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Evaluation of Households' Willingness to Accept the Ecological Restoration of Rivers Flowing in China

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During the past decade, many urban rivers in China have undergone ecological restoration overseen by government agencies at the local and national level. Ecological restoration efforts such as this can improve the welfare of urban residents. This study reports the willingness to accept (WTA) for Pingjiang and Guangtaiwei rivers degradation in Suzhou based on a contingent valuation study of 426 respondents. Our results indicate that 48% of respondents would not accept any money as compensation for river degradation. The mean WTA estimate for those willing to accept a finite amount of compensation is 39,607 RMB, while the median WTA estimate for this group is 25,000 RMB. Results from the econometric model show that residents who have previously donated in support of environmental causes, are more satisfied with the river, more frequently come in contact with the river, who are employed, and who own a house are less likely to provide a finite WTA amount. Moreover, the results also indicated that residents who have lived around the river for longer periods, who live near the river, who are younger, who have larger families, who have not donated to environmental issues, and who are unsatisfied with the landscaping around the river are willing to accept more money. Our results provide an estimate of the average welfare loss associated with not restoring rivers, while also suggesting that there is considerable heterogeneity in the responses of those willing to accept a finite WTA payment as well as those who reject such compensation. © American Institute of Chemical Engineers Environ Prog, 38:e13094, 2019

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INTRODUCTION

Increasing government investment has accelerated the ecological restoration of urban rivers within the Yangtze River Delta area. As a result, some rivers' pollution has been controlled effectively, as seen through a significant improvement in the surrounding environment. Following these improvements, it becomes important to discuss the effectiveness of environmental input, as measured by the change in residents' welfare and the distribution (and degree of distribution) of river residents after ecological restoration.

The contingent valuation method (CVM) is used to evaluate the benefits of ecological restoration projects [1,2]. It assumes that reliable information about the monetary values of specific projects can be obtained from respondents if they are provided with sufficient information to make informed decisions. This prompts a consideration of the properties of different preference elicitation formats and how to best present information related to the good of interest. Willingness to pay (WTP) and willingness to accept (WTA) are two types of measurements in the CVM structure [3,4]. Typically, WTP is used for welfare evaluation; however, WTA is the correct welfare measurement for the issue at hand.

Existing studies have theoretically discussed the disparity between WTP and WTA in microeconomic theory. Several explanations for this disparity have been suggested, such as commitment costs [5], the absence of substitutes [6], transaction costs and income effects [7], and endowment effects [8]. Hanemann highlights the degree of complementarity between income and goods, arguing that discrepancies between WTA and WTP are largely due to low complementarity between goods and income [6]; when the elasticity of substitution between them goes to zero, the WTA-WTP discrepancy becomes infinite. Amiran and Hagen also show that an infinite WTA-WTP discrepancy may occur even when the elasticity of substitution is not zero [9]. However, Horowitz and McConnell and Horowitz *et al.* countered that Hahnemann' argument is not sufficient to explain the observed results from contingent valuation studies [10,11]. Rather, they suggested that the theoretical analysis must go beyond standard microeconomic theory. Knetsch's study indicates that the measurement chosen in particular cases would largely depend on whether the reference state is before the change or after the change, corresponding with compensating variation (WTP) and equivalent variation (WTA), respectively [12]. If the valuation of a change is based on a reference point of the initial or present state, the appropriate measurement of its value is the compensating variation (WTP). Meanwhile, if individuals base their valuations of a change on a reference of the changed state, the appropriate welfare measurement is then the equivalent variation (WTA). Koetse *et al.*'s study supports Knetsch' point and suggests that welfare effects due to changes in public good provision depend not only on the direction of change (loss aversion), but also on the reference value [4].

In practice, most of the present studies on evaluating ecological restoration are grounded in WTP [13–15]. This is because these projects' assessments are mainly focused on improving the environment. As Knetsch *et al.* have pointed out, a large difference between WTA and WTP can have other, strong effects on environmental policy [16]. These occur when the appropriate welfare measurement is willingness-to-accept (because, in most instances, environmental quality can only deteriorate), but instead policy analysts use willingness-to-pay to measure benefits. In general, WTP is more reasonable for measuring the welfare improvement before the environmental changes [10]. In this study, we specifically focused on evaluating residents' welfare change after the ecological restoration of rivers' landscapes in the city of Suzhou, China. We assume that individuals evaluate their welfare based on their valuations of a change using a reference of the changed state. Since the projects have been completed, WTA is the appropriate welfare measurement. Additionally, it is common for developing countries to consider projects that will result in environmental degradation. Thus, a WTP measurement might underestimate the welfare changes resulting from environmental improvement [17].

SURVEY DESIGN AND IMPLEMENTATION

Study Areas

Suzhou is located in the Yangtze River Delta in the southeast region of Jiangsu Province. Historically, it has been called Wu. Suzhou plays an important role in the economy of Jiangsu Province, which is a center for trade, industry, and business. It is also a key location for economics, culture, arts, education, and transportation. Moreover, it has been recognized nationally as a scenic, tourist destination, and historical site. In 2015, the total population in Suzhou was around 10.66 million. The registered household population (including the account pending population) constituted 6.66 million of this, while the other 4.00 million people come from outside this population. Suzhou is also the most developed region in China. In 2015, the city's GDP *per capita* ranked top 6 in all of China, at $2,1987. The household income was over $7700 in 2015, which ranked top 5 in China.

Suzhou is widely recognized for its water-centric landscape and culture, with a total of 26 rivers running through the city. However, water pollution has been a serious problem here for quite some time. According to the 2009 City Environmental Report, only one river in this area qualified as Water Class II* and 13 qualified as Water Class III and can be used as the source of drinking water after treatment. Almost 50% of rivers here can only be used for industry or agriculture. The rivers in this study are the Pingjiang and Guangtaiwei rivers (Figure 1), which are connected and located in the eastern, downtown, Suzhou. Many ancient bridges cross over these rivers, creating a wonderful residential landscape. The Pingjiang River area has been developed as a tourist attraction, surrounded by boutiques and souvenir shops; meanwhile, Guangtaiwei River is primarily residential on both sides. The population within the Pingjiang River area (Pingjiang District) is around 268,700 and the population of the Guangtaiwei River area (Canglang District) is around 395,000.

In May 2012, the Suzhou City River harnessing project officially started with the dredging of the Pingjiang and Guangtaiwei rivers within or near the ancient city area. 5 km were dredged, with about 30,000 m^3 of earth cleaned. Over 200 tons of garbage was removed, including river weeds, living garbage, constructional waste, and other waste. At the same time, the project checked and repaired sewer outfalls, sewage and rain contact points, private drainage outfalls, and pipeline leaks.

Followed by a subproject called the "living water" plan, which was carried out by relevant departments on ancient city rivers, the Pingjiang River has seen accelerated water flow and gradual improvements in water quality by washing away the polluted water. This experimental technique was used earlier on the Guangtaiwei River, which has also seen an improvement in water quality.

Survey Design and Implementation

Based on prior survey experience [18–20], WTA was elicited using a payment card approach. Payment intervals reflect responses obtained in an earlier survey in Shanghai using an open-ended direct question elicitation format. Two pretests were conducted with the survey instrument, which was modified based on feedback. Compared with the WTA surveys that have been carried out in the Caohejin area of the Xuhui district in Shanghai [18], our survey is more detailed with the addition of questions on residents' environmental awareness and environmental behaviors, residents' perceptions of waterbody environments, and an index of nonresidents' social inclusion [18].

Like our previous studies, the survey in this study was conducted via face-to-face interviews in Fall 2012. The study area is defined as residents along the Pingjiang River and Guangtaiwei River (see Figure 1), including the land on either side of the river. Respondents are sampled randomly and include pedestrians, residents, peddlers, and white-collar workers. Of the 500 contacted individuals, 450 were successfully interviewed, yielding a response rate of 90%.

The main body of the survey is divided into four parts:

1. Questions revealing the residents' understanding of and attitude toward the environment, such as

- *Do you know about the Suzhou city government's 2-yr river harnessing project and post-project water quality changes?*
- *Did you know that the main river pollution source in Suzhou is organic contamination?*
- *Did you know that organic contamination can harm human health?*
- *Do you think the government's spending on the river harnessing project is appropriate?*
- *Did you or your family member make any donation to related environmental issues in the past 2 yr?*

Questions revealing the relationship between residents and the waterbodies under review, and questions determining residents' understanding and perceptions of the river environment and so on, such as

- *The perception of the overall river environment, water color, water odor, litter on the water's surface, riverbank landscapes, and so on.*
- *Can you view the river from your residence?*
- *Do you pass the river every day?*
- *With what frequency do you and your family enjoy leisure activities on the river bank?*
- *Would you increase the frequency of going to the river bank after the harnessing project's implementation?*

Questions revealing demographics, such as household income, education status, household registration status, estates records, and length of residence at their current location. For nonresidents, this survey adds questions to reflect nonresidents' social inclusion, such as

*China's water quality standards: Class I: The water is used as the source of drinking water, or as a National Nature Reserve. Class II: water is used for drinking, protected, in a precious fish protected area, or is a fish spawning ground. Class III: water is used for drinking, is a general fish protected area, or is a swimming area. Class IV: water is used for industry. Class V: Water is used for agriculture and meets general landscape requirements.

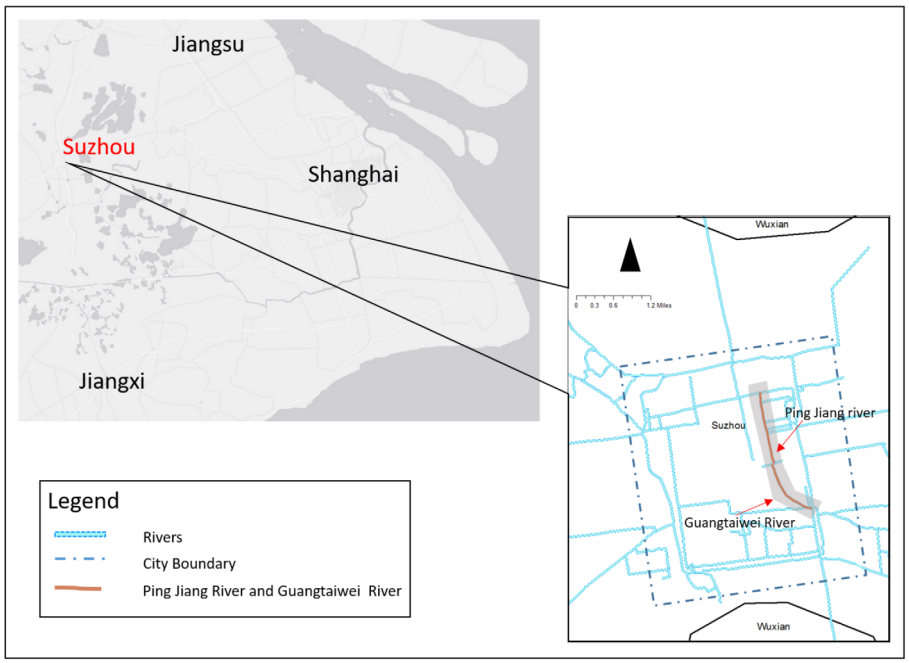

Figure 1. Map of Study Area. [Color figure can be viewed at **wileyonlinelibrary.com**]

- *Do you have local friends?*
- *Do you know local Suzhou dialects?*

One of the most vital interview questions asks residents about their desired financial compensation for environmental degradation and is presented as follows:

"Many rivers and bodies of water in Suzhou have been buried for development. In order for us to assess the value of this river and its surrounding environment, let's assume that the government intends to bury it for development as well. Do you think that the government should pay you for this environmental loss?"

☐ Yes ☐ No

"How much do you think the government should pay (one-time payment) per household for this environmental loss?"

☐ 1–100 RMB ☐ 101–1,000 RMB ☐ 1,001–10,000 RMB ☐ 10,001–50,000 RMB ☐ 50,000–100,000 RMB ☐ above 100,000 RMB ☐ I will not agree no matter how much

All the interviewers are senior undergraduate students with an environmental science background. After modification based on the two survey pretests, the formal survey is given. Within the research area, we collect 426 observations, 9% of which were ineligible. Dropping those results yields a sample size of 388 valid observations.

Statistic Description of Sample

Table 1 presents the summary statistics of our sample. Our sample shows consistencies in household characteristics, age, income, and other criteria and is representative of the demographics of Suzhou in general. Table 2 compares our sample data with the 2010 Suzhou census results. Most of the variables are statistically consistent with the census data except for education level (those with a high school education or above). This is possibly due to the location of our study area; since it is downtown, it is likely that most respondents have a higher education level than the city as a whole.

Interviewees' responses indicate that environmental protection plays an important role in national development. Before being presented with information in the survey, about 20% of the respondents indicated that they understand the current river pollution situation and characteristics of pollution. On the other hand, about 20% of respondents indicated that they had little or no understanding of the current river pollution situation. Additionally, approximately 15% of the respondents did not realize that river pollution is a human health threat. About a third of our respondents believed that government spending on the river is reasonable, while another third knew little about government spending on the improvement of river water quality. Finally, around 10% of respondents donated to environmental causes.

With respect to overall water quality, 5% of respondents thought that the river was very clean, and another 40% thought it was relatively clean. Meanwhile, around 8% of respondents indicated that they believed the river was seriously polluted. Additionally, about 50% of the sample thought that there was no oil and waste in the river; 22% of the sample believed the river was free of trash, and that the landscaping is beautiful, and only about 7% of the residents believed that the river is crystal clear. However, between 3–10% of the sample argued that the river appears black, smelled, contained oil and garbage, and was poorly landscaped. Most residents believed that the river and surrounding environment improved after treatment, at about 75% of the sample. With further government investment in river restoration projects, more than 40% of respondents said they would begin to use the river for recreation more frequently.

In regard to respondents' perceptions of government spending, 24% indicated that they trusted the government to appropriately use their funds for restoration projects. However, a sizeable fraction of the sample (almost two-thirds) indicated that they were "not clear" on how the government allocates its funds. Additionally, 68% of respondents stated that the government should provide compensation for the portion of the river that was filled. This proportion directly affects the result of WTA.

Distribution of WTA

Table 3 shows the distribution of WTA through the two investigative questions about compensation willingness. Nearly 70% of the respondents believe that the government should compensate them if the rivers are filled for municipal construction or economic development. Two hundred respondents are willing to accept compensation, while 188 are unwilling to

Table 1. Description of environmental preferences and socio-demographic characteristics variables

Variable	Description	Mean	Std. dev.
	Knowledge regarding environment and pollution		
KNOWRIVER	Do you know whether the rivers' condition has improved since restoration? (1 = unknown, 2 = known but not very clear, 3 = clear)	2.0	0.7
KNOWPOLLUT	Do you know if the pollution in the river can harm health? (1 = unknown, 2 = known but not very clear, 3 = clear)	2.0	0.6
WILLIMPORT	Do you think it is important for a developing country to protect the environment? (1 = unknown, 2 = known but not very clear, 3 = clear)	1.1	0.4
EXPEND	Do you think the government's cost for the environmental restoration project is reasonable? (1 = too much, 2 = medium, 3 = too small)	2.4	0.9
	Environmental activism		
DONATION	Have you donated to any environmental restoration projects in the past 24 months? (1 = yes, 0 = no).	0.1	0.3
SEERVER	Can you see this river from your house? (1 = yes, 0 = no)	0.5	0.5
PASSRIVER	Do you pass the river? (1 = yes, 0 = no)	0.8	0.4
FREQUENCY	How often do you walk along the river?	2.5	1.5
	Perception for current environment		
ENVIRONMENT	Are you satisfied with the current river environment? (1 = very clear, 4 = very dirty)	2.7	0.6
COLOR	The color of the river (1 = very clear, 2 = gray, 3 = black)	2.0	0.4
SMELL	The smell of the river (1 = fresh, 2 = slightly uncomfortable, 3 = bad smell)	1.5	0.6
OILSURFACE	The oil on the surface (1 = no oil, 2 = slightly oil, 3 = full of oil)	1.6	0.6
RUBBISH	The rubbish in the river (1 = no rubbish, 2 = slightly rubbish, 3 = full of rubbish)	1.9	0.5
GREEN	The green belt along the river (1 = very clean, 2 = slightly dirty, 3 = very dirty)	1.9	0.6
	Beliefs on environmental restoration		
INCREASE	Do you think the river's condition has been worse in previous years? (1 = fully support, 3 = fully refuse)	0.5	0.5
CONFIDENCE	Do you have confidence in the government's ability to improve the state of pollution in the future? (1 = yes, 0 = no)	0.24	0.4
	Socio-demographic characteristics		
GENDER	Gender (0 = male, 1 = female)	0.6	0.5
HOUSHOLDSIZE	Number in household	3.3	1.2
CHILD	Do you have children in your family? (0 = no, 1 = yes)	0.3	0.5
OLDMAN	Do you have elders (Age > 60) in your family? (0 = no, 1 = yes)	0.3	0.5
AGE	Age (1 = 18–34, 2 = 35–44,3 = 45–59,4 = 60–75, 5 = 75 or above)	2.3	1.2
*HUJI**	Do you have a local Huji (0 = no, 1 = yes)	0.7	0.2
YEAR	Number of years of residence in this area	8.8	9.5
PROPERTY	Do you own a property in the city? (1 = yes, 0 = no)	0.4	0.5
PVALUE1	If so, what is your property's value? (100 thousand Yuan)	4.8	2.5
EDU	Education level (1 = elementary school level or lower, 5 = graduate education)	3.0	1.1
EMPLOYE	Are you employed? (1 = yes, 2 = no)	0.22	0.4
INCOMESOURCE	Are you the primary source in your family? (1 = yes, 2 = no)	0.5	0.5
HINCOME	Household income (1 = less than 12,000 RMB, 2 = 12,000–36,000RMB, 3 = 36,000–60,000 RMB, 4 = 50,000–84,000 RMB, 5 = 84,000–120,000 RMB), 6 = 120,000–240,000 RMB, 7 = 240,000–360,000 RMB; 8 = above 360,000 RMB)	4.4	1.7
WILLA	Do you think the government needs to pay for the environmental pollution?	0.6	0.5
WTA	WTA government compensation? (1 = 1–100 RMB;2 = 101–1000 RMB;3 = 1001–10,000 RMB;4 = 10,001–50,000 RMB;5 = 50,000–100,000 RMB; 6 = 100,000 RMB above; 7 = refuse no matter what amount	5.7	3.8

*A Huji is a record of household registration required by law in mainland China. A household registration record officially identifies a person as a resident of an area and includes identifying information such as name, parents, spouse, and date of birth.

accept any amount of compensation. It is possible that these respondents are conveying the message that no amount of financial compensation can amount to the cost of voluntarily giving up ecological restoration. Another possibility is that these respondents feel as though they are not entitled to any compensation because they do not have property rights over the river. This may be because they do not have legal status (*Huji*) because since they only plan to live in Suzhou for a short period, or because they simply do not believe that the government needs/should provide compensation even though they will suffer a welfare loss by not having the rivers restored. A more complicated interpretation is that these respondents

Table 2. Sample data with respect to the 2010 census

	Census 2010	Sample mean	*t*-test value	Pr(|*T*| > |*t*|)
Male %	57%	58%	1.7	0.88
HUJI %	70%	69%	−0.6	0.54
Age				
15–64%	82%	80%	−0.94	0.34
>64%	18%	17%	0.21	0.83
Income (Yuan)	57,622	59,526	0.6	0.51
Education %			0.83	0
(over high school)	65%	1%		

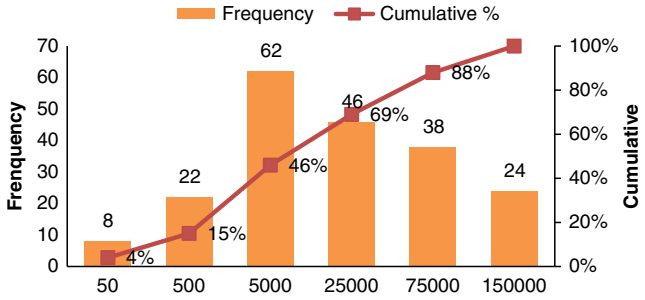

Figure 2. The distribution of WTA for respondents who accept compensation. [Color figure can be viewed at wileyonlinelibrary.com]

favor the development project over ecological restoration and thus would have a positive WTP for the development project even when accounting for the loss of the river. A special case would be when a respondent has a true WTA of zero, either because the perceived benefits and cost of the development project offset each other or because the respondent feels no loss when the river is filled.

Based on the survey responses, WTAs are distributed into six intervals in Table 3, excluding those who refused to accept compensation. The description of willing to accept compensation is as described in Figure 2. Of the 200 observations that are willing to accept compensation, most (31%) chose to accept compensation within the range of 1,000–10,000 RMB per household. This was followed by those who would accept 10,001–50,000 RMB per household, at 23% of those willing to accept compensation. The average WTA value in the sample is 39,607 RMB, and the median is 25,000 RMB.

An eigenvalue analysis was applied to the differences between groups, first by using a 2 × 2 contingency analysis, followed by a Chi-square test and finally a *t*-test. The major differences between the groups are on whether or not the government should compensate residents for filling the river. Obviously, the proportion of those who believe the government should compensate residents is much higher, and the mean compensation they are willing to accept is 39,607 RMB. Although both groups are aware of the importance of environmental protection, respondents who refuse to accept compensation are more sensitive to the environmental pollution.

Views on the future of the river differ significantly between those who agree to accept compensation ("accept" group) and those who refuse to ("reject" group). The more frequently a respondent spends time along the river, the higher the WTA value observed. However, the WTA is much higher for those who opt to walk by the river than for those who choose not to. Nearly all respondents believed that the river and surrounding environment has significantly improved since the government project. Of this majority of respondents, those who were also willing to accept compensation had a higher WTA than those who refused to.

Whether a respondent has a local friend or can speak a local dialect do not significantly affect the WTA of nonresidents. This is to be expected since Suzhou is the second largest immigrant city in China, following Shanghai, and therefore has a high level of social inclusion. Suzhou residents are typically concerned about water and river quality. The "accept" group tends to have larger families and a higher employment rate. The mean WTA for households with children is 46,874 RMB, while it is 36,265 RMB, otherwise. For households with elders, the mean WTA is 35,723 RMB, but for those without it is 42,155 RMB. Furthermore, households with both children and elders have a mean WTA of 34,459 RMB, while the mean WTA for households without either is 36,140 RMB. Within the "reject group," households tend to have elders rather than children.

Regarding household registration (*Huji*) and demographics, more than 70% of respondents reside locally. Among the other 30% of respondents, half are from other cities while the rest are from rural areas. Nonresidents who once resided along the river lived there for an average of 7 yr, compared to the overall sample average of 22 yr. Nearly 90% of nonresidents have local friends and nearly 20% claimed they are familiar with Suzhou dialects. On the other hand, less than 40% of nonresidents cannot speak a local dialect. Approximately 30% of households have one or more children under the age of 12, while about 50% have elders over the age of 60. The average household size is 3.3, and the mean age of household members is 43.79. These numbers support the fact that the majority of respondents are long-term residents. Finally, 36% of residents have an undergraduate education or higher, and 67% of residents have a job.

Additionally, 70% of respondents' houses were valued at below 1 million RMB, while less than 2% had houses priced at over 3 million RMB. Sixteen percentage residents claimed that they were preparing to buy a house in the next 3–5 yr. Our results show that the average monthly household income is about 8900 RMB, with 36% of the sample having a monthly household income below 5000 RMB and 54% having one between 5000 RMB and 10,000 RMB.

ECONOMETRIC ANALYSIS

The following econometric analysis follows the model proposed by [21,22]. The WTP has derived intervals instead of point estimates based on our survey questions. The interval levels are represented by the probability with which the

Table 3. Summary of the WTA for the Suzhou River in different intervals

Intervals	Lower-bound (RMB)	Up-bound (RMB)	Frequency	Percentage (%)	Median (RMB)
1	1	100	8	2.06	50
2	101	1,000	22	5.67	500
3	1,001	10,000	62	15.98	5,000
4	10,001	50,000	46	11.86	25,000
5	50,000	1000,000	38	9.79	75,000
6	1000,000		24	6.19	N.A.
7	Refuse to accept		188	48.45	N.A.

Table 4. Estimation results with econometric models

Variables	(1)	(2)	(3)	(4)
		Knowledge regarding environment and pollution		
KNOWRIVER	1.892***	2.157***	2.089***	2.709**
	(0.727)	(0.743)	(0.741)	(1.327)
KNOWPOLLUTION	1.367*	1.251	1.207	−0.235
	(0.822)	(0.829)	(0.827)	(1.142)
		Environmental activism		
EXPEND	−1.234*	−1.088*	−0.935	−1.622
	(0.63)	(0.629)	(0.643)	(0.989)
DONATION	−0.325	−0.4	−0.389	−3.245**
	(0.954)	(0.955)	(0.957)	(1.481)
SEERIVER	−0.854	−0.729	−0.807	−0.12
	(0.637)	(0.641)	(0.641)	(1.045)
PASSRIVER	0.0367	0.345	0.294	3.144*
	(0.869)	(0.897)	(0.899)	(1.676)
FREQUENCY	−0.273	−0.267	−0.277	−0.49
	(1.965)	(1.980)	(1.966)	(2.833)
		Perception of current environment		
ENVIRONMENT		−0.231	−0.146	−0.673**
		(0.649)	(0.648)	(0.256)
COLOUR		−0.643	−0.581	−1.524
		(1.086)	(1.082)	(1.701)
SMELL		−0.472	−0.514	−4.876***
		(0.609)	(0.61)	(1.005)
OILSURFACE		−0.581	−0.535	−1.592*
		(0.614)	(0.616)	(0.935)
RUBBISH		−0.11	−0.218	−1.26
		(0.718)	(0.718)	(1.194)
GREEN		−0.811	−0.905	−0.105
		(0.719)	(0.725)	(1.198)
CLEANEVER		−0.62	−0.578	−0.752
		(0.724)	(0.736)	(1.049)
		Beliefs regarding environment restoration		
INCREASE			0.745	0.71
			(0.61)	(0.909)
CONFIDENCE			−1.091	−4.515***
			(0.733)	(1.038)
		Socio-demographic characteristics		
GENDER				−1.676
				(1.192)
HOUSHOLDSIZE				1.291***
				(0.484)
CHILD				2.101**
				(1.058)
OLDMAN				0.161
				(1.173)
AGE1				4.813**
				(2.279)
AGE2				0.891
				(2.145)
AGE3				1.934
				(2.055)
HUJI				2.924**
				(1.194)
YEAR				0.0687**
				(0.0232)
DIS				1.872**
				(0.882)
PROPERTY				−1.303
				(2.122)
PVALUE1				1.434
				(2.117)
PVALUE2				5.140***
				(1.829)
EDU				1.463
				(1.038)

(Continues)

Table 4. Continued

Variables	(1)	(2)	(3)	(4)
EMPLOYE				4.114***
				(1.286)
INCOMESOURCE				3.02
				(2.169)
HINCOME2				4.001***
				(1.187)
HINCOME3				−0.742
				(1.39)
HINCOME4				−1.542
				(1.775)
Constant	9.602***	10.00***	9.880***	−4.857
	(1.413)	(1.52)	(1.514)	(4.037)
Observations	396	396	398	396

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

respondents agree to accept compensation. Therefore, we can calculate the WTA as

$$WTA_i = WTA_i(Pr_i) \tag{1}$$

Moreover, we can describe the upper and lower boundaries of the WTP interval as

$$\begin{aligned} WTA_i &= WTA_i(Pr_i) \\ &= \left[WTA - \lambda \ln\left(\frac{\Pr^{\text{up}}}{1-\Pr^{\text{up}}}\right); WTA - \lambda \ln\left(\frac{Pr^{Lp}}{1-Pr^{Lp}}\right) \right] \end{aligned} \tag{2}$$

The model can be used to refine the estimated distribution of WTA, and the logarithmic Lagrange estimation is:

$$\log L = \sum \left\{ \log \left[F\left(WTA^H;\theta,\lambda\right) - F\left(WTA^L;\theta,\lambda\right) \right] \right\} \tag{3}$$

where WTA^H are the upper and lower bounds of the interval around WTP, $F(\cdot)$ is the cumulative distribution function, and θ is the vector of parameters representing the distribution of WTA.

The results from the econometric analysis are presented in Table 4. Four specifications are listed as models 1 through 4. The Log likelihood is −687.34 in the first model and −1176.27 in the second, indicating that the full variables model is more suitable for our analysis. In all models, most of the variables are statistically significant.

Both *KNOWRIVER* and *KNOWPOLLUTION* yielded estimates that are positively correlated with WTA at a 5% significance level, indicating that residents who are concerned about environmental protection are more willing to accept compensation in exchange for development of the river. A higher level of environmental awareness means higher environmental valuation and therefore a higher requested compensation for environmental degradation. The statistical analysis revealed that the majority of residents fully understand the importance of the environment. However, donation experience (*DONATION*) was shown to be negatively correlated with WTA at a significance level of 5%, meaning that residents who have donated to environmental causes in the past are less willing to accept compensation. Donating to environmental groups can be thought of as altruistic behavior toward the environment or those who use its services. These respondents may tend to believe in sharing social responsibility. Therefore, their demand for government compensation was lower on average than those who expected the government to bear all of the cost.

Both distances from the river (DIS) and length of residence (*YEAR*) are positively correlated with WTA at a 5% significance level, implying that the farther one lives from the river, the more willing they are to accept compensation. Possible explanations for this are (1) the river provides additional direct and indirect use value to nearby residents (such as wastewater drainage and a place for recreation), while it primarily provides existence and option values to those living farther away. Use value is closely related to residents but is much lower than existence value. (2) Those who reside farther away spend less leisure time at the river due to higher transportation costs. Theoretically, the existence value of the river should be shared by all residents equally. To obtain the same existence value, high WTAs can be considered as containing compensation for residents who live farther away. The longer that residents reside along the river, the higher the WTA. Older residents had a stronger sense of belonging to their environment and considered the river to be an inseparable component of their lives. The river not only provides entertainment and leisure, but also contributes to production, life, experience, and memory.

The evaluation of riverside landscaping (*ENVIRONMENT*) was negatively correlated with WTA at a 5% significance level, showing that residents who gave riverside landscaping a higher evaluation are more willing to accept compensation. The quality of riverside landscaping is an important part of the ecological function of the river and often becomes a critical ecological factor in determining the maintenance and restoration of the river ecosystem. Therefore, compared with other environmental factors such as color and odor, which must be evaluated up close, riverside landscaping become one of the most important components in determining the value of the river.

Total household population (*HOUSHOLDSIZE*) was positively correlated with WTA at a 5% significance level. Households who are larger and have a more complicated family structure have a higher WTA compensation. Additionally, households with children (*CHILD*) have a higher WTA compensation than that of the control group at about 16.8%. Possible explanations are as follows: the river and surrounding environment may provide direct use value for children's recreation, thus increasing demand for houses located near the river.

Table 5 shows the estimation results across different groups in order to demonstrate differences in preferences. Residents and nonresidents (Model 5 and Model 6) are significantly different. Residents are more sensitive to environmental changes (most of the variables are statistically significant), indicated by more marginal effects on WTA. The preferences in employed and unemployed respondents are more complex. In general,

Table 5. Estimation results for different groups

	Residential	Nonresidential	Employed	Unemployed
Variables	(5)	(6)	(7)	(8)
	Knowledge regarding environment and pollution			
KNOWRIVER	6.534***	0.551	0.925	3.118
	(2.129)	(1.998)	(1.394)	(2.381)
KNOWPOLLUTION	−0.526	0.600	0.328	1.593
	(1.235)	(2.441)	(1.416)	(2.443)
	Environmental activism			
EXPEND	4.513***	3.258**	0.0676	9.077***
	(1.237)	(1.503)	(1.039)	(3.268)
DONATION	−5.963***	−2.135	−1.596	−2.717
	(1.672)	(2.381)	(1.580)	(2.133)
SEERIVER	0.835	0.242	1.070	6.392**
	(1.277)	(1.585)	(1.095)	(2.965)
PASSRIVER	6.841***	3.070	4.163**	1.006
	(2.342)	(3.255)	(1.712)	(3.350)
FREQUENCE	1.080***	0.0122	0.392	2.710***
	(0.346)	(0.512)	(0.341)	(0.892)
	Perception of current environment			
ENVIRONMENT	−7.358***	−1.962	−1.123	−0.280
	(1.893)	(1.368)	(1.044)	(1.812)
COLOUR	−9.954***	−7.219***	−4.475***	−1.750
	(2.578)	(2.499)	(1.675)	(3.386)
SMELL	−8.128***	−5.381***	−4.488***	1.727
	(1.481)	(2.027)	(1.041)	(2.006)
OILSURFACE	−0.171	2.263	2.279**	−2.062
	(1.253)	(1.793)	(0.947)	(1.749)
RUBBISH	−2.721	−2.234	−1.428	−0.803
	(1.736)	(2.030)	(1.260)	(2.427)
GREEN	−1.978	1.760	0.150	2.944
	(1.520)	(1.673)	(1.294)	(2.254)
CLEANEVER	−0.0538	−4.155***	1.524	2.265
	(1.390)	(1.422)	(1.070)	(1.948)
	Beliefs regarding environment restoration			
INCREASE	1.072	3.335*	−0.389	−1.285
	(1.240)	(1.808)	(0.930)	(1.523)
CONFIDENCE	−5.447***	−8.027***	−5.025***	−5.712**
	(1.616)	(1.661)	(1.122)	(2.280)
	Socio-demographic characteristics			
GENDER	−3.957**	−0.221	−2.476*	−2.531
	(1.633)	(2.277)	(1.269)	(1.574)
HOUSHOLDSIZE	0.185	2.046**	1.606***	0.196
	(0.892)	(0.953)	(0.532)	(0.663)
CHILD	0.489	4.150**	2.072*	4.689**
	(1.761)	(1.853)	(1.066)	(2.272)
OLDMAN	1.549	2.441	0.346	1.580
	(1.517)	(1.856)	(1.164)	(2.269)
AGE1	1.063	12.54*	7.053**	8.185*
	(3.150)	(6.915)	(2.743)	(4.458)
AGE2	4.021	15.05**	3.088	1.046
	(2.447)	(6.860)	(2.606)	(3.598)
AGE3	1.326	11.68*	4.364	5.655*
	(2.596)	(6.559)	(2.715)	(3.011)
YEAR	0.148***	0.0439	0.0135	0.0970*
	(0.0436)	(0.183)	(0.0547)	(0.0556)
DIS	1.721	7.486***	3.779**	10.53***
	(2.427)	(2.771)	(1.902)	(3.702)
PVALUE1	6.597***	14.49	12.30***	1.617
	(2.289)	(675.9)	(3.109)	(3.136)
PVALUE2	7.563***	20.77	9.747***	3.066
	(2.077)	(675.8)	(2.127)	(3.941)
EDU	2.455	2.924**	1.001	5.097*
	(1.817)	(1.462)	(0.982)	(2.931)

(Continues)

Table 5. Continued

	Residential	Nonresidential	Employed	Unemployed
INCOMESOURCE	2.326*	4.537*	6.084***	2.104
	(1.333)	(2.349)	(1.270)	(2.497)
HINCOME2	1.072	3.037	0.0648	0.0653
	(1.712)	(3.508)	(1.584)	(1.899)
HINCOME3	7.246***	−2.303	−0.957	−5.060*
	(2.605)	(3.377)	(2.123)	(2.798)
HINCOME4	−9.720*	2.996	1.690	9.141*
	(5.087)	(3.915)	(2.431)	(4.992)
HUJI			4.005***	1.256
			(1.146)	(2.848)
EMPLOYE	1.381	5.137		
	(2.487)	(1016)		
Constant	6.785	−7.459	−13.45***	24.55***
	(6.199)	(10.09)	(4.776)	(7.516)
Observations	396	396	398	396

employed respondents are more interested in water quality and are willing to accept less compensation.

CONCLUSION

The Chinese government has been accelerating city river restoration and governance. In comparison with "willingness to pay," "willingness to accept" is better suited to reveal residents' welfare improvement after government environmental investment. This study provides an empirical basis for scientific and efficient evaluation of government expenditures. A WTA analysis based on a survey with 426 observations was conducted on the Suzhou City River harnessing project on the Pingjiang and Guangtaiwei rivers. The results indicated that 48.4% of the sample is not willing to accept river degradation or disappearance even if provided with an unlimited monetary compensation. For those willing to accept compensation, the median compensation value is about 25,000 RMB, which is about 1600 RMB** annually. This is consistent with Xu *et al.*'s study which estimates the WTA (about 1186 RMB per year) for the conservation of drinking water sources in Beijing, China, as well as Zhai and Suzuki, who evaluated a WTA of 25,607 RMB for the loss of accessibility to a coastal waterfront in Japan [23,24]. Similarly, Amigues *et al*. used WTA for habitat preservation in France and found the mean WTA to be about 1155 RMB (value in 2015) [25]; however, the WTP for habitat preservation was much lower at only about 300 RMB. Additionally, similar results can be found in studies on the WTP for environmental restoration. Bliem and Getzner's study, however, found the willingness-to-pay for river restoration in Austria to be much lower, at about 250 RMB [26]. These results are comparable to Shang *et al*.'s finding in Shanghai, China, which found local communities' WTP for river network protection to be about 226.44 RMB per household per year.

With a limited understanding of the current level of economic development and the concept of WTA, as well as limited environmental awareness, respondents in this study may not have provided a clear answer. Meanwhile, WTA is suitable for the beneficiaries who own resources that provide services, and the ownership of natural resources in China is still questionable. Thus, residents may be concerned about the possibility of government compensation, thus leading to difficulties in obtaining answers to our WTA questions and thus our analysis. Since WTA is not affected by an income constraint, our study could not avoid the overestimated WTA in low-income groups. However, through the WTA survey, we have learned valuable information regarding the nonmarket price residents' place on these rivers; some believed the river to be irreplaceable. Meanwhile, since WTA is not affected by an income constraint, this study can help reveal low-income groups' real demand for environmental goods.

Finally, when one tries to assess ecological service value by applying the CVM method in China, full consideration should be given to China's unique cultural and socioeconomic conditions, as well as the research area's characteristics, prior to deciding between WTP or WTA as the measurement to be used in the study. It should also be noted that the WTA may complement the WTP.

**We assume the beneficiate time is 15 years.

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