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Building a Set of Internationally Comparable Value of Statistical Life Studies: Estimates of Chinese Willingness to Pay to Reduce Mortality Risk

Abstract: This study is the eighth in a series of stated-preference studies designed to enhance the basis for international benefits transfer of value of statistical life (VSL) estimates. The series has fielded essentially similar stated-preference surveys in Canada, China, France, Italy, Japan, Mongolia, the United Kingdom, and the United States. This Chinese study estimates the willingness to pay for contemporaneous and future mortality risk reductions of residents of Shanghai, Jiujiang, and Nanning, China using a stated-preference payment-card survey. The pooled VSL for a contemporaneous reduction in annual mortality risk reduction of 5 in 10,000 is about 1.47 million 2009 yuan ($614,805 U.S. $2016), with income elasticities of 0.2 to 0.25. This VSL estimate is at the lower end of estimates from the eight countries, between those from Mongolia and Japan, and in the mid-range of estimates of willingness to pay (WTP) for mortality risk reductions as a percentage of household income. We find lower discount rates in the Mongolia, Japan, and China studies than in those fielded in North America or Europe. The study also explores the relative performance of dichotomous choice and stated-preference card elicitation methods in a middle income country setting and develops a computerized "payment card" that allows testing for anchoring. Implicit transfer elasticities across countries, calculated using the VSLs we estimate and each country's income, relative to those of the United States, yields estimates of 0.88–0.95 for the lower income countries. These compare with the default assumption of 1.0 or assumed elasticities of 1.2 for developing countries.

Keywords: benefits transfer; China; dichotomous choice; environmental benefits valuation; health valuation; mortality valuation; payment card; risk valuation; stated preference; value of statistical life; anchoring; starting point bias.

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1 Introduction

As this symposium demonstrates, there is increasing demand for monetary esti-
mates of population health impacts in middle and lower income countries both
for use in evaluating national programs and for making global comparisons (see
also Bloom et al., 2012; Lomborg, 2013; World Bank IHME, 2016; Landrigan,
2017). There is particular interest in estimates of the value of reducing mortality
risk (termed the value of statistical life or VSL), the most significant benefit from
many population health and environmental programs (World Bank and IHME 2016
(air pollution); World Health Organization, 2015 (foodborne disease)). Yet, as a
practical matter for most countries, analysts must use benefits estimates developed
in other settings (see OECD, 2012). Such "benefits transfer" is most accurate when
benefits comparisons are drawn from studies conducted in settings as similar as
possible to those in which they are being applied (Johnston, Rolfe, Rosenberger &
Brouwer, 2015). A relatively large number of studies have been conducted in high
income countries (OECD, 2012). Unfortunately, there is a paucity of primary VSL
studies in low and middle income countries, which makes either finding appro-
priate country-specific VSL estimates or using benefits transfer from other low or
middle income countries or from high income countries difficult. (See the papers
in this symposium, including those by Robinson, by Hammitt, and by Viscusi and
Masterman. See also Hammitt & Robinson, 2011; Narain & Sall, 2016; Landrigan,
2017.)

This article presents new VSL estimates for urban China and contributes to a
set of studies explicitly designed to improve the capacity to transfer VSL values
between countries. The goal of this study is two-fold: first, to enlarge the pool of
high quality VSL studies in lower income countries; and second, to create a stronger
empirical "bridge" between VSL estimates in high income countries and those in
middle and low income countries as a means of strengthening the research founda-
tion for VSL benefits transfer from higher to lower income countries. The common
goal of the set of studies of which this study is a part is to use the same stated-
preference survey instruments to estimate the VSL in multiple countries. While
the survey instruments actually fielded vary slightly to accommodate differences in
local conditions, effort was made in all studies to keep the core of the survey as sim-
ilar as possible. These surveys have been fielded in cities in Mongolia (Hoffmann
et al., 2012), China (World Bank, 2007), the U.K., France, and Italy (Alberini, Hunt
& Markandya, 2006*b*), Canada (Krupnick et al., 2002), Japan (Itaoka et al., 2007),
and the United States (Alberini, Cropper, Krupnick & Simon, 2004). This article
presents results from a study using the instrument in additional Chinese cities.

This paper also strengthens the ability of Chinese researchers and policy makers to transfer VSL estimates within China. The survey was administered to stratified random samples that are representative of the urban population in each of three Chinese cities: Shanghai, Nanning, and Jiujiang. These cities were identified by the Chinese government as broadly representative of large, medium, and small cities in China. In the 2010 Chinese census, the urban population in Chinese cities ranged from less than 500,000, to Shanghai with 23.0 million people in urban districts (Shanghai Statistics Bureau of Statistics, 23 September 2011); Nanning had 2.9 million people (as cited in *"3-5主要年份各市按居住地分的城乡人口(2005-2014年)-数析网"*), and Jiujiang had 705,000 (as cited in http://www.citypopulation.de/php/china-jiangxi-admin.php). The survey examines both contemporaneous and future risk reductions of a size typically achieved by air pollution policy. The study structure allows testing for internal and external scope sensitivity, for discounting, and for responsiveness of willingness to pay (WTP) to variations in income, age, and health status. We know of no other stated-preference study in China that has all of these features.

Finally, the study advances our understanding of stated-preference survey methodology by developing a novel approach to studying anchoring effects in payment-card stated-preference elicitation. Payment-card elicitation was initially developed to overcome excessive yea-saying, a form of starting point bias or anchoring, observed in stated-preference surveys. Yet, the visual design of payment cards may also elicit its own form of anchoring bias. This effect has not been well studied. Such study is important because payment-card elicitation has performed better than dichotomous choice elicitation in several developing countries.

We developed a computerized payment card that permits exploration of possible anchoring. In addition, because in a prior effort to field this survey in Chinese cities we used both a dichotomous choice (DC) and a computerized payment-card ("payment screen") (PC) elicitation format (World Bank, 2007), we can explore the hypothesis that estimates from DC and PC elicitation differ because of excessive yea-saying, or anchoring bias in the DC but not the PC elicitation format.

This paper is organized as follows. Section 2 presents a review of the literature on stated-preference VSL studies in China, studies comparing DC and PC elicitation formats, and the literature on anchoring in stated-preference studies. Section 3 describes the methodology used in this study. Section 4 discusses data preparation. Section 5 presents key WTP results and comparisons with other Chinese VSL studies. Section 6 presents results exploring the possibility of anchoring induced by the PC elicitation format. Section 7 compares our results with those from the other countries using the same basic survey instrument and discusses their implications for international benefits transfer. The paper ends with a summary of results and a brief discussion of conclusions.

2 Literature reviews

2.1 Stated-Preference Studies of VSL in China[1]

There is a large and growing number of studies applying VSL estimates to measure policy impacts in China (Zhang, 2002; Aunan et al., 2004, 2007; Wang & Mauzerall, 2006; Mead & Brajer, 2008; Cao, Ho & Jorgenson, 2009; Zhang et al., 2010; Yang, Teng & Wang, 2013*b*; Aunan & Wang, 2014; Wang et al., 2015; Lu, Yao, Fung & Lin, 2016; Hua et al. 2013). Yet, there are only a handful of primary research studies estimating the VSL in China (Table 1).[2] One is a compensating wage differential study; the others use stated preference. These studies were conducted between 1995 and 2015. Our survey was fielded in 2006.

Past Chinese VSL studies vary widely in terms of both quality and quantitative estimates. Half of the eight studies in Table 1 either used convenience sampling or did not pass a scope test. Among the remaining studies, the VSL estimate from stated-preference surveys ranged from $150,619 to $1.1 million. Only one study clearly reported the size of the risk reduction. The high estimate is from a road fatality study. A recent meta-analysis finds that road fatalities have an ambiguous influence on VSL estimates, statistically higher VSL estimates in the meta-analysis's full sample models and not significant or lower VSL estimates when the sample is screened using the meta-analysis's authors preferred model (OECD, 2012). The one compensating wage study in Table 1 estimated a VSL of $65,587–$152,990, but noted that this estimate may be biased downward due to substantial unemployment compared with other compensating wage studies that can credibly assume full employment (Guo & Hammitt, 2009).

None of the Chinese stated-preference studies, including ours, use a nationally representative sample. Because of the size and economic and cultural diversity of China, one might expect regional variation in the VSL. All prior studies, except for those by Guo and Hammitt (2009), Zhai (2011), and Wang and He (2014), were conducted in urban areas (Table 1). Our study broadens the basis for estimating the VSL in China. We provide comparable results for three cities, Shanghai, Nanning, and Jiujiang, which were selected by the Chinese government as being representative of large, medium, and small cities. We know of no prior VSL studies in Shanghai and Nanning.

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1 In this review, we have not addressed issues with stated-preference studies in general, such as hypothetical bias. Johnston et al. (2017) provide a recent and comprehensive article on stated-preference best practices and issues.
2 We also found references to two additional studies (Li et al., 2002; Zeng & Jiang, 2010), but could not obtain the studies.

Table 1 Mean VSL for past mortality risk valuation studies in China.*

Study	Year survey conducted	Sample type	Risk type; reduction size #/10,000 population	Elicitation format	Scope tests	VSL ($US 2016)	Survey location
Yang, Liu and Xu (2016)	2014–2015	Random	Road fatality (public good); na	Double-bounded dichotomous choice	Passed[1]	$1,075,071	Nanjing
Wang and He (2014)	2000	Random	All cause cancer morbidity and mortality (private good); 100% of mean population cancer rate for 1 year	Multi-bounded dichotomous choice	na	$246,859–$417,761	Rural Danyang, Liupanshui, and Tianjin
Liu and Zhao (2013)	2011	Convenience	Road fatality (public good); 0.1–0.15	Choice experiment	Passed	$117,186	Dalian
Zhai (2011)	2006	Random	Fatality risk from tsunamis (public good); 20	Payment card	Not passed	$11,601	Coastal Tianjin
Ohdoko, Komatzu and Kaneko (2013)	2008	Convenience	Air pollution related cancer deaths (public good); 0–2.6	Choice experiment	Passed	$1,255,923 $1,672,901	Jiujiang Changsha

Table 1 (Continued).

Study	Year survey conducted	Sample type	Risk type; reduction size #/10,000 popula-tion	Elicitation format	Scope tests	VSL ($US 2016)	Survey location
Wang and Mullahy (2006)	1998	Random	All air pollution fatalities (public good); 0.5	Open-ended with follow up	na	$150,619	Chongqing
Hammitt and Zhou (2006)	1999	Random	Generic mortality, in survey about colds and bron-chitis (private good); 10	Double-bounded dichotomous choice	Not passed	$50,063–$100,126 $333,753–$600,756 $150,189–$200,252	Anqing Rural Anqing Beijing
Guo and Hammitt (2009)	1995 data	Random**	Occupational fatality (private good); 0.61	Compensating wage analysis	na	$62,587–$152.990	Eleven provinces

*Sources: OECD (2017), Purchasing power parities (PPP) (indicator). doi: 10.1787/1290ee5a-en (accessed on April 4, 2017). U.S. Consumer Price Index, all consumers, 1913–, https://www.minneapolisfed.org/community/teaching-aids/cpi-calculator-information/consumer-price-index-and-inflation-rates-1913 (accessed on April 4, 2017). DC = dichotomous choice; na = not applicable or not provided. **Registered urban residents only (have *hukou*), excludes migrants.
[1]Passing scope is defined as a decrease in risk being associated with a statistically significant increase in WTP for the risk reduction.

Prior Chinese studies vary by the type of benefit provided. All prior studies except for that by Wang and He (2014) and the two studies co-authored by Hammitt valued reduction of risk of death as a public good (Table 1). All studies except for those by Hammitt and Zhou (2006) and Wang and He (2014) asked about deaths from specific hazards, including road fatalities, tsunamis, occupational hazards, and air pollution. Ohdoko et al. (2013) and Wang and He (2014) elicited WTP to reduce risk of death from cancer. There is a substantial literature studying whether WTP to reduce risk of death is higher for cancer than other causes of death, namely the "cancer premium" (Viscusi, Huber & Bell, 2014). Our study elicited WTP for a private good that reduced risk of death. We did not specify the hazard creating the risk of death, and so the amount can be interpreted as the respondent's WTP to reduce a generic risk of their own individual death.

Current exposures or injuries can increase either contemporaneous or delayed risk of death. Among prior Chinese VSL studies, only Zhai (2011) estimated WTP for a delayed mortality risk reduction. Respondents were reminded, somewhat ambiguously, that "it may take 20 years to complete" construction of tsunami protection (Zhai, 2011). We ask respondents about their WTP during each of the next 10 years for reductions in their own risk of death over a decade of life starting at age 70. We also ask respondents about their WTP for contemporaneous reductions in their own risk of death. This clear delineation of the time when risk reduction occurs allows us to estimate a private discount rate for WTP for latent risk reductions.

The size of the risk reduction considered also varies among the studies. Prior Chinese VSL studies have looked at mortality risk reductions that range from (1/100,000 per year) to (20/10,000 per year) (Table 1). Our study examines risk reductions of 5 and 10 in 10,000 per year; reduction levels that are typical of those that have been achieved by policies that significantly reduced particulate air pollution in other countries.

Validity tests are increasingly looked to as evidence of stated-preference study reliability. Five of the eight prior Chinese studies were designed to test for sensitivity to the size of the risk reduction; only three passed this scope test in the sense that the study found a statistically significantly larger WTP for samples given the larger risk reduction (Table 1). Our study provides three tests of scope: (1) a direct comparison of single individuals responses (internal scope); (2) direct comparison of responses across individuals (external scope); and (3) tests for the statistical significance of the regression coefficient on the size of the risk reduction.

2.2 Payment-card studies

It has long been recognized that DC formats are subject to yea-saying bias, i.e., respondents tend to accept whatever bid is presented to them (Blamey, Bennett & Morrison, 1999). Yea-saying may be due to social acquiescence or anchoring on salient or first presented information (Blamey et al., 1999; Mitchell & Carson, 1989, 240–41). Mitchell and Carson (1981, 1984) developed the PC elicitation format as a means of addressing yea-saying bias observed in responses to open-ended and DC elicitation formats in stated-preference surveys.

Yea-saying or starting point bias has been offered as a reason why WTP estimated from DC surveys is typically higher than that estimated with PC formats (Champ & Bishop, 2006). In developed countries, WTP based on DC surveys generally has been found to be 2–4 times higher than that estimated using PC surveys (Holmes & Randall, 1995; Brown, Champ, Bishop & McCollum, 1996; Ready, Buzby & Hu, 1996; Welsh & Poe, 1998; Ready, Navrud & Richard Dubourg, 2001; Ryan, Scott & Donaldson, 2004; Blaine, Lichtkopper, Jones & Zondag, 2005; Champ & Bishop, 2006; Myers, Parsons & Edwards, 2010).

Payment-card elicitation presents respondents with a list or matrix of values and asks respondents to pick the value that most closely approximates their maximum willingness to pay for the good in question. The visual format of a payment card itself may inadvertently create anchoring points. This is most obvious with a list, but may also occur with a matrix. While the presence of starting point bias in DC stated-preference elicitation has been widely documented, there is far less research on whether or how it might occur with PC elicitation (Smith, 2006; Yang, Qing, Hu & Liu, 2013a). Smith (2006) compared three PC formats, a list ordered high to low, a list ordered low to high, and randomly sorted bid cards. It was found that WTP was higher for the high to low list than for the other two PC formats, suggesting that for lists, respondents may anchor on the first value seen when it is the highest value, but not when it is the lowest. Yang et al. (2013a,b) found evidence of starting point bias in PC elicitation about consumers' WTP for fair trade coffee in Wuhan, China, but did not describe the format of the PCs used. We develop a new approach to testing for starting point bias in a PC matrix that exploits the functionality of a computer screen. We intentionally create an anchor point in a computerized PC by randomly assigning the initial placement of a flashing cursor in a matrix of possible values and rigorously measuring the direction and distance the respondent moves away from that anchor to their final chosen value in the matrix.

There is an open question in the economics literature about the relative reliability of DC and PC elicitation formats in developing country settings. In industrialized countries, DC is widely used, in part due to a 1993 NOAA panel endorsement

(Arrow et al., 1993). Several researchers have suggested that yea-saying may be a greater problem for DC elicitation in developing countries because respondents more frequently lack experience with elections, may be more unaccustomed to being asked for their opinion on provision of public goods, may be more apt to fear those in authority, or may have a stronger culture of acquiescence (Zhongmin, Loomis, Zhigiang & Hamamura, 2006; Brown & Huff, 2011). It is also possible that PC elicitation may be more comfortable for respondents who typically bargain over price, more common in developing countries, rather than make purchases in fixed-price markets that are more common in high income countries.

There are a small, but growing, number of studies comparing performance of DC and PC elicitation formats in low and middle income countries (Zhongmin et al., 2006; Heinzen & Bridges, 2008; Jun-Peng & Yong, 2008; Zhang & Cai, 2010; Zhao et al., 2013). Most found that DC surveys produce higher WTP estimates than PC elicitation, but the studies provided only limited insight into why this may be occurring. In an earlier version of our China study, we administered a DC and PC version of the survey described this paper in Shanghai and Chongqing (World Bank, 2007). We found that a much higher percentage of respondents accepted all offers (yea-saying) in the DC version of the survey (21% of the sample in Shanghai) than chose the same bid in the PC version (10% of the Shanghai sample). Estimated WTP was 1.15–1.85 times as high in the DC as in the PC version of the survey. Finally, results from the DC version of the survey did not pass scope tests, in the sense of statistically significant increases in WTP with a decrease in risk, while those from the PC version did. Based on the literature described above and our own experience with using the DC survey in China (World Bank, 2007), we repeated the study using a PC approach. These new results are presented below.

3 Survey development

The survey instrument used in this study is in all ways except for the payment vehicle fundamentally the same as the survey we fielded in Shanghai and Chongqing, and fundamentally the same as those estimating WTP to reduce mortality risk in seven other countries (Krupnick et al., 2002; Alberini et al., 2004, 2006b; Itaoka et al., 2007; Hoffmann et al., 2012). The survey instrument used in these studies was translated into Chinese and adapted to reflect important demographic, cultural, and institutional conditions in China. In other respects, the survey was kept as close as possible to that administered elsewhere. In particular, it retains the same risk communication, risk comprehension testing, and the same elicitation design

that allows internal and external scope tests, and other robustness/validity testing described more fully in Hoffmann et al. (2012).

Focus group results led us to a change in the risk reduction vehicle used in the survey. In prior versions of the survey in high income countries, respondents were told that a "product" existed that they could purchase to reduce mortality risk by specified amounts. These surveys produced credible results. However, Chinese focus group participants did not find this product credible. In debriefings, they said that it brought to mind several recent, well-publicized cases in China of health products offered under fraudulent claims of efficacy. Working with focus groups, we developed an alternative that permits respondents to choose their method for reducing risk from among three options: a medical treatment, a prevention measure, and "other" measures. Focus group participants found this approach to be credible.

Focus group results suggested that the survey instrument used in high income countries could be successfully conducted in urban China with few other modifications. A concern prior to pretests was whether respondents, particularly older respondents, would be comfortable with using a computer to take the survey. Pretests showed that within five minutes or less, after initial assistance and brief training, ordinary Chinese respondents, even older respondents, were able to be self-sufficient in taking the computer-administered survey. Focus group results suggested that mortality risk reductions of 5 in 10,000 and 10 in 10,000 per year could be used in the study.

3.1 Survey questionnaire

All respondents were asked about their WTP for a 5 in 1000 and 10 in 1000 contemporaneous risk reduction over the next 10 years (Table 2). Half of the respondents (wave 1) were asked first about their willingness to pay for a 5 in 1000 risk reduction; the other half (wave 2) were asked first about their willingness to pay for a 10 in 1000 risk reduction. In both cases, for people under 61, the contemporaneous risk reduction question was followed by two delayed risk reduction questions. For people aged 61–65, the first question was followed by another contemporaneous risk reduction question followed by one with a delayed risk reduction (for people aged 61–65). Respondents over 65 were only given two contemporaneous risk reduction questions.

The contemporaneous risk reduction questions ask about a respondent's WTP for their choice of product or action that, when used and paid for over the next 10 years, will reduce baseline risk by x in 1000 over the 10-year period (Figure 1(a)). The delayed risk reduction questions ask about their willingness to pay for their

Table 2 Study design.

Group of respondents	Initial current risk reduction valued	Second risk reduction valued		Third risk reduction valued	
		Future risk reduction Age 40–60	Current risk reduction 61+	Future risk reduction Age 40–60	Age 61–65
Wave 1		5 in 1000	10 in 1000	5 in 1000	10 in 1000
Wave 2		10 in 1000	5 in 1000	10 in 1000	5 in 1000

Note: Respondents over 65 did not get a future risk reduction question.

choice of product or action that, when used and paid for over the next 10 years, will reduce their baseline risk by x in 1000, for a 10-year period beginning at age 70 (Figure 1(b)). The delayed risk reduction questions are preceded by a question concerning the respondent's perceived chance of surviving to age 80. This question encourages the respondent to think about their future life expectancy.

The survey design permits both internal and external scope tests. These tests involve comparing WTP responses across questions, either for an individual (the internal scope test) or between individuals (the external scope test).

3.2 Elicitation format

The elicitation uses a computerized version of a PC that we call a payment screen. All respondents see that same matrix of bids (Figure 1(a)). Respondents are asked to choose the bid most closely reflecting their maximum WTP. Possible bids range from 0 to 2500 yuan per year for 10 years. This covers the range of WTP found in other countries, converted to yuan using a purchasing power parity (PPP) exchange rate. Rowe, Schulze and Breffle (1996) found that PC elicitation did not show sensitivity to range as long as the range of respondents' desired bids was covered. Pretests found no indication that the 0–2500 yuan range was constraining respondents' choices. Intervals were designed to be roughly constant in percentage terms. Psychometric studies and experimental economics suggest this approach as a means of reducing response error (Rowe et al., 1996; Ready et al., 2001).

Computer administration of the survey allowed us to randomly assign an initial cursor placement within the matrix of possible bids to each individual respondent. For a given individual respondent, this initial cursor placement was kept the same for all WTP questions. If there were starting point bias, using the same starting point

(a)

(b)
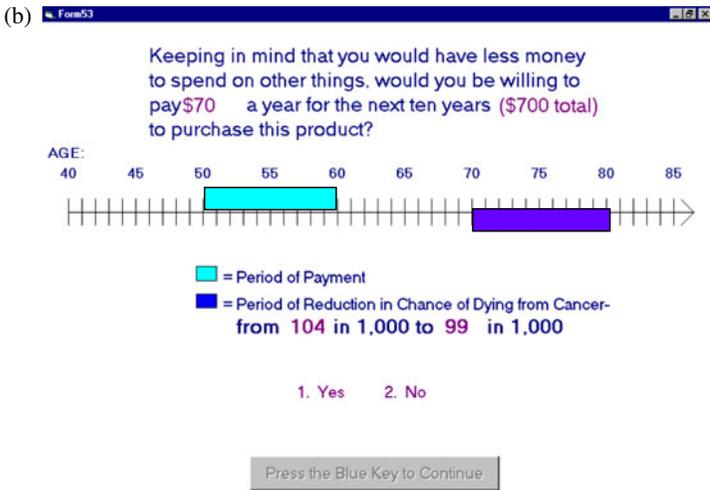
Figure 1 (a) The payment screen elicitation format. Current risk reduction. (b) Delayed risk reduction (in dichotomous choice format).

for each question for a given individual would work against finding sensitivity to scope, strengthening the internal scope test.

Use of a computerized payment screen rather than a paper PC allows us to track movement of the cursor between initial placement and final choice. This allows us to test for influence of the starting point on WTP. Coupled with debriefing questions and screening criteria, it also allows us to test the hypothesis that respondents who

click on a number further from the starting cursor position produce more consistent answers (are more engaged in the survey process) than those who click at or closer to the starting position. Finally, the randomized starting point and computerized tracking of cursor movements allow us to test for whether there is any bias in the direction of cursor movement, either numerically or visually.

3.3 Estimation model

The theoretical framework for this study is a life-cycle model of consumption linking WTP for mortality risk reduction and the VSL (Cropper & Sussman, 1990). This framework is described in depth in Alberini, Cropper, Krupnick and Simon (2006*a*).

We use estimation methods that are as similar as possible to those used in prior versions of the survey (Alberini et al., 2004; Hoffmann et al., 2012). Because we are using a PC format, the chosen WTP can be thought of in one of three ways. One, we estimate WTP as a direct estimate of the respondent's actual WTP (stated WTP). Two, we estimate WTP as the top end of an interval between the chosen number and the next lowest number (which we estimated using a Weibull and lognormal distribution, though we report only the former due to space concerns). Three, to be yet more conservative, we also set WTP at the value in the matrix immediately below the chosen number (which is similar to the lower Turnbull estimate in the DC version of the survey). In order of conservativeness of the WTP estimate, (3) is most conservative and (1) is least conservative.

3.4 Survey administration

The same stratified random sampling protocol was used in all study cities. Shanghai provides an example of this protocol. At the time of this survey, Shanghai had a population of 17,110,000. The city was divided into 18 urban districts which were subdivided into 100 communities (street offices in Chinese). These, in turn, were further subdivided into 3241 neighborhoods. Three urban districts (Pu Dong, Hong Kou, and Yang Pu districts), four communities within each district, and four neighborhoods per community were chosen at random. Within each neighborhood, households were randomly drawn from a "population information network" set up by the Shanghai Government to provide reproductive services to married couples. An adult aged 40 or over was chosen randomly from within the household. As most Shanghai residents over age 40 are married or living with younger married family members, this network provided us with sufficient information for sampling.

We recognize that people who never married, older people who do not live with their children (3%–4% of older people (State Statistical Bureau of the People's Republic of China, 2006)), and recent migrants were not included in the sampling frame. Chinese researchers advised that the population information network was the best available database for sampling in the studied cities and is widely used as a sampling frame in population surveys. Education, gender, and age structure were considered when sampling. The protocol oversampled older adults, calling for one-third of the sample to be 61 or over model to examine the relationship between age and WTP for reductions in mortality risk.

The survey was administrated on the weekends to accommodate working people. Neighborhood-center staff contacted respondents, inviting them to take the survey on the following weekend. Those who agreed came to the neighborhood center, where a Fudan University graduate student administered the survey. Participants were given a gift valued at 20 yuan for their participation. The survey was administered in 2006; 980 respondents completed the survey in Shanghai, 337 in Nanning, and 344 in Jiujiang. Response rates were about 64% in Shanghai, and higher in the other cities. Given the approach of obtaining interviews, such rates are not comparable to those of other more standard approaches used in the West.

4 Screening on response quality

We employed a number of methods recommended to address concerns about consequentiality and potential hypothetical bias (Kling, Phaneuf & Zhao, 2012). These included reminding respondents of their incomes and household expenditure needs, using focus groups to create as credible and consequential a choice setting as possible, and using follow-up questions and tests of understanding of probability to identify respondents who did not understand the survey or take it seriously (Table 3). Characteristics flagged included those who failed tests on understanding of probability (FLAG1), chose the initial cursor position for all choices (NOMOVE), always gave the same bid (SAMEBID), and those who said they did not understand probability, but still passed the probability tests (FLAG6). We also identified those who always bid zero (BAD ZERO) or always bid the highest possible amount (BAD 2500) and answered debriefing questions in a way suggesting that they did not believe the survey or had other problems with the survey. Finally, because life expectancy of Chinese urban dwellers at 65 is 84 for males and 87 for females (Li, 2015), people over 80 years of age are not expected to experience many of the benefits offered and were therefore dropped from the sample (OVER80). Table 3 reports descriptive statistics on these screening criteria.

Table 3 Descriptive statistics for full sample.

	Pooled (*n* = 1081)		Shanghai (*n* = 380)		Nanning (*n* = 357)		Jiujiang (*n* = 344)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age	54.47	10.29	55.43	10.22	54.55	10.28	53.32	10.31
Household income (yuan)	49,500	35,821	77,550	39,251	34,811	25,073	33,760	18,460
Household size	3.69	1.45	3.17	1.36	3.94	1.44	4.01	1.39
	Per cent							
Male	51.25		49.21		50.98		53.78	
Married	89		86.3		90.2		90.7	
Have some college education	11.1		22.37		5.6		4.46	
Buy commercial insurance	26.3		10		35.9		34.3	
Have had cancer	1.67		2.11		0.56		2.03	
Have high blood pressure	27.66		38.16		17.09		22.38	
Have had a coronary attack	5.99		10.5		3.6		3.5	
Have had a stroke	2.03		4.2		1.4		0.3	
Have had other types of heart disease	7.20		10.5		3.6		7.3	
Have diabetes	5.53		8.9		1.1		6.4	
Have chronic bronchitis	11.36		7.63		9.24		15.90	
Have asthma	4.26		3.7		2.8		6.4	
Have chronic obstructed pulmonary disease (COPD)	0.91		0.5		0.6		1.7	

Table 3 (Continued).

	Pooled ($n = 1081$)		Shanghai ($n = 380$)		Nanning ($n = 357$)		Jiujiang ($n = 344$)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Have visited an emergency room	8.12		8.4		3.6		12.5	
Have stayed in a hospital	2.56		3.9		0.8		2.9	
Expect to have worse health in 10 years	79.75		76.6		76.5		86.6	
Expect to have better health at 75	1.11		1.58		0.84		0.87	
Expect to live to age 80	45.08		65.3		45.4		22.4	
Failed probability test (FLAG1)	0.19		0.26		0		0.29	
Chose initial bid placement (NOMOVE)	9.63		7.37		8.96		12.50	
Always chose same bid (SAMEBID)	9.07		10.0		11.48		5.52	
Always chose zero + bad debriefing (BAD ZERO)	2.13		3.68		1.96		0.58	
Always chose 2500 + bad debriefing (BAD 2500)	0.18		0.0		0.56		0.0	
Said did not understand probability (FLAG6)	19.52		7.37		33.89		18.02	
Over age 80 (OVER80)	1.67		2.11		2.24		0.58	

Two screening approaches proved to be useful in explaining WTP. The first, screening approach A, dropped only those over 80 and those who failed the probability test. The second, screening approach B, additionally dropped those who failed any of the screening criteria discussed above (Table 3). Follow-up questions indicating that respondents were not taking the survey seriously were explored, but not found to explain WTP. In the pooled data across all cities, screening approach A dropped 2.3% of the sample; screening approach B dropped 34.3% (Tables 3 and 4).

5 Willingness to pay results

5.1 Descriptive statistics

Table 3 reports descriptive statistics in aggregate and across cities. Differences in income, education, and, to some extent, health are seen across the cities included in the study. The respondents from Jiujiang were slightly younger than those from Shanghai or Nanning (mean age of 53 compared with 55). This difference is statistically significant. A higher percentage of respondents in Shanghai had some college education (22.4%) compared with respondents in Jiujiang (4.5%) or Nanning (5.6%). The difference between Jiujiang and Nanning is not statistically significant. Mean household income in Shanghai was also significantly higher than that in the other cities – 77,550 RMB compared with Nanning (34,811 RMB) and Jiujiang (33,760 RMB). Income differences between Nanning and Jiujiang are not statistically significant.

Experience with health and health care is expected to affect WTP to reduce mortality risk, based on results in other countries. Differences between the percentage of respondents who believe they will live to age 80 in each of the three cities are statistically significant, 22.4% in Jiujiang, 45.4% in Nanning, and 65.3% in Shanghai. A higher percentage of respondents in Shanghai had some sort of heart disease than in Nanning and Jiujiang, and a higher percentage of respondents in Jiujiang reported having had asthma or bronchitis than respondents in the other cities. Fewer respondents in Nanning had had cancer than in Shanghai or Jiujiang. Respondents in Nanning were less likely to have visited an emergency room or stayed in a hospital than respondents in the other cities. A higher percentage of respondents in Jiujiang expected their health to be worse in 10 years (87%), even though they were slightly younger than respondents in Nanning or Shanghai (both about 77%). This difference is statistically significant. Various specifications of health status or experience were tried below in regressions explaining WTP.

Table 4 Willingness to pay (in yuan) under alternative data screening approaches.[a]

Screening Approach	Shanghai				Nanning				Jiujiang				Pooled			
	A		B		A		B		A		B		A		B	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Lower Turnbull																
WTP5°	177	560	143	614	166	667	43	1037	153	657	73	868	496	626	333	663
WTP10°	193	784	150	838	179	782	55	1159	188	865	89	1167	560	811	377	877
WTP5_70	145	520	111	565	138	468	47	738	126	400	59	588	409	466	284	506
WTP10_70	118	732	92	824	122	631	39	1185	127	755	70	1080	367	706	248	827
Scope tests	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p
5 versus 10	3.90*	0.00	3.48*	0.00	1.68*	0.05	0.79	0.22	3.53*	0.00	3.36*	0.00	5.19*	0.00	5.01*	0.00
5_70 versus 10_70	3.00*	0.00	3.13*	0.00	2.33*	0.01	2.86*	0.09	5.7*	0.00	4.81*	0.00	6.15*	0.00	6.64*	0.00
Discount test																
5 versus 5_70	0.75	0.23	0.77	0.22	2.93*	0.00	1.95*	0.03	4.57*	0.00	32.89*	0.00	4.64*	0.00	3.77*	0.00
10 versus 10_70	0.71	0.24	0.17	0.43	2.09*	0.02	0.16	0.56	1.68*	0.05	0.92	0.18	2.57*	0.01	0.10	0.16
Weibull																
WTP5°	168	606	142	687	161	753	43	1043	152	726	73	874	481	710	331	736
WTP10°	186	888	150	912	167	915	55	1166	187	943	89	1164	540	915	377	954
WTP5_70	139	606	111	633	129	551	45	774	123	458	59	593	391	541	282	565
WTP10_70	109	864	90	918	112	763	38	1218	127	823	70	1077	348	817	244	923

Continued on next page.

Table 4   (Continued).

Screening Approach	Shanghai				Nanning				Jiujiang				Pooled			
	A		B		A		B		A		B		A		B	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Scope tests	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p	t-statistic	p
5 versus 10b	62.50*	0.00	41.02*	0.00	2.62*	0.01	2.54*	0.01	4.85*	0.00	5.56*	0.00	128.5*	0.00	95.79*	0.00
5_70 versus 10_70	33.91*	0.00	30.15*	0.00	3.13*	0.00	3.96*	0.00	6.69*	0.00	7.38*	0.00	123.4*	0.00	111.69*	0.00
Discount test																
5 versus 5_70	0.00	0.5	8.91*	0.00	6.17*	0.00	5.86*	0.00	6.89*	0.00	6.31*	0.00	102.18*	0.00	72.69*	0.00
10 versus 10_70	3.24*	0.00	0.66	0.26	5.76*	0.00	4.46*	0.00	5.17*	0.00	4.32*	0.00	44.69*	0.00	9.84*	0.00

[a]Sample A: removed observation with FLAG1 or OVER80. Sample B: removed observation with FLAG1, OVER80, SAMEBID, NOMOVE, BADZERO, BAD2500, or FLAG6. WTPx is willingness to pay in yuan for an x in 1000 reduction of mortality risk over the next 10 years, or an x in 10,000 risk reduction annually. WTPx_70 is willingness to pay in yuan for an x in 1000 reduction of mortality risk over 10 years beginning at age 70, or an x in 10,000 risk reduction annually beginning at age 70.

The estimates for contemporaneous WTP are based on the first WTP question. The delayed WTP is based on the second and third WTP questions. There is not much difference between using only the second WTP question and using both the second and third WTP questions.

°First question.

*Significant at the 10% level based on a 1-tailed t-test.
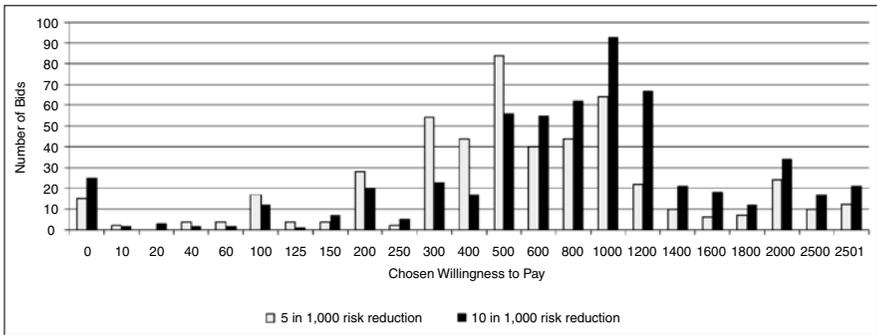
Figure 2 Frequency of current WTP by risk reduction (first question) for PC survey in Shanghai, Nanning, and Jiujiang (full sample).

5.2 Willingness to pay raw responses

Figure 2 shows the frequency distribution of raw responses (full sample over three cities) to the first WTP question by both waves, i.e., respondents who received either the 5 in 1000 or 10 in 1000 risk reduction question first. Low WTP values were chosen more frequently by those seeing the 5 in 1000 question first. From WTP of 600 and above, the relative number of those choosing a WTP category is higher for the group seeing the 10 in 1000 risk reduction question first. The figure also shows a tendency of responses to clump at the round numbers, i.e., 100, 1000, and 2000 yuan, a phenomenon that has been observed in past PC studies. The distributions for the screened samples (A and B) are quite similar to that shown in Figure 2 for the full sample, although the distribution for the 10 in 1000 first question is skewed toward the higher numbers relative to the curve for the 5 in 1000 distribution, and no respondents bid zero for the 10 in 1000 question.

5.3 Contemporaneous WTP estimates and external scope tests

Table 4 reports the WTP results for each city based on the two screening approaches. It should be noted that in screening approach B, we drop from 28% to 38% of the observations retained by screening approach A. The table contains WTP estimates for both contemporaneous and delayed risk reduction, and Wald test statistics for differences among these estimates. The WTP estimates were generated using lower

Turnbull, Weibull, and stated value models, but only the first two are given in the table.

The WTP associated with a contemporaneous 5 in 1000 risk reduction over 10 years (or 5 in 10,000 per year) varies across cities, estimation models, and screening approaches. By construction, the lowest values are for the lower Turnbull model and the highest for the stated value model (not shown), with the Weibull model falling in the middle. Even though Shanghai has higher income than the other two cities, it tends to have the lowest WTP values across the cities, a statistically significant difference. Screening approach B always produces larger values than screening approach A, but not all of these differences are significant. The Weibull model provides the most consistent results across the two screening approaches. External scope tests were passed for all contemporaneous risk models, except screening approach B in Nanning (Table 4). Pooling all observations, the average lower Turnbull WTP estimate for a 5 in 10,000 annual mortality risk reduction is 663 yuan, or a VSL of 1.33 million yuan.

Were these results used to estimate WTP for mortality risk reduction in urban China, we would recommend binning Chinese cities into cities that socio-economically match one of the three cities in this study and applying the lower Turnbull estimator and screening approach B. For comparison with other countries, we find the Weibull model results to be more consistent with those from past studies. With screening B, the Weibull estimate of WTP for a 5 in 10,000 annual morality risk reduction is 736 yuan (VSL = 1.47 million yuan).

5.4 Regression analysis on contemporaneous WTP

Table 5 presents results of pooled regressions examining the construct validity of the payment screen survey responses to the first WTP question using a Weibull model. We report two model specifications. Model 1 examines the effect of age, education, and income on the WTP response as well as testing for scope effects. Model 2 adds health and other covariates.

For both A and B screening samples, income and the 5 in 1000 risk reduction are both significant and of the expected sign. The negative and highly significant coefficient on the 5 in 1000 risk reduction variable indicates that responses pass external scope even after controlling for other factors. Per capita income is measured as reported household income divided by the corresponding household size. The coefficient on per capita income in log form varies from 0.07 to 0.22, which suggests an income elasticity of around 0.1 when the two risk change scenarios are

Table 5 Construct validity of WTP for the current risk reduction. Pooled data from Shanghai, Nanning, and Jiujiang; Weibull distribution; first question.

Variable	A sample		B sample	
	Model 1	Model 2	Model 1	Model 2
Intercept	6.16***	6.33***	5.46***	4.47***
	(0.05)	(0.37)	(0.41)	(0.68)
Age 51–60	−0.17***	−0.11**	−0.23***	−0.17**
	0.05	(0.05)	(0.06)	(0.06)
Age 61–70	−0.25***	−0.18***	−0.41***	−0.32***
	(0.06)	(0.06)	(0.07)	(0.07)
Age 71–80	−0.49***	−0.41***	−0.68***	−0.53***
	(0.09)	(0.09)	(0.11)	(0.11)
Education (1 = some college)	0.18***	0.27***	0.04	0.12
	(0.07)	(0.07)	(0.07)	(0.07)
Gender dummy (1 = male)	0.09**	0.08*	0.03	0.003
	(0.04)	(0.04)	(0.46)	(0.05)
Per capita income (log form)	0.07**	0.07**	0.14***	0.22***
	(0.02)	(0.02)	(0.03)	(0.04)
High blood pressure dummy		0.05		−0.000
		(0.05)		(0.06)
Bronchitis dummy		0.07		0.10
		(0.06)		(0.08)
Cancer dummy		−0.26**		−0.15
		(0.12)		(0.17)
Better health at age of 75 dummy (=1)		0.07		0.10
		(0.21)		(0.28)
Buy commercial insurance with one's own money dummy (=1)		−0.36***		−0.28***
		(0.05)		(0.06)
Jiujiang dummy		0.22***		0.31***
		(0.06)		(0.07)
Nanning dummy		0.23**		0.26**
		(0.06)		(0.07)
If the risk variable is 5 in 1000 reduction	−0.22***	−0.27***	−0.27***	−0.29***
	(0.04)	(0.04)	(0.05)	(0.05)
Shape parameter (ln_p)	0.39***	0.43***	0.47***	0.50***
	(0.02)	(0.37)	(0.05)	(0.05)
Number of observations	1020	1020	707	707

Note: *indicates significance at the 10% level; ** indicates significance at the 5% level; ***indicates significance at the 1% level. The reference base for city dummy is Shanghai; for age it is under 50. Standard error in parentheses.

pooled.[3] Based on separate regressions for 5 in 1000 and 10 in 1000 risk reductions, the income elasticity of WTP is 0.22 for the 5 in 1000 risk reduction case and 0.30 for the 10 in 1000 risk reduction case. Guo and Hammitt (2009) report income elasticities of 0.16 for Beijing, 0.2 for urban Anqing and 0.6 for rural Anqing. Wang and Mullahy (2006) report an income elasticity of 1.42 for China based on surveys in Chongqing. Alberini et al. (2004) report income elasticities of WTP for U.S. respondents ranging from 0.26 to 0.33 for 5 in 1000 risk reduction based on different model specifications.

Both gender (being male) and having at least some college education are positive and significant for screening approach A, but not for screening approach B. Differences among cities are highly significant, even after controlling for income, education, and health.

We also test for the effects of age on WTP for mortality risk reductions (Krupnick, 2007; Brey & Pinto-Prades, 2017; Robinson & Hammitt, 2016). We find that WTP declines with age. In both screening approaches A and B, coefficients for all age categories over 50 are negative relative to respondents aged 50 and under, and highly significant. We only observe responses of individuals from 40 to 80 years of age. Over this age range, we find a concave relationship between age and WTP, with the steepness of the downward slope increasing with age. This result is robust across model specifications and screening approaches.

Experience with health and individuals' degree of financial risk aversion would be expected to influence WTP to reduce mortality risk. Some studies using this basic survey instrument find health effects to be significant (Krupnick & Alberini, 2000; Alberini et al., 2004). We examined the influence of personal and family experience with a variety of illnesses on WTP, but the only influence of health on WTP we found was for respondents who had personally had cancer. These respondents were willing to pay *less* for the mortality risk reduction than those who had not had cancer. This result was significant only for screening approach A. We also found that after controlling for differences in income and other covariates, respondents who purchased commercial insurance, which we included as a measure of financial risk aversion, had a lower WTP for mortality risk reduction than those who did not. This result was robust to the screening approach used.

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3 The Weibull regression assumed that $WTP = \exp(x_i\beta)WTP_0^{1/\theta}$. A log transformation produces the equation $\log WTP = x_i\beta + (1/\theta)\log WTP_0$, where $\log WTP_0$ follows the type I extreme value distribution. If we log income in the regression, then the coefficient of income variable measures the elasticity of income. Of the three regions, Nanning has the highest income elasticity (0.19), followed by Jiujiang (0.23), and then by Shanghai (0.26).

5.5 Willingness to pay for delayed risk reductions

We also estimate WTP for delayed risk reductions for respondents aged 40–60. The pooled WTP estimate for a delayed risk reduction of 5 in 1000 over 10 years starting at age 70 ranges from 466 yuan per year for the screening approach A, lower Turnbull model to 565 yuan per year for the screening approach B, Weibull model (Table 4). Comparisons across cities are not robust to the screening approach. With screening approach A, WTP in Shanghai is statistically higher than in Nanning and Jiujiang. With screening approach B, WTP values in Shanghai and Jiujiang are similar and statistically lower than WTP in Nanning.

By comparing WTP estimates for the same risk reduction, but either contemporaneous or delayed, we can examine whether this delay resulted in a lower WTP, which is evidence for the use of discounting. The results from Nanning and Jiujiang show statistically significant discounting for all models except the lower Turnbull screening approach B. The Shanghai results do not show statistically significant discounting in the lower Turnbull model and mixed results with the Weibull model. Pooled data show strongly significant discounting with all models and both screening approaches (Table 4).

6 Payment screen cursor analysis to test for anchoring bias

The payment screen approach provides a unique opportunity to study how the structure of a PC affects respondents' behavior, because cursor movements can be digitally recorded. We recorded the initial, randomly assigned, cursor location for each respondent, their final choice, and the length of time they spent on each payment screen. Table 6 presents several variables created in order to describe how respondents moved around the payment screen from initial to final cursor placement. Use of these variables allows us to test for starting point bias and for level of engagement in the survey.

Starting point bias involves respondents anchoring on an initial bid, in this study the initial random cursor placement. Constraint in movement from the initial cursor placement is a necessary, but not sufficient, condition for starting point bias. For some respondents, the initial cursor placement is their true WTP. The default probability that a randomly placed cursor would appear over an individual's true WTP is 1/25 or 4%. With 25 possible cells (five rows and five columns) over which the cursor could appear, the probability that the cursor would appear in the same row or column as the individual's true WTP is 1/5 or 20%. Vertical move-

Table 6 Variables used in analysis of payment screen cursor movement.

Variable name	Variable definition
Cursor starting point	Initial x, y coordinates on the payment screen matrix
Cursor ending point	x, y coordinates associated with the final chosen WTP.
Absolute cursor movement	Sum of the absolute horizontal and vertical distance between the cursor starting and ending point. This ranges from 0 to 8.
Relative cursor movement	*Actual* absolute cursor movement as a percentage of total *maximum possible* absolute vertical plus horizontal movement from randomly assigned starting point.

ment between rows generally implies a greater numerical change than horizontal movements within rows.

T-test results suggest some evidence of anchoring: 9.5% of respondents did not move their cursor at all (nonmovers) compared with the expected 4%; this difference is statistically significant. Only slightly fewer respondents moved out of their assigned row or column than expected (19% did not move vertically and 18% did not move horizontally compared with the expected 20%).

The amount of time respondents spend on the survey may be evidence of lack of engagement. We find no statistical difference in the length of time spent on the survey by those who fail to move the cursor according to one of our three definitions and those who do. It is possible that people with a lack of cursor movement are those who would get dropped for other reasons. We tested this hypothesis for each of the three ways in which respondents might "not move" from where the cursor was randomly assigned. Those who did not move at all from their randomly assigned cursor position were statistically more likely to be dropped from the sample under screening approach B than others. Those who moved horizontally, but not vertically, or who moved vertically, but not horizontally, were no more likely than others to be dropped from the sample. We found few other statistically significant relationships between each of the individual criteria for dropping respondents and any of the variables describing a lack of movement from the initial cursor position.

We also tested the hypothesis that personal characteristics of nonmovers are different from those of movers. The only statistically significant difference we found was that a higher percentage of respondents from Jiujiang (12%) were nonmovers than respondents in Nanning (9%) or Shanghai (7%). For all but one debriefing question, there was no statistically significant difference between movers and nonmovers. Those who did not believe the probability of dying given their age and gender applied to them were also more likely not to move the cursor than those who did believe the probability of dying provided on the basis of population

mortality statistics. This may indicate that these respondents were not "buying into" the survey.

The critical question is whether the cursor starting point affects WTP. We tested for equality of WTP between movers and nonmovers using an F-test, a Wilcoxon–Mann–Whitney test, a Kruskal–Wallis test, a Kolmogorov–Smirnov test, and a median score test. None of these tests shows a difference in WTP between movers and nonmovers.

Table 7 presents regression analyses examining the influence of cursor movement on WTP for current risk reductions. The regressions include variables that are generally found to explain WTP as well as the randomly assigned starting value. The random cursor placement coefficients are statistically significant for both the lower Turnbull and Weibull models with screening approach A, but insignificant for the Weibull model for the preferred screening approach B. Using the lower Turnbull model, an increase in the starting value of one yuan results in an increase in WTP of 0.1 yuan – a 10% bias. With the preferred screening approach B, this bias is 5%. In the preferred Weibull model, the effect is significant for screening approach A, but very small, and zero for preferred screening approach B. That is, a higher starting point value tends to be associated with a higher WTP. This effect is greater when WTP is assumed to be the value immediately below the chosen WTP (lower Turnbull model) than when chosen WTP is assumed to represent the upper end of an interval between the chosen WTP and the next lower value on the payment screen (Weibull model).

To sum up, while there is evidence that more nonmovers were observed in the study than would be expected with completely random behavior taken as a whole, and we see some evidence of starting point bias influencing WTP, the effect ranges from zero for the preferred screening method and model to 10% for the less preferred model. It is also worth noting that we found sizable percentages of respondents who choose round numbers in the matrix (such as 100 and 1000). To counter this well-known tendency (Pope & Simonsohn, 2011; Lynn, Masaki Flynn & Helion, 2013), perhaps PCs should be constructed without round numbers.

7 Comparisons with results from other countries using the same survey

Table 8 reports selected results from the eight studies using essentially the same survey instrument as we used in China, with a few exceptions as noted above. For comparability purposes, Table 8 presents results from Weibull models and a contemporaneous (or latent) 5/1000 risk reduction over the next 10 years. All values

Table 7 Regressions on WTP on the first WTP question for current risk reduction with random starting WTP value.

Variable	Lower Turnbull		Weibull	
	Screening A	Screening B	Screening A	Screening B
Intercept	756.08***	559.52	7.13***	6.66***
	(252.70)	(389.52)	(0.26)	(0.44)
Random starting WTP cursor placement	0.10***	0.05*	0.0001***	0.00002
	(0.02)	(0.03)	(0.00)	(0.00)
Age	−8.41***	−12.68***	−0.011***	−0.02***
	(1.95)	(2.42)	(0.00)	0.00
Some college	146.89**	57.56	0.21***	0.08
	(59.15)	(68.33)	(0.07)	(0.08)
Per capita income (000 yuan)	40.31**	81.56**	0.03	0.10**
	(19.49)	(31.87)	(0.02)	0.04
Good/excellent present health dummy	7.85	41.79	0.05	0.08
	(37.76)	(44.76)	(0.04)	(.05)
Buy commercial insurance with one's own money dummy	−247.04***	−121.87**	−0.33***	−0.26***
	(43.13)	(55.16)	(0.05)	(0.06)
Risk 5	−195.44***	−242.89***	−0.25***	−0.30***
	(35.59)	42.07	(0.04)	(0.05)
	LR chi2 (pr. > chi2)		Scale	
	138.62***	89.77***	0.43***	0.50***
	(0.00)	0.00	(0.02)	(0.03)
N	1010	677		

Note: * indicates significance at the 10% level; ** indicates significance at the 5% level; *** indicates significance at the 1% level. The reference base for city dummy is Shanghai; for age it is under 50. Standard errors in parentheses.

are converted to $US using PPP exchange rates in the year of the survey and then adjusted to 2016 dollars using the U.S. All Items Urban Consumer Price Index (CPI). Both internal and external scope tests were passed in China, Canada, the United States, Japan, and Mongolia. Modifications to the survey design used in the U.K., France, and Italy did not permit an external scope test. The World Bank classified both Mongolia and China as lower middle income countries at the time surveys were fielded in each country (World Bank, 2017). All other countries where this survey was fielded were classified as high income countries.

Table 8 Mean VSL by country and study using the 5 in 10,000 annual risk change and Weibull model ($US figures obtained with PPP conversions and CPI adjustment to 2016).

	China* Shanghai, Jiujiang, Nanning	Canada Hamilton, Ontario	United States Entire country	Japan Shizuoke	U.K.± Bath	France± Strasbourg	Italy± Five cities	Mongolia* Ulaanbaatar
WTP (current 5 in 1000) as a % of mean household income	1.49%	1.00%	1.45%	0.81%	1.59%	7.71%	3.50%	3.3%
Current VSL: 5/1000 $US (millions)	0.61**	1.04	1.72	0.74	1.31	5.09	2.55	0.64
Scope test: ratio of WTP values for 10 versus 5 in 1000 changes	1.3	1.3	1.6	1.5	NA	NA	NA	1.15
Future VSL: 5/1000 $US (millions)	0.47	0.59	0.77	0.54	0.57	1.40	0.97	0.45
Ratio of future to contemporaneous VSL	0.77	0.57	0.45	0.73	0.44	0.27	0.38	0.70

*Payment screen elicitation. All other surveys use DC elicitation.
±Scope tests were not conducted.
**In $US 2016, the Chinese VSL for a current risk reduction is $614,805 and for a future risk reduction is $471,963.

Table 8 reports mean WTP for a 5 in 1000 contemporaneous risk reduction as a percentage of mean household income. The value for China, 1.49%, is roughly comparable to that in the United States and the U.K. (1.45% and 1.59%, respectively). The values for France, Mongolia, and Italy are higher and cover a larger range (3.3%–7.7%).

China has the lowest VSL for the contemporaneous 5 in 1000 risk reduction ($0.61 million); slightly lower than that for Mongolia, the other developing country in which the survey was conducted.[4] The contemporaneous VSL for Japan is also low ($0.74 million). China also has the lowest VSL for a future risk reduction of the same magnitude ($0.47 million), again, roughly comparable to Ulaanbaatar, Mongolia and only slightly less than Japan and the U.K.

The Chinese cities have the highest ratio of future to current VSL (0.77), driven primarily by Shanghai. All three Asian countries have high ratios (0.70–0.77) compared with the western countries (0.27–0.57). The results suggest that the Chinese may be more future oriented than people from other countries – a result in line with reported household savings rates in urban China of nearly 30% compared with savings rates in western countries of close to zero or even negative (Horioka & Wan, 2006).

With all of the studies in Table 8 put into (nearly) comparable terms, we can begin to examine the efficacy of using benefits transfers by comparing such transferred estimates with the actual VSL estimates from the country itself. Benefits transfers are performed by taking a VSL from a "study site" and transferring it to a "policy site." The transfer itself can be performed in a number of ways, but the most prevalent is to base the transfer on income differentials across countries (see, e.g., Hammitt & Robinson, 2011 and papers in this symposium). The studies cited in Table 8, as well as a long history of research underlying national VSL estimates, show that WTP to reduce risk is sensitive to income (Lindhjem, Navrud, Axel Braathen & Biausque, 2011), but also to cultural, demographic, and other factors that may differ across countries. The influence of these nonincome factors suggests that transfers based solely on income differentials may not provide entirely accurate assessments of policy site preferences for mortality risk reduction. Estimates of WTP using primary research in different countries, as reported in Table 8, reflect differences in both income and non-income influences on WTP to reduce mortality risk and thus can provide some insight into the importance of considering nonincome influences in benefits transfer.

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4 As with our Chinese study, the Mongolian study only surveyed people living in an urban area, Ulaanbaatar. Ulaanbaatar is Mongolia's capital and by far its largest city. With a population of 1.3 million in 2013, Ulaanbaatar accounts for slightly less than a third of the national population (National Statistics Office of Mongolia 2017).

Formally, WTP for risk reduction, expressed in inverted demand form, is a function of the risk reduction, real income, and prices of other goods, holding other influences constant, i.e., $\text{WTP}_i(r) = f(r, P_i, Y_i; Q_i)$. If risk reduction is a normal good, then countries with higher real incomes should have higher VSLs than countries with lower real incomes, all else being equal.[5] Typically, the percentage difference in VSLs between the study and policy site countries is assumed to be proportional to the percentage difference in real incomes, meaning that what we refer to as the transfer elasticity equals one. We use the term transfer elasticity to distinguish it from a standard income elasticity of WTP for mortality risk reductions, which is usually estimated in a regression of income on WTP *within* a country.[6] Hammitt and Robinson (2011), Narain and Sall (2016), and Viscusi and Masterman in this issue review the use of such transfer elasticities. Recent work by the World Bank (i.e., Narain & Sall, 2016; World Bank, 2016) assumes that the income elasticity to use for transferring a U.S. or other developed country VSL to a developing country (low or middle income) is greater than 1.0, specifically 1.2, while the elasticity to transfer between developed countries is assumed to be 0.8.

Because we have estimated a VSL in a number of possible "policy and study countries" using essentially the same survey, we can compare these estimates with transferred VSL values and test the accuracy of the above assumptions. The first section of Table 9 presents income estimates both for the year the study was conducted and for 2015 converted to U.S. dollars using PPP adjustment factors. The most recent year for which there are internationally comparable estimates of real gross national income (GNI) per capita is 2015. The second section of Table 9 presents VSL estimates for each country cited in Table 8 adjusted to \$US 2015. The second row of the second section of Table 9 presents the implied transfer elasticities – i.e., the ratio of the percentage difference between the empirically estimated VSL for each country of interest and the United States relative to the percentage difference between GNI per capita in each country and the U.S. GNI per capita. These empirical estimates range from −4.89 in France to 2.17 in Japan; the estimate for China is 0.90 and that for Mongolia is 0.88. These ratios are consistently different from one; those for our two lower income countries are less than, not greater than, one, in contrast to that suggested in the World Bank analysis. The third row of the second section of Table 9 makes these comparisons more explicit by showing what

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[5] For more on this topic, see other papers in this issue, particularly Hammitt as well as Viscusi and Masterman in this symposium.

[6] The basic elasticity relationship of percentage change of one variable of interest, here VSL, in response to a percentage change in the other variable, here income, can be solved for the variable of interest, here VSL, in either discrete, $\text{VSL}_1 = \text{VSL}_0 (1 + \varepsilon *\% \text{ change in income})$, or continuous form, $\text{VSL}_1 = \text{VSL}_0(\text{Inc}_1/\text{Inc}_0)^{\varepsilon}$. Empirically, estimates based on the two approaches can differ when the elasticity or change in income is large. We use discrete estimates.

Table 9 Impact on benefits transfer of adjusting for inflation only versus adjusting for inflation and income growth: mean VSL by country and study using the 5 in 10,000 annual risk change and the Weibull model.

	China*	United States	Japan	UK	France	Italy	Mongolia
Income							
Year survey conducted	2006	2000	1999	2002	2002	2002	2009
Study year real GNI per capita (constant 2011 $US)*	9313	46,267	33,433	34,951	35,825	37,030	7082
2015 real GNI per capita (constant 2011 $US)	10,932	53,442	39,313	37,975	38,399	34,028	10,851
Adjusting for inflation							
VSL ($US 2015) adjusted for U.S. inflation only	608,388	2,119,512	904,660	1,292,727	5,038,322	2,519,161	624,266
Estimated transfer elasticity	0.90	NA	2.17	1.35	−4.89	−0.52	0.88
VSL ($US 2015) if transfer elasticity = 1 and the U.S. VSL estimate is transferred	433,555	2,119,512	1,559,158	1,506,073	1,522,907	1,349,558	419,641
Adjusting for inflation and income growth							
VSL ($US year survey conducted)	517,514	1,540,000	635,934	981,273	3,824,448	1,912,224	565,000
Income elasticity of household WTP from regressions	0.22	0.33	0.41	0.51	0.51	0.51	0.60
% Change in real GNI per capita ($US 2011) from year survey conducted to 2015*	17.4	15.5	17.6	8.7	7.2	−8.1	49.4
Estimated transfer elasticity	0.85	NA	2.13	1.39	−4.88	−0.24	0.76
VSL ($US 2015) adjusted for inflation and income growth	631,651	2,227,982	969,900	1,349,772	5,222,946	2,415,009	809,343

Transfer elasticity = (% difference between VSL in United States and study country)/(% difference between GNI/capita in United States and study country).
Income elasticity of household WTP is the estimated income elasticity of demand taken from construct validity regressions in each study.
*International price adjustments are conducted using PPP factors to adjust to U.S. dollars. *Source*: World Development Indicators: Table 4.16. Exchange rates and prices; World Development Indicators: size of the economy; PPP GNI per capita in 2015. Income is taken from World Bank, GNI per capita, PPP (constant 2011 international $), accessed at http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.KD. Chinese income calculated from 2011 Chinese GNI per capita, PPP and Chinese PP estimates for 2006, 2011 and 2015, based on World Bank methods for extrapolating PPP estimates, https://datahelpdesk.worldbank.org/knowledgebase/articles/665452-how-do-you-extrapolate-the-ppp-conversion-factors, accessed May 15, 2016.
**Inflation adjustment made using U.S. All Items Urban CPI.

the $2015 VSLs would be in each country were one transferring U.S. VSLs to each country under the assumption that the transfer elasticity is 1.0. The differences in these VSL estimates are substantial.

Over time, real income within a country may change. Where changes in real income are substantial, it becomes important to reflect the responsiveness of WTP to income in VSL estimates. Major U.S. regulatory agencies include such updating for real income growth, based on estimates of the income elasticity of WTP for mortality risk reduction in the United States or on assumptions, as part of their standard adjustment of the VSL used in their regulatory impact analyses (see Hammitt & Robinson, 2011).[7] In the third section of Table 9, we present income elasticities of WTP estimated for each of the countries where this survey was conducted except Canada, where the form of the income variable did not permit estimation of a comparable income elasticity. These income elasticities reflect the responsiveness of WTP estimates to income differences *within* each study country. This is the conventional concept of an income elasticity of WTP for mortality risk reduction. Both China and Mongolia have experienced significant real income growth in recent years (Table 9). Thus, failure to account for such growth biases estimated VSLs downwards. In Table 9, we compare "inflation adjusted" and "inflation and income growth adjusted" VSLs. In the case of Mongolia, the VSL is 30% higher when responsiveness to real income growth is taken into account. A lower row of Table 9 shows the effect of taking real income growth into account on transfer elasticities. When this is done, the transfer elasticities for China and Mongolia fall, further widening the gap between them and the assumed transfer elasticity appearing in the literature of 1.0 (or even 1.2).

8 Conclusion

Standard practice in estimating mortality benefits from pollution policies in countries where no in-country estimates are available or are of insufficient quality is to assume that the VSL from the policy site is proportional to the VSL from the

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7 DOT and HHS now use elasticities of 1.0, EPA uses a range. See U.S. Environmental Protection Agency, 2015, *BenMAP: Environmental Benefits Mapping and Analysis Program – Community Edition User's Manual*, prepared for the Office of Air Quality Planning and Standards by RTI International (http://www2.epa.gov/sites/production/files/2015-04/documents/benmap-ce_user_manual_march _2015.pdf). U.S. Department of Health and Human Services, 2016, Guidelines for Regulatory Impact Analysis (https://aspe.hhs.gov/pdf-report/guidelines-regulatory-impact-analysis), (Primer: https://aspe. hhs.gov/pdf-report/guidelines-regulatory-impact-analysis-primer). U.S. Department of Transportation, 2016, Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in Departmental Analyses – 2016 Adjustment (http://www.dot.gov/regulations/economic-values-used-in-analysis).

study site based on their difference in income (a transfer elasticity of 1.0). Certainly this approach is preferable to an alternative approach that assumes that the VSL is identical in all countries. The latter approach would result in unrealistically high ratios of the VSL to the real GNI per capita and would likely be much higher than mitigation costs, biasing toward too much cleanup. At the same time, preferences for reducing risk of death may well have a lot to do with cultural differences and other factors beyond income differences. Therefore, assuming, as is standard practice, that transfer elasticities are around 1.0 may not reflect underlying preferences, under- or over-estimating the VSL.

It is usually difficult to test these propositions because studies estimating the VSL in one country are so different from those used in another country. The research reported on in this paper enables such a test because the same basic survey instrument was used to estimate the VSL in eight countries, including both developed and developing countries. This paper describes results from one of these studies conducted in China, adding the eighth country to the comparison.

Comparing across the eight countries in which this survey has been fielded, we see substantial difference in contemporaneous VSL estimates, ranging widely across countries from $614,805 ($US 2016) for China to $5.09 million ($US 2016) for France, adjusting for inflation only. Most contemporaneous VSL estimates range from $0.61 to $2.55 million ($US 2016). Estimates of VSL for China and Mongolia, the two low to middle income countries in the set, are lower than they are for the six high income countries in absolute terms, but not as a percentage of mean household income. Willingness to pay for future risk reduction is lower than WTP for current risk reduction in all countries. China, Mongolia, and Japan are future oriented, with ratios of future to contemporaneous VSLs of 0.70–0.77, compared with western countries which have ratios of 0.27–0.57.

Using the contemporaneous VSL estimates and income differences across countries in our sample, it is clear that the VSLs computed using a transfer elasticity of 1.0 do not match up well with VSLs estimated directly. Interestingly, the percentage difference between the U.S. VSL and the Mongolian or Chinese VSL estimates is only slightly less than proportional to the income differences of these countries with the United States (0.88 and 0.90, respectively) when VSL estimates are only adjusted for inflation, but these transfer elasticities become smaller when the VSLs are adjusted for income growth in each country before the comparison is made. These results reinforce the need for more VSL studies in low and middle income countries to strengthen the empirical basis for benefits transfer to low and middle income countries.

Finally, our study in China gave us the opportunity to use a payment "screen" (an electronic and more flexible version of the payment card approach) as a new

type of method for elicitation of WTP. It has been suggested in the literature that elicitation using payment cards works better in terms of passing scope tests in developing countries than elicitation using a dichotomous choice approach. Our experience supports this argument. While we find some evidence of starting point bias in the sense of less movement from the starting point than would be expected randomly, we find no statistical difference in WTP between participants who moved their cursor from the starting point and those who did not.

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