mortality baseline risk and the risk reduction is even smaller than asthma, expressed as chances in 10,000. Respondents may have more difficulty to appreciate the smaller magnitude. Another possible reason is that researchers could not measure very well the perceived baseline risk and the perceived effectiveness of the treatment of respondent. If respondents decide their WTP based on their perceived risk and effectiveness, but not the stated average risk and the stated risk reduction, we would not observe scope/scale effect of WTP to the stated risk reduction amount.

[7] Experiments of new system of public health insurance for rural residents recently has been carried out in limited rural areas in China recently.

To answer the question whether public provision affects the scale sensitivity of WTP, the interaction term of public provision with the log of risk reduction is added into the regression[8]. As reported in Table 12, this interaction term is negative but insignificant, suggesting that the hypothesis that public provision has no impact to the scale sensitivity of WTP cannot by rejected.

Within-group Regression on the Provision Mechanisms

The within-group regression result is reported in Table 13. Different than the between-group result in Table 11, the public provision is positive but insignificant here. If we add the interaction of the public provision with the log of risk reduction into the regression, the estimated coefficient of this term is positive but insignificant.

Estimated WTP for mortality risk reduction and VSL

Parameter estimates in Table 11 are used for the WTP computation, with the weighted means of the independent variables. The estimated mean of WTP is 18,555 yuan (US$2319), and the estimated median WTP is 102 yuan (US$12.75). As stated in the asthma WTP section, the flaw of design of bid prices leads to the expected WTP overestimated. The Turnbull lower bound of the mean of WTP (weighted) is estimated as 51.50 yuan (US$6.4) with a variance of 0.0016 yuan. Dividing the WTP estimates by the weighted mean of the risk reduction amount, the estimated median VSL is 189,960 yuan (US$23,745). The Turnbull estimate of VSL is 95,903 yuan (US$11,988).

[8] The interaction term of household income and log of risk reduction, and the interaction term of public provision and household income are deleted from the regression since they are not significant.

Analysis on Why Respondents Answer No to the Mortality WTP Question

To the respondents who answer no-no to both the initial bid and the follow-up WTP question, we asked why they would be willing to pay and what would be the maximum amount that the respondent would be willing to pay for the treatment. There are totally 280 in 901 respondents (31%) asked these questions. Asked why they would not pay the bid price, 42 respondents (3.66%) answered that their income is too low or the bid price is too high for them; 111 respondents (12.32%) answered that they do not think the treatment is necessary for them because they are in very good health condition, or with no specific reasons; 18 respondents (2.00%) answered that they do not want to take time or effort to participate in this treatment; 17 respondents (1.89%) answered that they have health insurance or other ways to protect themselves; 7 respondents (0.78%) think that the government should pay for this, but not themselves; 35 respondents (3.88%) answered that they have suspicion to the stated treatment; 5 respondents (0.55%) answered that they have distrust to the government; 1 respondent (0.11%) answered that the risk reduction amount is too small; other respondents had other miscellaneous reasons or missed this question.

When asked on the maximum WTP, 256 respondents (28.41%) answered 'zero' or 'I would not pay for the treatment'; 16 of them answered greater than zero WTP from 1 yuan to 50 yuan. Then, the 256 respondents who answered zero were asked whether they would participate in the treatment if it were free. Among them, 164 said yes, 92 respondents answered no. Then, these 92 respondents were asked why they would not participate in the treatment even if it were free. 18 respondents of them (2%) answered

that they do not trust or believe in the hypothetical treatment. These respondents have obvious scenario rejection to the WTP question. 35 respondents (3.88%) answered that they think it is not necessary for them to participate in this treatment because they are in very good health condition or with no specific reason. 18 (2%) respondents answered that it would be time consuming or troublesome to participate in the treatment; 3 respondents (0.67%) answered that they have health insurance or other methods that would be helpful to prevent the disease; these 8.55% respondents may also have various levels of scenario rejection, but expressed it in an indirect way. 2 respondents (0.22%) expressed that they have distrust to the government. Other respondents had other miscellaneous reasons. The percentages of respondents with different reasons are very similar to the percentages of the asthma WTP question.

Analysis the Stated Preference of Respondents to Different Provision Mechanisms

Similar to Table 8 for the analysis on asthma, Table 14 reports the numbers and percents of respondents with different preferences to the private provision and the public provision in the mortality case. There are 43.53% respondents stated that they prefer the government provision, whereas 24.29% stated they prefer the private provision, and 30.91% stated that the two provision mechanisms are indifferent to them. The percentage prefers the public/government provision is significantly greater than the percentage prefers the private provision. But the sum of percentages of who prefer the private provision and who are indifferent is greater than percentage of who prefer the public/government provision. This is probably why the result in Table 13 shows that the coefficient of public provision is positive but insignificant.

Asked why they prefer the public/government provision, 95 in 317 respondents (30%) answered that the government provision would be more trustworthy or more effective; 13 respondents (4%) answered that the government provision would induce themselves or others more incentive to participate in the treatment; 6 respondents (2%) thought that they would be subsidized by the government or their employer if the treatment is provided by the government. On the other hand, among those who prefer the private provision, 25 respondents (8%) answered that they have distrust to the government; 47 respondents (15%) answered that they would have more freedom to choose the hospitals or the time to participate in the treatment if it was privately provided. Similar to the asthma case, the preference to the government provision of people is mainly caused by their trust to the government or the perceived high effectiveness of the government provision. The main reasons that respondents prefer the private provision are the distrust to the government and the perceived freedom on choices of hospitals and treatment time. The between-group regression and the within-group regression yield different estimates of the public provision dummy variable. Again, it seems that when respondents compare the private provision with the public/government provision directly, they are less likely to say no to the public/government provision than when they are offered with the public/government provision only.

Conclusion

To summarize this article, a contingent valuation study is conducted in China to value the health risks of asthma and mortality by using in-person interviews. The private and public/government provision mechanisms are tested for their effect to respondents'

WTP. Scope/scale effects of WTP to the magnitude of the risk reduction and the description of severity of asthma also tested.

Using a probit model, the median of the value of a statistical case of asthma is estimated as 13,685 yuan (US$1711). The between-group regression result cannot reject the hypothesis that the public provision has no significant effect to WTP. The scope/scale effects of WTP to the risk reduction amount and the severity of description of symptoms of asthma are increasing with the household income of respondents. A possible reason is that people with higher income may have better understanding on the questionnaire and the small probabilities, since the income is usually increasing with education level and capability. The within-group regression shows that the public provision has a positive and significant impact to the asthma WTP. This suggests that when comparing the private provision and the public/government provision directly, respondents are more likely to say 'yes' to the public provision. From respondents' responses on why they prefer the public/government provision, it can be seen that their trust to the government and perceived high effectiveness of government provision is the main reason. No significant altruistic incentive is found. Peng and Tian (2003) surveyed 356 inpatients with respiratory diseases on their total willingness-to-pay in order to cure asthma if they had asthma in Shanghai, China. They estimated that the average WTP per person for cure of asthma as 21,739 yuan (US$2717). One obvious reason that this estimate is higher than our estimate is the difference of the survey samples: we surveyed the general population, whereas they surveyed inpatients with respiratory diseases.

The median of the value of a statistical life is estimated as 189,960 yuan (US$23,745). No significant scale effect of the WTP is found. A possible reason is that the magnitude of the mortality risk is even smaller than the asthma risk, which makes it even more difficult to understand for the respondents. Another possible reason is the unknown perceived risk of respondents. The between-group regression shows that the public/government provision has a significantly negative effect to people's WTP magnitude. A possible explanation is that the respondents answer no to the WTP question with the public provision since they think that it is not very possible for the government to provide the treatment to reduce the mortality risk. In the within-group regression, the estimated coefficient of the public provision is positive but insignificant. Similar to the asthma case, this may suggest that when comparing the private provision with the public/government provision directly, respondents value the advantages of the public provision more, or value its disadvantages less, than they were offered the public provision only.

Comparing to my results, World Bank (1997) reported a VSL of US$60,000 in urban area of China transformed from contingent valuation result of U.S. Hammitt and Zhou (2006) reported an estimated mean VSL of US$45,500 and median VSL of US$16,300 estimated from the WTP responses in Beijing, and mean VSL of US$29,400 and median VSL of US$4,220 in Anqing, by a contingent valuation study in 1999. Our median VSL estimate falls in the interval of the median estimates of Hammitt and Zhou. Since possible scenario rejection may cause respondents to answer No to the WTP question, our estimate should be close to the lower bound of the true VSL, thus we

suggest that US$20,000 to US$60,000 seems a proper interval of VSL estimate from the evidence of the current studies.

We can also compare the estimated VSL for China with the VSL for U.S. and other countries. Viscusi and Aldy (2003) provided a comprehensive review of the wage differential method with more than 60 studies from ten countries. It shows that most estimated VSL from US data fall from 1 to 10 millions US dollars. Some studies based on non-US labor market data provide estimates as follow: UK, from 4 to 70 millions dollars; Canada, from 4 to 20 millions dollars; India, from 1 to 4 millions dollars; Japan, about 10 millions dollars; South Korea, about 0.8 million dollars; Taiwan, from 0.2 to 0.9 million dollars. Table 15 summarizes the estimated VSL and annual per capita income of China, Taiwan and US. The per capita income of Taiwan is about 13 times of China's, and the per capita income of U.S. is about 32 times of China's. The VSL estimate of Taiwan is about 10-13 times of the estimates of China; the VSL of US is about 45-150 times of the VSL of China. The income elasticity between China and Taiwan seems around 1, but the income elasticities between China and US and between Taiwan and US seem much larger. This suggests that the income elasticity between countries might not stay constant with the increasing income level. The difference of income elasticity may also be caused by different cultural backgrounds.

To improve the economic valuation of health risks and environment in China, future studies should make effort onto improving respondents understanding of the health risk probabilities and reducing scenario rejection. In-depth interview could be used to test

the understanding and the effects of different tools (including visual aids, oral analogies and others) aiming to improve the understanding.

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Table 1: Sub-Sample Design of the Asthma WTP Question

Group	Version	Provision	Symptom	Risk reduction	Number of observations
1	1	Private	Light	3/1000	237
2	1	Private	Severe	3/1000	246
3	2	Public	Severe	3/1000	172
4	3	Private and public	Severe	1/1000	163
5	4	Public and private	Severe	1/1000	176

Table 2: Variable Definitions and Statistics

Variables	Definition	Sample Size	Mean (Std. Deviation)	
			Un-weighted	Weighted
Age	Age in years	962	38.66 (13.77)	37.04 (12.25)
Gender	Dummy variable equal to 1 if male	962	0.46 (0.50)	0.49 (0.50)
Education Years	Education years received by respondent	960	10.79 (3.95)	10.88 (4.09)
Health	Respondent's perception of own current health on a scale between 1 (excellent) and 5 (bad)	962	2.80 (0.91)	2.76 (0.93)
Exercise	Average exercise hours per week	952	3.51 (4.94)	3.20 (4.71)
Smoke	Dummy variable equal to 1 if smoke	962	0.30 (0.46)	0.27 (0.44)
Public Insurance	Dummy variable equal to 1 if the respondent has some form of public health insurance	953	0.57 (0.50)	0.62 (0.49)
Asthma Symptom	Dummy variable equal to 1 if respondent was randomized into the group with the severe symptom descriptions provided	940	0.76 (0.43)	0.77 (0.42)
Familiar	Dummy variable equal to 1 if the respondent perceives that he/she is familiar with asthma	940	0.54 (0.50)	0.56 (0.50)
Large Risk	Dummy variable equal to 1 if the respondent believes own chance of developing asthma is higher than the average	940	0.21 (0.41)	0.19 (0.39)

Table 2 Continued

Log Asthma Risk Reduction	Natural log of the asthma risk reduction amount per 1000 offered to each respondent, i.e., log(1) or log(3)	940	0.73 (0.52)	0.71 (0.52)
Log Mortality Risk Reduction	Natural log of the mortality risk reduction amount per 10,000 offered to each respondent, i.e., log(3), log(5) or log(10)	962	1.67 (0.49)	1.65 (0.47)
Asthma Believe	Dummy variable equal to 1 if respondent believes the stated scenario of asthma risk reduction is realistic	940	0.70 (0.46)	0.69 (0.46)
Mortality Believe	Dummy variable equal to 1 if respondent believes the stated scenario of mortality risk reduction is realistic	962	0.59 (0.49)	0.55 (0.50)
Household Size	Number of people living in the household	912	3.00 (1.16)	3.27 (1.16)
Household Income	Annual household income divided by 10000 (yuan)	843	2.31 (2.72)	3.15 (4.37)
Rural Reg	Dummy variable equal to 1 if the respondent is registered as a rural resident	962	0.29 (0.46)	0.30 (0.46)
Public Provision	Dummy variable equal to 1 if respondent was randomized into the group in which public provision scenario was provided in the first WTP question (version 2 and 4)	962	0.35 (0.48)	0.38 (0.49)
Government Effectiveness	Dummy variable equal to 1 if respondent of version 2 and 4 thinks that the public provision of treatments by government would be efficient	962	0.22 (0.41)	0.27 (0.44)

Table 3: Statistics of the Independent Variables in the Asthma WTP Model

Variables	Definition	Mean (Std. Deviation)	
		Un-weighted	Weighted
Log of Bid Price	Natural log of the bid price assigned to each respondent	3.17	3.22
		(1.11)	(1.15)
Education Years	Education years received by respondent	10.97	11.28
		(3.83)	(3.99)
Public Insurance	Dummy variable equal to 1 if the respondent has some form of public health insurance	0.60	0.67
		(0.49)	(0.47)
Asthma Symptom	Dummy variable equal to 1 if respondent was randomized into the group with the severe symptom descriptions provided	0.76	0.77
		(0.42)	(0.42)
Familiar	Dummy variable equal to 1 if the respondent perceives that he/she is familiar with asthma	0.56	0.57
		(0.50)	(0.50)
Large Risk	Dummy variable equal to 1 if the respondent believes own chance of developing asthma is higher than the average	0.21	0.20
		(0.41)	(0.40)
Log Asthma Risk Reduction	Natural log of the asthma risk reduction amount per 1000 offered to each respondent, i.e., log(1) or log(3)	0.74	0.71
		(0.52)	(0.52)
Asthma Believe	Dummy variable equal to 1 if respondent believes the stated scenario of asthma risk reduction is realistic	0.72	0.74
		(0.45)	(0.44)
Household Size	Number of people living in the household	2.95	3.23
		(1.15)	(66.10)
Household Income	Annual household income divided by 10000 (yuan)	2.38	3.39
		(2.86)	(4.68)

Table 3 Continued

Public Provision	Dummy variable equal to 1 if respondent was randomized into the group in which public provision scenario was provided in the first WTP question (version 2 and 4)	0.36 (0.48)	0.40 (0.49)
Government Effectiveness	Dummy variable equal to 1 if respondent of version 2 and 4 thinks that the public provision of treatments by government would be efficient	0.23 (0.42)	0.30 (0.46)
Household Income×LARR	Household income multiplied by the log of the asthma risk reduction amount per 1000	1.81 (3.12)	2.75 (5.32)
Household Income×Public Provision	Household income multiplied by the dummy variable of public provision	0.90 (2.20)	1.71 (4.65)
N	Sample size	726	726

Table 4: Bid Vectors and Percentage of People Saying 'yes' to the Bid for Stated Risk Reduction of Asthma

Bid price (yuan)	Yes Rate		N
	Un-weighted	Weighted	
5	72.07%	69.12%	179
15	61.85%	70.63%	173
40	46.67%	39.77%	195
100	32.40%	40.14%	179

Table 5: Coefficient Estimates for Asthma

Independent Variables	Coefficient	Prob>ChiSq
Intercept	0.50	0.41
Log of Bid Price* **	-0.42	0.00
Education Years* **	0.074	0.00
Public Insurance	-0.14	0.44
Asthma Symptom	-0.074	0.76
Log of Risk Reduction	-0.41	0.22
Asthma Believe* **	0.71	0.00
Public Provision	0.42	0.26
Household income	-0.20	0.13
Familiar	0.13	0.42
Larger Risk	-0.10	0.63
Government Effectiveness	-0.41	0.28
Household Income×Log of Risk Reduction*	0.20	0.09
Household Income×Public Provision**	-0.12	0.05
Household Size	0.083	0.25
N=726, -2LL=2535836, LLR=633131.47, Wald=82.41		

Note: *, **, *** indicate *p*-values <0.1, 0.05, and 0.01, respectively.

Table 6: Coefficient Estimates for Asthma

Independent Variables	Coefficient	Prob>ChiSq
Intercept	0.23	0.72
Log of Bid Price* **	-0.43	0.00
Education Years* **	0.073	0.00
Public Insurance	0.04	0.88
Asthma Symptom	-0.019	0.94
Log of Risk Reduction	-0.07	0.84
Asthma Believe* **	0.73	0.00
Public Provision	0.74	0.30
Household income	-0.19	0.22
Familiar	0.10	0.53
Larger Risk	-0.09	0.62
Government Effectiveness	-0.41	0.25
Household Income×Log of Risk Reduction	0.19	0.19
Household Income×Public Provision	-0.099	0.64
Household Size	0.077	0.30
Public Provision×Log of Risk Reduction	-0.57	0.35
Public Provision×Household Income×Log of Risk Reduction	-0.017	0.93
N=726, -2LL=2512614.6, LLR=656352.63, Wald=80.67		

Note: *, **, *** indicate *p*-values <0.1, 0.05, and 0.01, respectively.

Table 7: Within-Group Regression Estimates for Asthma

Independent Variables	Coefficient	Prob>ChiSq
Intercept* **	1.31	0.01
Log of Bid Price* **	-0.63	0.00
Education Years*	0.057	0.07
Public Insurance*	-0.36	0.09
Asthma Believe **	0.56	0.03
Public Provision* **	1.19	0.01
Household income	-0.03	0.72
Familiar	-0.30	0.12
Larger Risk	0.014	0.96
Government Effectiveness	-0.50	0.18
Household Income×Public Provision	-0.12	0.27
Household Size	-0.021	0.81
Ordering Effect*	-0.41	0.06
N=478, -2LL=1611396, LLR=601470.48, Wald=90.38		

Note: *, **, *** indicate *p*-values <0.1, 0.05, and 0.01, respectively.

Table 8: Provision Preference for Asthma

Stated Preference of Provision Mechanism	Number of Respondents	Percentage %
Public/Government Provision	123	42.27
Private Provision	69	23.71
Indifference	93	31.96
Don't know and Missing Value	6	2.06
Total Number of Respondents Asked	291	

Table 9: Independent Variable Statistics for the Mortality Model

Variables	Definition	Mean (Std. Deviation)	
		Un-weighted	Weighted
Log of Bid Price	Natural log of the bid price assigned to each respondent	3.18 (1.12)	3.24 (1.16)
Education Years	Education years received by respondent	10.96 (3.84)	11.26 (3.99)
Public Insurance	Dummy variable equal to 1 if the respondent has some form of public health insurance	0.60 (0.49)	0.67 (0.47)
Log Mortality Risk Reduction	Natural log of the mortality risk reduction amount per 10,000 offered to each respondent, i.e., log(3), log(5) or log(10)	1.69 (0.49)	1.68 (0.46)
Mortality Believe	Dummy variable equal to 1 if respondent believes the stated scenario of mortality risk reduction is realistic	0.61 (0.49)	0.57 (0.50)
Household Size	Number of people living in the household	2.96 (1.14)	3.22 (1.17)
Household Income	Annual household income divided by 10000 (yuan)	2.23 (2.80)	3.31 (4.63)
Public Provision	Dummy variable equal to 1 if respondent was randomized into the group in which public provision scenario was provided in the first WTP question (version 2 and 4)	0.36 (0.48)	0.40 (0.49)

Table 9 Continued

Government Effectiveness	Dummy variable equal to 1 if respondent of version 2 and 4 thinks that the public provision of treatments by government would be efficient	0.23 (0.42)	0.29 (0.45)
Household Income×LMRR	Household income multiplied by the log of the mortality risk reduction amount per 10,000	3.87 (4.50)	5.25 (6.04)
Household Income×Public Provision	Household income multiplied by the dummy variable of public provision	0.85 (2.12)	1.65 (4.59)
N	Sample Size	741	741

Table 10: Bid Vectors and Percentage of People Saying "yes" to the Bid for Stated Risk Reduction of Mortality

Bid price (yuan)	Yes Rate		N
	Un-weighted	Weighted	
5	77.78%	84.11%	189
15	65.84%	58.67%	161
40	57.14%	49.21%	203
100	40.43%	48.52%	188

Table 11: Coefficient Estimates for Mortality

Independent Variables	Coefficient	Prob>ChiSq
Intercept**	1.22	0.03
Log of Bid Price***	-0.35	0.00
Education Years	-0.0066	0.81
Public Insurance	0.18	0.35
Log of Risk Reduction	-0.32	0.22
Mortality Believe***	1.02	0.00
Public Provision*	-0.40	0.08
Household Income	-0.063	0.52
Government Effectiveness*	0.54	0.07
Household Income×Log of Risk Reduction	0.069	0.39
Household Size	0.00077	0.99
Rural registration	0.30	0.21
Rural registration×Public Provision**	-1.02	0.02
N=741, -2LL=2434102.80, LLR=729174.11, Wald=87.53		

Note: *, **, *** indicate *p*-values <0.1, 0.05, and 0.01, respectively.

Table 12: Coefficient Estimates for Mortality

Independent Variables	Coefficient	Prob>ChiSq
Intercept	0.79	0.17
Log of Bid Price* **	-0.33	0.00
Education Years	-0.00048	0.99
Public Insurance	0.19	0.33
Log of Risk Reduction	-0.11	0.66
Mortality Believe* **	1.03	0.00
Public Provision	-0.13	0.84
Household income	0.039	0.33
Government Effectiveness*	0.51	0.09
Household Size	0.0037	0.96
Public Provision×Log of Risk Reduction	-0.17	0.66
Rural Registration	0.28	0.23
Rural registration×Public Provision**	-0.98	0.02
N=741, -2LL=2442146.10, LLR=721130.90, Wald=82.94		

Note: *, **, *** indicate *p*-values <0.1, 0.05, and 0.01, respectively.

Table 13: Within-Group Regression Estimates for Mortality

Independent Variables	Coefficient	Prob>ChiSq
Intercept**	1.35	0.03
Log of Bid Price***	-0.49	0.00
Education Years	0.033	0.23
Public Insurance**	-0.48	0.05
Log of Risk Reduction	0.27	0.30
Mortality Believe***	0.70	0.00
Public Provision	0.18	0.41
Household income	0.018	0.81
Government Effectiveness*	0.52	0.07
Household Size***	-0.23	0.00
Ordering Effect	0.085	0.71
Rural Registration*	-0.57	0.09
Rural registration×Public Provision	-0.81	0.16
N=498, -2LL=1547126.90, LLR=398940.13, Wald=69.82		

Note: *, **, *** indicate *p*-values <0.1, 0.05, and 0.01, respectively.

Table 14: Provision Preference for Mortality

Stated Preference of Provision Mechanism	Number of Respondents	Percentage %
Public/Government Provision	138	43.53
Private Provision	77	24.29
Indifference	98	30.91
Don't know and Missing Value	4	1.26
Total Number of Respondents Asked	317	

Table 15: Comparison of VSL and Per Capita Income

Country or Region	Income (annual per capita 2002)	VSL
China	$960 (Urban Resident, disposable)	$0.02-0.06 million
Taiwan	$14,000	$0.2-0.9 million
U S	$30,906	$1-10 million