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ABSTRACT. This paper compares protest rates and willingness to pay (WTP) using a payment card versus single and double bounded voter referendum contingent valuation question formats. Using a chi-square test, the payment card had a significantly higher protest rate (6.7 per cent) than the voter referendum question format (2.2 per cent). The median WTP of the single bounded and double bounded referendum format exceeds the payment card by a factor of nine and seven, respectively. The median WTP from the referendum formats represent about 8 per cent of income, while the payment card results represents about 1 per cent of income. These large differences in WTP between question formats are double what have been found in past studies. We believe this result may be due to excessive yea saying at high bid amounts in the dichotomous choice question formats. This behavior may arise in our case study in rural China because citizens have not had a long history of open elections or voting on tax referenda.

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Introduction

Interest in protection of environmental quality is increasing worldwide. Some of it may be due to the growing awareness that the well being of people is closely tied to the health of natural ecosystems and the services these natural systems provide (Daily, 1997). The increasing attention toward environmental quality has brought forward proposals for clean-up and restoration of natural environments. However, most developing countries face competing high priority social investments including education, transportation, etc. In our case study in China, the country's ambitious plan of western-style development has growing environmental costs, which have become apparent to Chinese scientists and the government. As such, China is beginning to consider restoration of watersheds degraded by intensive agricultural development.

Problem statement

One method used by government and development agencies to evaluate competing investments is benefit–cost analysis (BCA). BCA requires that all benefits and costs including non-market ones be quantified. The contingent valuation method (CVM) has been used extensively for valuation of environmental quality (Carson *et al.*, 1994), and is seeing increased application in less developed countries as well (Whittington, 2002). Initial applications of CVM in developing countries were 'proof of concept', investigating whether CVM could be applied to low education respondents residing in limited cash economies (Whittington *et al.*, 1990). CVM surveys are now becoming more commonplace in countries throughout the world (de Dios Ortuzar *et al.*, 2000; Whittington, 1998) especially for valuing water supply infrastructure (Anand and Perman, 1999; Phuong and Gopalakrishan, 2003). However, as noted by Whittington (2002) and Memon and Matsuoka (2002), additional research on CVM in developing countries is needed. Specifically, Whittington urges split sample experiments to test the robustness of results to differences in CVM designs. To date, there has been only one split sample test of CVM that we are aware of in a developing country, that of Memon and Matsuoka.

To accept the challenge of Whittington (2002) and build upon Memon and Matsuoka, our paper uses a split sample to explore the performance of three different question formats for eliciting a household's willingness to pay (WTP) for restoration of an oasis ecosystem and associated water related ecosystem services in rural China. We compare the payment card, single bounded and double bounded dichotomous choice elicitation methods in terms of the relative number of households refusing to pay, and the median WTP. We then discuss the merits of the three WTP elicitation methods for use in CVM surveys and offer some modifications to the traditional dichotomous choice questions. In performing this methodological comparison of WTP question formats, this paper builds upon and extends Zhongmin *et al.* (2003) which just applied the payment card method. Thus, besides the methodological comparison of the merits of different WTP question formats in countries without open elections, this paper will also explore the sensitivity of the previous

WTP results of Zhongmin *et al.* to use two alternative WTP question formats.

WTP elicitation methods

CVM involves a description of the good to be valued, a means by which the respondent will pay (e.g., higher taxes, water bills), and a format to elicit respondent WTP. Originally, respondents were asked an open-ended question requiring them to simply state their maximum WTP. This WTP question format is demanding on respondent's cognitive abilities, and they often leave the question blank. Mitchell and Carson (1989) developed a payment card approach to reduce the item non-response associated with open-ended WTP questions. The payment card does this by displaying a range of dollar amounts (including zero) on a card, and allowing the respondent to circle their maximum willingness to pay. In some ways, the payment card resembles a familiar pledge card used by charities or conservation organizations to elicit donations.

The payment card approach has been eclipsed by the dichotomous choice question approach to CVM first used by Bishop and Heberlein (1979) and subsequently endorsed by the NOAA panel on CVM (Arrow *et al.*, 1993). In the dichotomous choice approach a respondent simply indicates whether they would pay a given monetary amount (X), where the level of X varies across the sample. Thus, the dichotomous choice question format is a price-taking approach similar to a market situation. The approach can also be cast as a voter referendum, with the decision rule or provision rule being the majority rule. The dichotomous choice approach is believed to be potentially incentive compatible if the choice has some consequences to the respondent (e.g., the government may use the results of the survey to provide the public good and increase taxes – see Carson *et al.* 2000). Research by Hoehn and Randall (1987) and Carson *et al*. (2000) suggests that dichotomous choice WTP questions are more likely to yield estimates of maximum WTP than open-ended WTP questions.

Unfortunately, dichotomous choice questions may be susceptible to yea saying, whereby a respondent simply agrees to pay the monetary amount they are asked (Kanninen, 1995; Ready *et al.*, 1996; Berrens *et al.*, 1997). A variant of the dichotomous choice approach, which is called dichotomous choice with a follow-up WTP question or the double bounded dichotomous choice (where each respondent is asked two linked WTP questions), is believed to be even more susceptible to yea saying (Herriges and Shogren, 1996). The propensity for yea saying is hypothesized to be partly due to (1) it takes less thought to respond to a bid posted in the survey than to formulate your own WTP; (2) the dichotomous choice question format puts the respondent who is favorable to the public project but faces a high bid amount in a quandary, i.e. either to say 'No' to the bid amount and possibly signal they do not want the project – when in fact they may, but only at a lower price – or to say 'Yes' to a bid amount higher than their true WTP to signal overall support of the project. Loomis *et al.* (1999) have found some evidence of this problem in valuation of open space. This tendency for yea saying may be exacerbated in countries where people do not have experience with open elections or voting on tax referenda. For

example, Bell (2004) at Resources for the Future recently commented that in Asia 'traditional attitudes of deference to governments and authority' are common. These traditional attitudes of deference are reinforced by the fact that local people are: (1) not routinely asked their opinion on policies; (2) fearful of government and may have a tendency to provide a socially acceptable answer.

The payment card does not lend itself to yea saying, in part because a respondent favorably inclined toward the project but with a low WTP can circle a low monetary amount that may be reflective of their true WTP rather than feeling compelled to say 'Yes' to the particular monetary amount they are asked to pay. Further, this flexibility of the payment card may reduce the number of households that protest the WTP question, i.e. refuse to pay for the project based on perceptions of inequity of having to pay rather than their personal benefits and costs.

While there have been some comparisons of WTP elicited using payment card and dichotomous choice CVM, there are none we are aware of using the double bounded dichotomous choice format. The first comparison of single bounded dichotomous choice and the payment card by Holmes and Kramer (1995) found that WTP elicited by dichotomous choice CVM substantially larger than from a payment card for forest protection from insects. The authors attributed the higher WTP from dichotomous choice CVM to yea saying with that format. The most direct test of the single bounded dichotomous choice question format and the payment card was performed by Welsh and Poe (1998). They found WTP for protection of the Grand Canyon National Park environment elicited using the dichotomous choice approach was nearly three times that of the payment card. However, a limitation in their study is the reliance on undergraduate students. Ready *et al.* (1996) provided a comparison using a sample of adults asked to value safety of grapefruits from pesticides. They too found that dichotomous choice yielded estimates of WTP 2–4 times larger than the payment card. However, a recent study by Ready *et al.* (2001) showed that this gap can be narrowed if respondents are instructed to use a pre-specified level of certainty in answering each type of question. This reduces the dichotomous choice CVM WTP estimate down closer to the payment card. While there are comparisons of payment card and dichotomous choice in the health economics field that also show WTP from single bounded dichotomous choice CVM is substantially larger than WTP from the payment card (Ryan *et al.*, 2004), we are aware of no comparison of the payment card with the double bounded dichotomous choice, and no comparisons of the payment card and dichotomous choice approaches for valuing environmental restoration in a developing country.

Informal hypotheses and study objectives

We suspect that yea saying in countries where citizens do not have substantial experience with open elections may result in a larger divergence in WTP between the payment card and dichotomous choice question formats than has been found in the past. This may be due to the tendency of residents to give supportive answers to government institutions like state

research institutions, the fear of opposing government action, or the novelty of surveys (Bell, 2004). While casting the dichotomous choice as an advisory referendum has the potential to make it incentive compatible, the analogy of the dichotomous choice to referendum voting is somewhat strained in countries where citizens have not had experience of voting in free and open elections. These countries are just now having elections for officials, and voting on referenda involving raising taxes to pay for public projects is rare.

Further, we are interested in whether the double bounded dichotomous choice approach would mitigate this problem. In past studies, the double bounded dichotomous choice has substantially lowered WTP compared to single bounded dichotomous choice (Hanemann *et al.*, 1991). Thus it is possible that there may be closer correspondence between WTP elicited with the payment card and the double bounded dichotomous choice elicitation methods than with single bounded dichotomous choice. However, to our knowledge this has not been previously compared.

Thus the objectives in this study are to compare WTP and protest responses from the payment card to the single and double bounded dichotomous choice WTP question formats for a watershed restoration project. Differences in protest responses will be tested using a chi-square test. The differences in WTP between payment card and single/double bounded dichotomous choice will be evaluated using confidence intervals around the WTP measures.

Case study of environmental restoration

To compare WTP question formats we value a watershed restoration of the Ejina oasis in the Inner Mongolia Province of China. Ejina oasis, located at the lower reach of Hei River Valley, is one of the two largest inland river valleys in China. This river valley is spread out over three provinces including Qin Hai, Gansu, and Inner Mongolia. Hei River's water resources are the basis of Ejina ecology, economic development, and people's lives. Water use has grown rapidly over the past 40 years due to economic growth and population increasing in the middle of Hei River. However, the flow in the lower reaches of the river has decreased by 44 per cent during the period from the 1950s to the 1990s. Generally, the river flow stops in the Ejina River from May to July, when agriculture production peaks due to increased irrigation water withdrawls from the mid Hei River. From August to October runoff in Ejina River begins to increase due to increasing snow melt in the high mountains. Runoff then decreases and entirely disappears after November.

The reduction of runoff directly threatens the existence of the Ejina ecosystem. Much of the cultivated land in 1960 has now been reduced and the rest of the cultivated oasis has turned into desert. The area of degraded forest and desert grassland has increased since 1960.

Due to the desert area increasing and oasis area decreasing in Ejina, sandstorms have increased recently in the middle of the Hei River (Wang and Cheng, 1999). This deterioration of the Ejina watershed has a huge influence on much of northern China. In the spring of 2000, an unprecedented heavy sandstorm event took place in Beijing, Tianjin, and

their neighboring areas. The dust mainly consisted of soil particles from the Enjina watershed. This storm had adverse effects on air quality, with very thick dust creating traffic problems, and aversely affected other aspects of people's daily life and health. This storm resulted in several types of economic losses, including reduced sunlight to cultivated land resulting in a decrease in its production.

Ejina watershed proposed restoration program

The Ejina oasis is the first barrier to sandstorms in the middle of the Hei River valley and northwestern China. As a result, the government and the Hei River management bureau decided to consider conservation measures to restore Ejina's ecosystem. These measures include restoring the natural vegetation to establish an effective ecological protective shield in Ejina, to reduce the magnitude of the sandstorm problem. It is estimated that this restoration effort will cost approximately 600 million RMB (the RMB is the Chinese currency, $1USD equal to 8.3 RMB) in total over five years. Thus, the economic efficiency question is whether these costs are worth the benefits to the Chinese people.

Survey design

Obtaining accurate benefit estimates using CVM requires detailed descriptions of the resource being valued. The cover and first section of the survey provided a series of maps to remind respondents where the Ejina oasis is located and of its current condition. The first section showed the location of Ejina and discussed the history of the area. The respondents were told that their answers would be used as input at all levels of government in its study of restoring Ejina ecosystem services. We feel the respondents believed that the survey results would be used by the government since the survey team were identified as members of the Chinese Academy and the regional university, making it quite credible that these survey team members have access to government officials.

Second, respondents were handed a card that listed the five key ecosystem services that restoring Ejina ecosystem could provide, which are: (1) control soil erosion and reducing sandstorms, (2) provide habitat for wildlife, (3) natural purification of water, (4) dilution of wastewater, and (5) curb land salinization. The current state and restored level of each individual ecosystem service, along with the current management methods, were described and illustrated in detail in the survey questionnaire. At the same time, the means by which ecosystem services could be restored from their current level were also described in detail.

Due to uncertainty over what are acceptable payment mechanisms for this watershed restoration program, respondents were given the option of the type of payment they would make. The four methods of payment were: (a) donation, (b) ecological protection tax, (c) water bill, and (d) other. Before the respondent expressed their WTP, these payment vehicles were presented to them, and they were asked to choose their preferred means of payment. While this is not a standard approach for conducting a CVM, it was believed necessary for the Chinese context, where finding a single acceptable payment vehicle was unlikely. As noted below in the results

section, the percentage of respondents choosing each payment vehicle is similar and not statistically different, thus our comparison of the effects of WTP question format should be unaffected by this feature of our CVM survey.

WTP question formats

The wording of the CVM question section is as follows:

> If the majority of households agree to pay the costs of restoring Ejina ecosystem, the Ejina's ecosystem will be restored to the level of the early 1980s.
>
> If a majority of households are not willing to pay the costs of restoring Ejina ecosystem, the Ejina ecosystem will remain in the current conditions and deteriorated as its current tendency, at last, it has the likelihood to disappear in the world like the historic country 'LouLan'.

While not central to our comparison of payment card and dichotomous choice WTP question formats, the wording above may be less than ideal. First, the concept of an ecosystem is not always well understood by everyone, although it is becoming a popularly used word, even in rural China. Second, the statement 'likelihood to disappear' may be too general such that different respondents interpret the probabilities of disappearing differently. Since this was the same wording used for both the payment card and the dichotomous choice, it should not affect our comparison as long as these concerns influence payment card and dichotomous choice responses equally.

For the payment card version, the WTP question was:

> If the project of restoring Ejina ecosystem is at the stage of raising capital, if you vote in favor of it, please draw a circle around the maximum amount your household would vote for and a line under the lowest amount your household would switch to a 'No' each year for the following 20 years.

The payment card included 11 different dollar amounts ranging from zero to 300 RMB.

For the single bounded voter referendum format, the question wording for people who indicated in the initial screener question that they were willing to pay some amount was: *If an increase in your household's costs for the next 20 years by _____ (RMB) each year to restoring Ejina Ecosystem, would you vote in favor? (Please circle) 'Yes' 'No'*

In the single bounded voter referendum question format the chosen cost ____(RMB) was randomly filled in with one of 13 bid amounts (2, 5, 10, 15, 20, 35, 50, 75, 100, 150, 200, 250, 300). The RMB amounts were chosen based on the initial results from the payment card analysis.

In the double bounded question follow up, the second bid amount was higher or lower, according to the respondent's answer to the first WTP question. If the respondent said 'Yes' to their first bid amount (for example, 10 RMB), then the second bid was chosen by the interviewer at the next higher bid in the above bid list (that is to say, the second bid is 15 RMB). If the respondent said 'No' to 10 RMB, then the interviewer used the next lowest bid amount on the list (i.e., 5 RMB). For the extreme bid amounts of 2 and 300, we added new bids 1 and 400, so that there were 15 bids for

the follow-up question and 13 bids at the initial question. Finally, there is a series of personal questions, aimed at knowing the respondents' reactions to the interview and to obtain respondents' socio-economic information.

Sample design and implementation

The sampling frame were households living within Hei River valley. We first divided the region into two strata: (a) the main valley and (b) the surrounding district. In-person interviews were used for both the payment card and the dichotomous choice questions. Sufficient funds were available to allow for in-person interviews of 700 households for the payment card and 500 households for the dichotomous choice (note that given the relative informational inefficiency of dichotomous choice responses as compared to payment card, the larger sample size should have been allocated to the dichotomous choice method rather than more information efficient payment card).

Within the two main strata, there was a total of nine regions or 'countries' that were used as the next sampling strata. Within each of these nine strata, two or more towns or villages were randomly selected. This resulted in 24 towns or villages being sampled. These towns/villages would be considered the primary sampling units. Within each of these towns/villages, 10–35 households were sampled, with the exact number sampled within each town/village being proportional to its population size. Thus households are considered the primary elements. To identify individual households to be sampled within the primary sampling unit, random digit dialing was used in cities and towns that have the telecommunication network to choose a total of 324 households for the payment card treatment and 224 households for the dichotomous choice treatment. Phone coverage in the cities and towns is quite good with 72 per cent of households in this area having phones (China City Statistical Yearbook, 2003). In more rural and remote regions that have no telephones, we collected the names of the heads of households and recorded them on a slip of paper. Then a random drawing of household names from a box was used to select a total of 376 households in the payment card treatment and 276 households in the dichotomous choice treatment.

The initial contact phase involved briefly explaining the general topic of the survey and soliciting agreement to complete an in-depth in-person interview at the appointed time. With a view to increasing the response rate, examples provided by Dillman were used for developing the questionnaire's cover, and a 2 RMB bill was presented as a token of appreciation (before beginning the interview).

Before directly asking how much respondents would pay for restoring the Ejina watershed and its services, we gave the respondent five minutes to reflect on why they might care about restoring the Ejina watershed. People are aware of controversy regarding drying out of the river through diversions because of dissension on how to allocate water resources between the middle of the Hei River and the Ejina River, for economic and ecological purposes. Residents of the Hei Valley have been exposed to extensive sandstorms resulting from the degradation of the Ejina

Table 1. *Distribution of dichotomous choice and payment card refusals to pay*

	Number and percent of respondents			
	Dichotomous choice		*Payment card*	
Response	*Number*	*Percentage*	*Number*	*Percentage*
Willing to pay some amount	423	84.6%	646	92.3%
'restoring ecosystem service is not worth this money to me'	5	1.0%	0	0.0%
'I can't afford to pay this amount'	16	3.2%	7	1.0%
'It is unfair to expect me to pay for increasing ecosystem services'*	5	1.0%	17	2.4%
'Restoring Ejina ecosystem services cannot get expected effect'*	2	0.4%	8	1.1%
'I am opposed to paying for this government program'*	2	0.4%	17	2.4%
Other reasons*	4	0.8%	5	0.7%
Did not finish completely the questionnaires	43	8.6%	N/A	N/A
Total**	500	100.0%	700	100.0%
Total considered protest	13	2.6%	47	6.7%

Notes: *Classified as a protest response. ** Due to numeric rounding, the totals do not equal to one hundred percent.

watershed that have adversely affected their normal routine. Thus, Hei Valley residents have suffered from the sandstorms associated with the drying out of the river and oasis, and they are becoming more aware of the process of soil desertification in their region. We believe from these experiences that Hei Valley residents have some knowledge about the watershed and range of services it currently provides and would provide if restored.

Response rate and protest responses

Adopting in-person interviews resulted in high response rates to our survey. Response rates were 96 per cent from the main valley and surrounding district. Out of 700 payment card contacts, 695 interviews were completed. For the dichotomous choice, there were 500 contacts, with 457 questionnaires completed. The high response rate may be attributed to our follow-up efforts and to the novelty of being asked to participate in a survey.

A series of follow-up check questions were asked to determine if those refusing to pay represent a valid representation of their value or reflect a protest about some feature of the CVM scenario (Mitchell and Carson, 1989). As shown in table 1, the check question had five response categories

plus an 'other' category. The first two categories were, 'restoring ecosystem service is not worth this money to me' and 'I cannot afford to pay the amount'. The two categories represent valid reasons for indicating why they would not pay and are *not* considered to be a protest response against the survey. In the dichotomous choice and payment card WTP questions, about 3 per cent and 1 per cent, respectively, of respondents stated they would not pay any amount and checked inability to pay as the reason.

The third, fourth, and fifth response categories are often classified as protest or scenario rejection responses. These included, 'It is unfair to expect me to pay for increasing ecosystem services', 'Restoring Ejina ecosystem services cannot get the expected effect', 'I am opposed to paying for this government program'. The percentage of each of the two samples selecting each reason is summarized by type of WTP question in table 1.

The bottom of table 1 is quite instructive in that the payment card has nearly three times the protest rate as the dichotomous choice question format. Using a chi-square test of the sum of protest responses across the two samples crossed with question format, indicates a statistically significant difference at the 1 per cent level (calculated chi-square is 11.914). This lower protest rate for dichotomous choice WTP question format might be another indicator of the yea saying problem with this question format as compared to the payment card.

Estimation of willingness to pay

Payment card

In the payment card (PC) format, respondents are confronted with an ordered sequence of bids where they choose the maximum amount they are willing to pay. Following Welsh and Poe (1998), WTP responses are treated in form of intervals instead of point valuations. T_L is defined as the maximum amount that the respondent would pay and T_U to be the lowest amount that she would switch to a 'No' rather than a 'Yes' response. WTP then lies somewhere in the switching interval $[T_L, T_U]$, where individual WTP values are estimated using parametric models. Since the distribution of WTP values is often skewed, the lognormal distribution is chosen (Cameron and Huppert, 1989)

$$\mathrm{Ln}WTP = X'\beta + \mu \tag{1}$$

where X are the characteristics of a respondent or the public good and μ is normally distributed with zero mean and standard deviation σ, and β are regression coefficients. We are essentially using a multiple bounded likelihood model, where WTP becomes a random variable (Welsh and Poe, 1998). The probability that a respondent will select a given monetary amount is

$$\Pr(yes) = \Pr(WTP \geq T_L) = 1 - G_{WTP}(T_L) \tag{2}$$

where $G_{WTP}(T_L)$ is the cumulative distribution function of the random WTP variable. The probability that WTP falls between any two price thresholds is $G_{WTP}(T_U) - G_{WTP}(T_L)$, resulting in the corresponding log-likelihood

function for all n respondents

$$\text{Ln}(L) = \sum_{i=1}^{n} \text{Ln}[G_{WTP}(\eta T_U - \gamma X_i) - G_{WTP}(\eta T_L - \gamma X_i)] \tag{3}$$

where $\gamma = \beta/\sigma$ and $\eta = 1/\sigma$. By using the estimated values of β and σ we can obtain Ln*WTP*. The conditional mean of the Ln*WTP* for any given vector of variables will be βX, and the mean of the untransformed WTP variable is $\exp(\beta X + \sigma^2/2)$ and the median is $\exp(\beta X)$ (Dudewicz and Mishra, 1988). Because mean WTP is more sensitive to the disturbance standard deviation σ, in our analysis, the median of WTP will be calculated and compared across question formats.

Dichotomous choice voter referendum

Since the printed RMB amount varies across the sample, the dichotomous choice voter referendum format allows the analyst to statistically trace out a relationship between probability of a 'Yes' response and the RMB amount (Hanemann, 1984).

The basic relationship is

$$\Pr(yes) = 1 - \{1 + \exp[B_0 - B_1 X]\}^{-1} \tag{4}$$

where Bs are coefficients to be estimated using either logit or probit statistical techniques and X is the monetary amount (in RMB) the household was asked to pay. At a minimum, the coefficients include the bid amount the individual is asked to pay. Additional coefficients may include responses to attitude questions or the respondent's demographic information such as age, education, membership in environmental organizations, etc. From equation (4), Hanemann (1984) provides a formula to calculate median WTP

$$\text{Median } WTP = B_0/B_1 \tag{5}$$

where B_1 is the coefficient estimated on the bid amount and B_0 is either the estimated constant (if no other independent variables are included) or the grand constant calculated as the sum of the estimated constant plus the product of the other coefficients times the value of the respective independent variables for each individual. Note this formula for the median implies a mean WTP calculated from plus infinity to minus infinity. Confidence intervals around the associated willingness to pay measure are constructed using the Krinsky and Robb method applied to dichotomous choice CVM by Park *et al.* (1991).

The double bounded version of discrete response contingent valuation follows up on the initial question with a second question, again involving a specific cost to which the respondent can respond with a 'Yes' or a 'No'. Let A denote the amount of the first bid. The amount presented in the second bid depends on the response to the first bid; if the individual answered 'No' to A, the second bid is some lower amount $A_d < A$, while if they answered 'Yes' it is some higher amount $A_u > A$. Thus, there are four possible response combinations: (a) both answers are 'Yes'; (b) both answers are 'No'; (c) a 'Yes' followed by a 'No'; and (d) a 'No' followed by a 'Yes'. In this way, the

latent WTP amount is limited to a narrower interval than the single binary choice question, and thereby a higher statistical efficiency is achieved.

For any given underlying WTP distribution $G_C(\cdot)$, the probability of the responses is given by equation (6)

$$\begin{aligned} \Pr(yes/yes) &= P^{yy} = 1 - G_c(A_u) \\ \Pr(no/no) &= P^{nn} = G_c(A_d) \\ \Pr(yes/no) &= P^{yn} = G_c(A_u) - G_c(A) \\ \Pr(no/yes) &= P^{ny} = G_c(A) - G_c(A_d) \end{aligned} \tag{6}$$

Given (6), the log-likelihood function for the double bounded model is equation (7)

$$\mathrm{In}L = \sum_{i=1}^{n} \left[I_{yy} \mathrm{In} P_i^{yy} + I_{yn} \mathrm{In} P_i^{yn} + I_{ny} \mathrm{In} P_i^{ny} + I_{nn} \mathrm{In} P_i^{nn} \right] \tag{7}$$

where P^{xz} is an indicator function that equals one when the two responses are xz, and zero otherwise. When the probability density function of WTP is assumed to be logistically distributed, the same formula as above can be used to calculate median WTP. An alternative statistical modeling strategy of Cameron *et al.* (2002) is to pool dichotomous choice and payment card data, and jointly estimate the underlying utility function directly to account for potential differences in heterogeneity between question formats. She found this can reduce the disparity between WTP estimated by the two question formats. This approach is an interesting avenue for further research.

WTP results

Before comparing WTP results, it is worthwhile noting that, while respondents were given the flexibility of selecting among payment vehicles, the distribution of payment vehicles selected is similar and not statistically different between the dichotomous choice and payment card WTP question formats. In particular, in the payment card question format 76 per cent, 11 per cent, 6 per cent, and 6 per cent chose donation, ecological protection tax, water bill, and working, respectively. In the dichotomous choice, these were 77 per cent, 9 per cent, 7 per cent, and 7 per cent for the same categories of payment vehicles. A chi square test on the absolute number of respondents in each category by WTP question format yields a calculated chi-square of 1.024, far below the critical value of 7.815 with three degrees of freedom.

To provide the reader with an intuitive feel of the WTP responses with the payment card and dichotomous choice CVM, we wish to describe a couple of patterns of the raw data. First, in the payment card, about 7.3 per cent of the respondents circled a zero WTP amount. This is nearly identical to the 7.4 per cent of dichotomous choice respondents, who, when initially asked if they would pay anything (as a screener to determine whether to ask the bid amount), indicated they would not pay anything. Thus at the zero WTP end, having a zero on the payment card and a 'won't pay anything' screener to the dichotomous choice CVM question worked equivalently. However, with the payment card only 3.4 per cent of respondents circled 200 RMB and

Table 2. *WTP equation results*

	Coefficient(t statistic)		
Variable	*Payment card*	*Single bounded DC*	*Double bounded DC*
Constant	1.761 (8.04**)	0.341(2.655**)	0.567 (2.18*)
Bid	N/A	−0.013(9.684**)	−0.016(12.5**)
Urban	0.177(2.79**)	−0.437(2.420*)	−0.439 (1.985*)
Education	0.057(2.97**)	0.168(3.093**)	0.134(2.76**)
Income	0.179E–03 (7.15)**	0.252E–04 (2.443*)	0.375E–04 (2.41*)
Log likelihood	−1094.6	−188.666	−460.641
Sample Size	646	423	423
Median WTP	19.37	173.86	143.71
Confidence interval (95%)	16.72–22.01	152.11–199.80	130.74–159.75

Notes: **significant at the 0.01 level. *significant at the 0.05 level.
Urban: equals one if a person lives in an urban/suburban area; it equals zero if the person lives in a rural/farm area.
Education: specifies years of schooling the respondent has undertaken.
Income: is household's annual income.

none circled 300 RMB. This contrasts with the pattern of responses in the dichotomous choice survey. Here, ten times as many respondents (36 per cent) indicated they would pay 200 RMB and 3.45 per cent indicated they would pay 300 RMB. The double bounded dichotomous choice responses suggests yea saying may be even more prevalent in response to the second bid as slightly more than 50 per cent (0.536) of respondents to the double bounded dichotomous choice gave 'Yes–Yes' responses, meaning they said 'Yes' to their initial bid amount and then 'Yes' again to the higher follow up bid amount.

Table 2 presents the results of the payment card, single bounded and double bounded voter referendum logit models. In the two voter referendum logit models, the bid coefficient is negative and statistically significant. The positive signs on the education and income coefficients are found for both dichotomous choice and the payment card with responses. However, the sign on the urban coefficient flips from positive in the payment card to negative in the voter referendum dichotomous choice.

The bottom lines of table 2 present the median WTP and 95 per cent confidence intervals. The difference between the two dichotomous choice and payment card methods is dramatic. The single bounded estimate of median WTP (173.86 RMB) is nine times that of the payment card, while the double bounded estimate of the median is smaller (143.71 RMB), but still seven times that of the payment card (19.37 RMB). There is no overlap in confidence intervals, suggesting the voter referendum dichotomous choice estimates are statistically different from the payment card. Including the 7.4 per cent of dichotomous choice respondents that indicated they would not pay anything does not change our median WTP, but would reduce the

mean by 13 RMB and 10 RMB, for the single and double bounded models, respectively. Thus, the differences between payment card and dichotomous choice do not appear in our sample to be driven by the whether zero WTP is an option or not in the dichotomous choice but rather the yea saying at higher bid levels in the dichotomous choice method.

These differences between payment card and dichotomous choice questions are much larger than differences of three- to four-fold found in past payment card–dichotomous choice comparisons (Welsh and Poe, 1998; Ready *et al.*, 1996; Ryan *et al.*, 2004). This supports the initial concern that yea saying might be more of a problem in countries that do not have a history of open elections or citizens voting on referenda. The much larger difference in WTP between PC and DC CVM in our study as compared to other studies may also be influenced by focusing on 'ecosystem restoration', which is a less well-defined good than has been used in some comparisons (e.g., Ready *et al.*, 1996) but it is similar to the commodity in Welsh and Poe (1998).

Without a criterion validity test it is always difficult to know what is the true WTP. Is the payment card too low or is the potentially incentive compatible dichotomous choice too high? In this case we can gain some insight into this question by comparing the median WTP estimates against per capita income in the region. The median WTP from the payment card represents about 1 per cent of yearly per capita income. In contrast, the dichotomous choice median estimates represent about 8 per cent of income. While the Ejina watershed is important in the daily lives of people living in the region, given their relatively low income to meet basic needs, it is unlikely that individuals would be able to afford to devote 8 per cent of their income to restoration of the Ejina watershed. Thus it seems plausible that the yea saying may be inflating WTP from the voter referendum dichotomous choice question format.

We suspect that some of this difference between payment card and dichotomous choice may be due to a very large income disparity between respondents coupled with the random assignment of bids. The payment card avoids this bid assignment problem since the respondents select their WTP. Perhaps a way to avoid this bid–income mismatch problem in the dichotomous choice format in samples with large differences in income (whether rural vs urban, or within developing countries) may be to ask respondents their income and then have a random set of bids stratified by income. This is similar in spirit to the way Mitchell and Carson tailored their anchored payment cards in their water quality study (Mitchell and Carson, 1989). Another solution to the possibility of yea saying is the trichotomous choice approach of Loomis *et al.* (1999). Here the respondent is given an additional option to saying 'No' to the bid amount: 'I would vote in favor but a lower price'. This allows the respondent to indicate if they desire the project but not at the bid amount. This would be particularly effective at reducing the number of 'Yes' responses at high bid amounts.

Conclusions

There are numerous conceptual advantages to the dichotomous choice WTP question format as compared to the payment card approach. One of these is the potential incentive compatibility of an advisory referendum format of

the dichotomous choice question. However, in the past comparisons of the payment card and dichotomous choice questions, WTP from dichotomous choice questions was three to four times higher than WTP elicited using a payment card. This has been attributed to yea saying in the dichotomous choice question format.

We hypothesized that in countries where citizens have not had the freedom to express opposition to government proposals, yea saying might be even more pronounced, leading to even larger differences between WTP elicited by the two formats. Further, the analogy of the dichotomous choice to referendum voting is somewhat strained in countries just now having open elections for officials and rarely voting on referenda involving raising taxes to pay for public projects.

In our case study of restoring the Ejina watershed in north central China, we found that median WTP elicited using the single bounded voter referendum question format was nine times larger, and using the double bounded dichotomous choice seven times larger than the payment card. The median WTP from the dichotomous choice voter referendum questions were about 8 per cent of income, as compared to 1 per cent from the payment card approach. Given the low income of the population, we believe it is unlikely they could afford to devote 8 per cent of their income to restoration of this watershed. This suggests the payment card approach or alternatives such as the trichotomous choice model approach may be more appropriate for eliciting WTP for environmental improvements in countries that do not have a tradition of open elections than referendum style dichotomous choice questions. In these situations, the lack of potential incentive compatibility in the payment card or trichotomous choice WTP question format may not be a critical drawback. However, replication in other countries and for other, perhaps more well-defined environmental issues, is needed before this suggestion can be generalized into a recommendation.

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