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Supported by the CGIAR

IFPRI Discussion Paper 01043

December 2010

Valuing the Environment in Developing Countries

Modeling the Impact of Distrust in Public Authorities' Ability to Deliver Public Services on the Citizens' Willingness to Pay for Improved Environmental Quality

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PARTNERS AND CONTRIBUTORS

IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, the Netherlands, Norway, the Philippines, South Africa, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

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ABSTRACT

In this paper, we employ the choice experiment method to estimate local citizens' valuation of a public intervention that proposes to improve the quality of an important environmental resource, namely, the Ganges River in India. To elicit citizens' willingness to pay (WTP) higher municipality taxes for an intervention that proposes to improve the quantity and quality of wastewater treated by the local sewage treatment plant (STP), 150 randomly selected citizens of the municipality of Chandernagore, located on the banks of the Ganges River in West Bengal, were interviewed. The findings reveal that almost all (98 percent) of the citizens value the quality of the water and the environment in the Ganges, though a great majority (90 percent) protested the intervention by not choosing the improved STP scenario in at least one of the eight hypothetical markets in which they were asked to participate. When asked their reasons for not preferring the improved scenarios, 92 percent of them stated that they do not trust the authorities to efficiently and effectively manage the funds generated through additional taxes. The protest responses were controlled for with the use of the nested logit model (NLM). The results reveal that the citizens are willing to pay significant amounts to ensure that the intervention takes place and that an improved STP treats larger amounts of wastewater to a higher quality before discharging it to the Ganges. Therefore, to improve the wastewater management services and the related environmental quality in the water bodies into which treated wastewater is deposited, the municipalities could rely—at least to some extent—on their citizens' WTP higher taxes for provision of improved services. To capture this WTP, however, municipalities' performance, trustworthiness, and accountability, as well as the citizens' perceptions of these, should be improved.

Keywords: choice experiment method, nested logit model, willingness to pay, sewage treatment plant, distrust in public authorities

ACKNOWLEDGMENTS

We would like to thank Devesh Roy, P. B. Anand and R.N. Bhattacharya for their valuable comments and suggestions. Any errors and omissions are the authors' own.

1. INTRODUCTION

Stated preference methods, such as the contingent valuation method and the choice experiment method, have traditionally been applied in developed countries to estimate citizens' willingness to pay (WTP) for various interventions (such as policies, programs, or projects) for environmental conservation and sustainable management of natural resources (for example, Bateman and Willis 1999; Pearce 2009). The economic benefits estimated from such studies (captured as WTP) are weighed against the economic costs of interventions targeted at environmental conservation and sustainable management of natural resources to understand whether such interventions would be efficient or, in economic terms, a Pareto improvement. Environmental goods (such as biodiversity) and natural resources (such as water, air, or forests) are public goods that are not traded in markets and hence do not possess readily available prices (or economic values) that can be used for such cost–benefit analysis. Therefore, stated preference methods, which rely on constructed, hypothetical markets in which respondents state their WTP for different interventions, are used to capture the value of economic benefits generated by such interventions.

Such studies are not so often conducted in developing country contexts since it is assumed that due to tight budget constraints and high discount rates, citizens in these countries may not have the ability to pay for "luxury" goods, such as interventions for environmental conservation or sustainable natural resources management. Recent studies, however, have revealed that citizens of developing countries have positive and significant WTP for the conservation of the environment or for the sustainable management of natural resources (for example, Bennett and Birol 2010). These studies reveal that, when framed in a manner relevant to the environmental conservation or natural resource management question at hand and when designed with the cultural and institutional setting in mind, they can yield valuable information, just as they have in developed countries for decades. There is, however, a need to investigate further how stated preference methods can be implemented effectively in developing country contexts to capture and model citizens' valuation of environmental conservation or sustainable natural resources management.

In this paper, we endeavor to contribute to this growing literature on developing country citizens' valuation of interventions that propose environmental conservation or sustainable natural resources management by presenting the results of a choice experiment study conducted in India. This study investigates whether citizens of a West Bengal municipality located along the banks of the Ganges River are willing to pay higher municipality taxes for an intervention, namely, an improvement in the capacity and technology of a sewage treatment plant (STP). This improved STP proposes to reduce water pollution in this river, which is not only a major input to various economic activities (such as agriculture, aquaculture, hydropower generation, industry, and water supply for household consumption) but also an important source of religious, cultural, and historical values (Alley 2002; Markandya and Murty 2004; Birol and Das 2010).

Our findings reveal that almost all (98 percent) of the randomly selected 150 local citizens stated that they care about the ecological status of the Ganges in general and the quality of the water in particular; however, a great majority (90 percent) protested the intervention by not choosing the improved water quality scenario in at least one of the eight hypothetical markets in which they were asked to participate. When asked their reasons for not preferring the improved scenarios, 92 percent of them stated that they do not trust the authorities to efficiently and effectively manage the funds generated through additional taxes. These findings are in line with previous research that has shown that urban citizens in India are not willing to pay for improvements in publicly provided goods (such as water supply), possibly due to their lack of trust in the efficacy of the local governments to provide such improvements (Anand 2002).

To support the finding that citizens protest the intervention—not because they do not care about the quality of the water and associated environmental problems in the Ganges, but rather because of the perceived ineffectiveness of the system—a nested logit model (NLM) was used to model the citizens' decision-making process as a two-stage process. In this model, respondents first decide whether or not to "participate" in the intervention by paying increased taxes for its implementation; those who choose to participate decide which attributes of the intervention they would be willing to pay for and how much they would be willing to pay.

Our preliminary results reveal that the NLM explains the data better than more conventional models, such as the conditional logit model (CLM). Moreover, similar to their developed country counterparts, citizens from households with higher income levels (measured as spending lower shares of their expenditure, as a proxy for income, on food), larger households (which is correlated with having children and a higher number of children), and households with heads who have a university degree or higher are more likely to participate in the STP improvement intervention. These findings have implications in terms of designing interventions for improving the STP in the study site, as well as in terms of improving the credibility and accountability of the public institutions that are responsible for providing these interventions.

The rest of the paper unfolds as follows. Section 2 explains the choice experiment method and decision modeling approaches used in this paper. Section 3 describes the survey design and administration and presents the descriptive statistics. The results are presented in Section 4, and Section 5 concludes the paper with policy implications.

2. METHODOLOGY

The choice experiment method has its theoretical grounding in Lancaster's model of consumer choice (Lancaster 1966) and its econometric basis in random utility theory (Luce 1959; McFadden 1974). Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. According to the random utility theory, the utility of a choice is comprised of a deterministic component (*V*) and an error component (*e*), which is independent of the deterministic part and follows a predetermined distribution. This error component implies that predictions cannot be made with certainty. Choices made between alternatives will be a function of the probability that the utility associated with a particular alternative *j* (such as a wastewater treatment program option) is higher than those for other alternatives.

$$U_{ij} = V(Z_{ij}) + e(Z_{ij}) \quad , \tag{1}$$

where, in the case of the experiment presented here, for any citizen *i*, a given level of utility will be associated with any wastewater treatment program alternative *j*. Following Lancaster's theory of consumer choice, the utility derived from any of the wastewater treatment alternatives depends on its attributes (*Z*), such as the quantity and quality of wastewater treated in the STP and the regeneration of the Wonderland Park.

Assuming that the relationship between utility and attributes is linear in the parameters and variables function and that the error terms are identically and independently distributed with a Weibull distribution, the probability of any particular wastewater treatment program alternative *j* being chosen can be expressed in terms of a logistic distribution. Equation (1) can be estimated with a CLM (McFadden 1974; Greene 1997, 913–914; Maddala 1999, 42), which takes the following general form:

$$P_{ij} = \frac{\exp(V(Z_{ij}))}{\sum_{h=1}^{C} \exp(V(Z_{ih}))} \quad , \tag{2}$$

where the conditional indirect utility function generally estimated is as follows:

$$V_{ij} = \alpha + \beta_1 Z_1 + \beta_2 Z_2 + ... + \beta_n Z_n \quad , \tag{3}$$

where α is the alternative specific constant (ASC) that captures the effects on utility of any attributes not included in choice-specific wastewater treatment program attributes, *n* is the number of wastewater treatment program attributes considered, and the vectors of coefficients β_1 to β_n are attached to the vector of attributes (*Z*).

The assumptions about the distribution of error terms implicit in the use of the CLM impose a particular condition known as the independence of irrelevant alternatives (IIA) property, which states that the ratio of the probabilities of choosing one alternative over another (given that both alternatives have a nonzero probability of choice) is unaffected by the presence or absence of any additional alternatives in the choice set. Another limitation of the CLM is the independent and identically distributed (IID) assumption of the error terms. This assumption implies that cross-substitutions between pairs of alternatives are equal and unaffected by the presence or absence of other alternatives. If the IIA property is violated, then CLM results will be biased; hence a discrete choice model that does not require the IIA property, such as random parameter logit model, should be used. Birol and Das (2010) show that according to the Hausman and McFadden (1984) test, the IIA property is rejected, and therefore use a random parameter logit model which relaxes the IIA assumption.

In this paper, we use the NLM, which relaxes the IIA and IID assumptions (McFadden 1981; Louviere et al. 2000). In this model, the alternatives are grouped according to similarity of the unobserved error terms of the indirect utility. NLM was preferred over other models that could circumvent IIA violation (such as the random parameter or mixed logit model and conditional or random parameter logit model with interactions for respondent-level characteristics) because we wanted to explicitly control and account for a high number of citizens who have protested the program. Here we model the citizens' decision as a two-level NLM, in which they make the decision about whether to choose an improved wastewater treatment program or stay with the current program (status quo) and in which, if they choose the improved program, they make a choice between the two different improved programs, A and B.

In the NLM, the random error terms (*e* in Equation 1) are assumed to have an extreme value distribution and are correlated within each nest (that is, the random error terms of programs A and B are correlated). However, the random error terms of programs A and B are not correlated with that of the status quo alternative, which is no intervention. The overall probability of choosing program A is the product of participating in a new program and the probability of choosing program A among the two programs offered.

Prob(Program A)=Prob(New Program) x Prob(Program A|New Program) =P(NP) x P(A|NP) (4)

$$P(A \mid NP) = \frac{e^{V_A|\tau}}{e^{V_A|\tau} + e^{V_B|\tau}} \quad (5)$$

$$P(NP) = \frac{e^{\tau IV}}{e^{\tau IV} + e^{V_{SQ}}} , \quad (6)$$

where NP is a new program, A and B are the two new alternative programs, SQ is the status quo, IV is the inclusive value on the new program group, and τ is the coefficient of the IV.

$$IV = \ln(e^{V_A|\tau} + e^{V_B|\tau}) \quad (7)$$

Utility maximization requires the IV coefficient τ to be in the 0–1 interval. Values of τ closer to 0 indicate a higher correlation. If τ is 1, then the correlation is 0, which is the case of the CLM; that is, the random components of the alternatives are not similar. Finally, the probability of choosing the status quo option is as follows:

$$P(C) = \frac{e^{V_{SQ}}}{e^{\tau IV} + e^{V_{SQ}}} \quad (8)$$

3. DATA

Case Study

The details of the case study site and the proposed intervention to improve water and environmental quality in the Ganges are explained in greater detail in Birol and Das (2010). Here we present a summary of the background of the case study. The case study site is the Chandernagore municipality in West Bengal, which is situated along the banks of the Ganges River. Currently this municipality hosts a conventional STP built in 1991. The capacity of the local STP is twice that of the total volume of wastewater generated by the municipality; however, due to major financial constraints, the STP utilizes only a small fraction of its capacity, conducting primary treatment on only 24 percent of the sewage generated by the municipality.

The raw sewage treated by the STP is treated to permissible limits for biochemical and chemical oxygen demand for primary treatment as set by the West Bengal Pollution Control Board in 1999. This primary treatment, however, is not high enough to remove all pathogens; hence, after this primary treatment, significant health and environmental risks remain. Due to budget constraints, 76 percent of the wastewater generated by the municipality is untreated by the STP. Less than half of the untreated wastewater is used for the replenishment of the lake in the Wonderland Park, in which the STP is located, and for local agriculture (specifically vegetable farming) and aquaculture activities conducted in the surrounding areas. The use of untreated wastewater for these purposes poses serious health risks to visitors of the park as well as to consumers and producers of fish and vegetables for which this water is used. The remaining untreated wastewater is discharged to the Ganges, creating environmental pollution and negatively affecting the sustainability of the ecosystem functions of the river. There is therefore an urgent need to invest in the improvement of the STP of the Chandernagore municipality in order to ensure that it functions at its maximum capacity for primary treatment and treats higher quantities of wastewater and also in order to upgrade its technology to treat wastewater at a higher quality (that is, secondary treatment).

Survey Design and Administration

The details of the process that enabled the selection of the attributes and attribute levels used in this choice experiment, experimental design, and sampling design are reported in great detail in Birol and Das (2010). Here we summarize these steps. Following extensive background work (which included a detailed review of the published and gray literature on wastewater treatment in general and on the Ganges River in particular, two focus group discussions with local citizens, and consultations with civil and chemical engineers and hydrologists employed by the Kolkata Metropolitan Development Authority and Public Health Engineering Directorate, as well as a pilot open-ended contingent valuation study), the attributes and levels reported in Table 1 were identified to describe the current (status quo or no intervention) and improved situations that would result from the intervention (that is, implementation of the wastewater management program).

Table 1. Wastewater treatment program attributes and attribute levels used in the choice experiment

Attributes	Definition	Levels
Quantity of treated wastewater	Total volume of wastewater treated with primary treatment by the STP. Currently, the STP is working below its capacity, treating only a quarter of wastewater generated in the municipality. The capacity of the STP can, however, be increased to treat *all* the wastewater generated by the municipality with primary treatment. This would significantly reduce the discharge of untreated wastewater in the Ganges.	*Low**, High
Quality of treated wastewater	The current capacity of the STP can only treat wastewater with primary treatment technology. The quality of wastewater treated with primary treatment is low, and when used for agri/aquaculture or discharged to the Ganges, it would still create health and environmental hazards. Secondary treatment technology could be used to increase the quality of the treated wastewater to a higher level so as to minimize the health and environmental risks.	*Low*, High
Regeneration of the park	Investment in the Wonderland Park around the STP to improve its use as a recreational site. Currently, there are no investments to sustain or improve the recreational services provided by the park, such as walking and picnicking.	*No*, Yes
Monthly increase in the municipal tax	Payment vehicle in Indian Rupees (Rs) identified through the pilot open-ended contingent valuation survey (1 Euro = 59.85 Indian Rupees)	Rs 1.5, Rs 4.5, Rs 12.5, and Rs 20

Source: Birol and Das (2010).
Note: *Levels in italics indicate the status quo level.

Experimental design techniques (Louviere et al. 2000) were used to obtain an orthogonal design, which consisted of only the main effects and resulted in 32 pairwise comparisons of alternative wastewater treatment programs. These were randomly blocked to four different versions, each with eight choice sets. Each set contained two wastewater treatment scenarios and an opt-out option, which is considered as a status quo or baseline alternative. The inclusion of the opt-out option in the choice set is instrumental to achieving welfare measures that are consistent with demand theory (Louviere et al. 2000; Bateman et al. 2003).

The pilot choice experiment survey was implemented in November and December 2007 and consisted of face-to-face interviews with a total of 150 randomly selected households located in Chandernagore municipality. The municipality population is 32,939 households, according to the latest census conducted in 2001. Due to budget and time constraints, a sample of 200 households (0.6 percent of the population) was feasible. Even though this small sample could not be representative of the population from which it is drawn, it would generate some indication of public preferences with respect to improvements to the STP and hence to the improvement of environmental quality in the Ganges.

The choice experiment survey was administered to be representative of the sample population in terms of income, social status, and proximity to the Ganges River and the Wonderland Park. Households were sampled from four randomly selected wards (neighborhoods in the municipality), chosen randomly from four lists of wards which were stratified according to proximity to the park and income level. Each ward hosts about 1,000 households, and 50 households (that is, 5 percent of all households in each ward) were within the project budget and timeline of this pilot study. To select households, a cross-sampling method was used. That is, a cross X was drawn on the ward map and every *n*th household was asked to participate in the survey. The overall response rate was 75 percent, with 150 households taking part in the survey.

The head of each household was interviewed. An introductory section explained to the respondents the context in which the choices were to be made and described each attribute, its present status, and its implications on public and environmental health. Respondents were reminded that there were no right or wrong answers and that we were only interested in their opinions. They were informed that the municipality did not have sufficient funds to improve the wastewater treatment facilities of the STP and that therefore it would be necessary to increase the monthly municipal taxes paid by each household. The respondents were also reminded of their households' budget constraints, as well as other local public goods that could be funded through their taxes.

In addition to the choice experiment questions, data on each household's social, economic, and demographic characteristics were collected. Descriptive statistics of the sample are reported in Table 2. These statistics reveal that, on average, the households interviewed in this survey have been residents in the Chandernagore municipality for 26 years and are located very near the Wonderland Park (a little more than 10 minutes' walking distance). The average number of household members is five people, which is the same as the average number of household members in Hugli District, under which the Chandernagore municipality falls (Census of India, 2001). More than half (60 percent) of the households have at least one child younger than 18 years of age. A great majority (91 percent) of the household heads is male, and their average age is 59 years. About 15 percent of the household heads have completed (or dropped out of) primary school education, whereas 33 percent hold technical school or university degrees and above. The average household monthly expenditure (proxy for disposable income in developing countries) is Rs 5,840 (97.8 euro), and a great majority of the household expenditure is spent on food, followed by health and personal care and transport. The average per capita expenditure (Rs 1,145) is similar to the average monthly per capita income for Hugli District, which was estimated to be Rs 1,127 in 2005 (Bureau of Applied Economics and Statistics, Government of West Bengal 2005).

Table 2. Social, economic, and demographic characteristics of the sampled households

Characteristic	Sample mean (standard deviation)
Household size	5.1 (2.4)
Household head age	58.8 (13.1)
Monthly food expenditure (in Rs)	3,498.3 (1,618.4)
Monthly expenditure (in Rs)	5,839.6 (2,397.5)
Share of income spent on food	60.1 (12.3)
Number of years resident in the area	26 (16.1)
Distance to the park (in minutes)	11.4 (3.7)
	Percentage
Household has a child < 18 years of age = 1, 0 otherwise	60
Household head female = 1, 0 otherwise	8.7
Household head completed primary school or less = 1, 0 otherwise	15.3
Household head has a university degree or above = 1, 0 otherwise	33.3
Employment in service sector = 1, 0 otherwise	26
Self-employed = 1, 0 otherwise	40
Pensioner = 1, 0 otherwise	22.7
Housewife = 1, 0 otherwise	8.7
Manual worker = 1, 0 otherwise	2.7
Visited the park = 1, 0 otherwise	80

Source: Birol and Das (2010).

4. RESULTS

Conditional Logit Model

The choice experiment was designed with the assumption that the observable utility function would follow a strictly additive form. The model was specified so that the probability of choosing a particular wastewater treatment program was a function of the attributes and the ASC (Equation 3). Using the 1,200 choices elicited from 150 households, the CLM was estimated with LIMDEP 9.0 NLOGIT 4.0. The results for the CLM are reported in Birol and Das (2010) and replicated in Table 3 to provide background for the NLM results.

Table 3. CLM estimates for wastewater treatment program attributes

Attributes	CLM Coefficient (standard error))
ASC	–1.1***(0.174)
Quality of treated wastewater	0.665*** (0.071)
Quantity of treated wastewater	0.407*** (0.069)
Regeneration of the park	–0.421*** (0.064)
Monthly increase in municipality tax	–0.147*** (0.012)
Pseudo ρ^2	0.219
Log-likelihood	–867.133
Sample size	1,200

Source: Birol and Das (2010).
Note: ***1% significance with two-tailed tests.

McFadden's ρ^2 value in CLM is similar to the R^2 in conventional analysis except that significance occurs at lower levels. According to Hensher, Rose, and Greene (2005, 338), values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits. According to this criterion, the overall fit of the CLM (0.219) is extremely good, and all the coefficients are statistically significant. Treated wastewater quantity and quality are significant factors in the choice of a wastewater treatment program; *ceteris paribus*, these two attributes increase the probability that an improved wastewater treatment program is selected. In other words, households value those improved wastewater treatment programs that result in higher quality and quantity of wastewater treated.

The coefficient on the wastewater quality is about one-and-a-half times the magnitude of the coefficient on wastewater quantity. This result can be explained by the fact that even though residents recognize the need to increase the capacity of the current STP so that all of the wastewater generated by the residents of the municipality can be treated with primary treatment, they are especially concerned about treating wastewater to a higher quality (secondary treatment) level before discharging in the Ganges River or using it for irrigation or aquaculture. This result reveals that residents acknowledge that the quality of treated wastewater has implications for health and environmental risks. Therefore, plans for improvements to the STP should include not only expanding the capacity (or ensuring full use of its current capacity) for primary treatment but also upgrading of the current technology, from primary to secondary treatment, so that wastewater can be treated to a higher quality to minimize risks to public and environmental health.

Local households prefer those wastewater treatment programs that do not propose additional investments in the regeneration of the Wonderland Park around the STP to improve its use as a recreational park. This result is also not surprising, given that 98.7 percent of the households interviewed agree that the park is already an attractive recreational site. In fact, since its opening in 1999, 80 percent of the respondents have visited the park for recreational purposes an average of 7 times.

The coefficient on ASC is negative and significant, implying that there is some degree of status quo bias—all else held constant, respondents would prefer to move away from the status quo (no intervention) situation (Hanley, Adamowicz, and Wright 2005) and toward improved wastewater treatment programs even if they would have to pay higher monthly taxes for these. Finally, the sign of the payment coefficient indicates that the effect on utility of choosing a choice set with a higher payment level is negative, as expected.

Protest Responses

One feature of the data that needs further investigation is the high number of citizens who chose the status quo alternative in at least one of the eight choice sets offered to them. In fact 90 percent of citizens chose to opt out in at least one choice set, 89 percent in two, 82 percent in three, 77 percent in four, 71 percent in five, 64 percent in six, 39 percent in seven, and 21 percent in all eight. To differentiate true zero WTP values from protest responses, five follow-up statements (Haab 1999) were responded to in Likert scale format (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree):

1. I should not be asked to pay higher taxes for improvement of the STP.
2. I do not trust the authorities to manage the funds generated efficiently and effectively.
3. I do not have the financial capability to pay higher taxes.
4. I do not care about the quality of water and environmental problems in the Ganges.
5. I do not care about the Wonderland Park.

Those citizens who agreed or strongly agreed with statements 1 and 2 were classified as protesters of the STP improvement intervention, whereas those who agreed or strongly agreed with statements 3, 4, and 5 were classified as true zeros. Of the 31 respondents who chose the status quo in all eight of the choice sets, 94 percent agreed or strongly agreed with statements 1 and 2, whereas 55 percent agreed or strongly agreed with statement 3and only two respondents (6.5 percent) agreed or strongly agreed with statements 4 and 5. Therefore, a significantly greater proportion of respondents who chose to opt out in all eight choice scenarios are protestors rather than true zeros.

Similarly, of all the respondents who chose to opt out in at least one choice set, 71 percent agreed or strongly agreed with statement 1, 92 percent agreed or strongly agreed with statement 2, 38 percent agreed or strongly agreed with statement 3, only 1.5 percent agreed or strongly agreed with statement 4, and 11 percent agreed or strongly agreed with statement 5. Therefore, overall, the main reasons for not choosing the improvement scenarios were not because of citizens' inability to pay or because they do not value the water quality and the environmental conditions in the Ganges. Almost all (90 percent) of the citizens opted out at least in one scenario mainly because they did not think the intervention (that is, the improved program) would work; they hold this belief because they do not trust that the authorities would implement the intervention efficiently and effectively, because they do not think that they themselves should be providing the financial resources for this investment, or both.

Nested Logit Model

To account for the high percentage of no intervention (status quo) responses and to relax the IIA and IID assumption, the NLM was used to analyze the data. In this model, the citizens' decision-making process was modeled as explained in Section 2. That is, the citizens first decide whether to choose an improved wastewater treatment program or to stay with the current STP (status quo); if they choose the improved program, they make a choice between the two different improved programs, A and B. The NLM was estimated using LIMDEP 9.0 NLOGIT 4.0 and the full data set of 1,200 observations from 150 respondents. The results are reported in Table 4.

The Swait-Louviere log likelihood ratio test rejects the null hypothesis that the regression parameters of CLM and NLM are equal at 0.5 percent significance level. There are other statistical tests that point to the superiority of the NLM to CLM in explanation of the citizens' valuation process. First, the scale parameter must be different from unity to indicate a nested structure (Li et al. 2004). Since the choice model in each branch is CLM, this implies that the scale of the utilities of one branch is equal to the inverse of the branch inclusive value (Louviere et al. 2000). Therefore, the scale parameter for the *Change* branch is 1/0.69 = 1.45, which is greater than unity, and hence NLM should be employed to explain the decision-making process.

Second, a significant IV parameter estimate suggests that the parameter is not equal to zero, but it does not indicate whether the parameter lies outside the upper bound of the (0,1) range. Thus for significant IV parameters, a second test is required to determine whether the upper bound has been exceeded. This test is the Wald test, which is measured as (IV parameter–1)/standard error, which in this case yields (0.69–1)/0.11 = –2.82 for the *Improvement* branch. Comparing the test statistics of –2.82 to the critical value of +/1.96, we cannot accept the hypothesis that the *Improvement* IV parameter is statistically equal to 1. This finding implies that the two branches should not collapse into a single branch. Thus, for our example, the NLM model would be preferable (Hensher, Rose, and Greene 2005).

Table 4. NLM estimates for wastewater treatment program attributes

Attributes	Coefficient (standard error)
Attributes in the Utility Functions	
ASC	0.086 (0.248)
Quality of treated wastewater	0.784***(0.098)
Quantity of treated wastewater	0.504***(0.094)
Regeneration of the park	–0.498***(0.083)
Monthly increase in municipality tax	–0.182***(0.022)
Attributes of Branch Choice Equations	
ASC	0.086 (0.248)
Share of food expenditure in total household expenditure	–3.377***(0.556)
Household size	0.111***(0.028)
Household head has a university degree or above	0.374*** (0.147)
IV Parameters	
Improvement	0.724*** (0.115)
Status Quo	1*** Fixed Parameter
Pseudo ρ2	0.249
Log-likelihood	–833.013
Sample size	1,200

Source: River Ganga Wastewater Treatment Choice Experiment Survey, 2008.
Note: ***1% significancesignificance level with two-tailed tests.

The results of the NLM reveal that the citizens prefer those wastewater treatment program alternatives that provide higher water quality to be discharged in the Ganges and higher water quantity to be treated by the STP. The citizens, however, do not prefer programs that propose to invest in the regeneration of the Wonderland Park. Consistent with economic theory, the citizens prefer those programs that cost less in terms of increased municipality taxes.

To better understand the citizens' choice of participation, we included some household-level characteristics in the branch choice equation. These characteristics are household size, share of food expenditure in total expenditure, and whether or not the household head has a university degree. The results reveal that those households that spend greater proportions of their total expenditure (as a proxy for income) on food are less likely to choose the improvement programs. Engel's Law states that "the poorer is a family, the greater is the proportion of the total outgo which must be used for food" (Zimmerman 1932, 80). Therefore, poorer households are less likely to agree to pay higher taxes for the provision of the intervention.

On the other hand, citizens from larger households, which are likely to include children, as well as those from households with heads who hold university degrees and above, are more likely to choose the improvement programs. These findings are in line with those from developed countries, where more educated citizens, those with higher incomes, and those with children (due to "bequest motives" (Krutilla 1967)) are more likely to participate in and be willing to pay higher values for interventions for environmental conservation and sustainable natural resources management (for example, Kosz 1996; Birol, Karousakis, and Koundouri 2006).

Willingness to Pay Estimations

The choice experiment method is consistent with utility maximization and demand theory (Hanemann 1984; Bateman et al. 2003); therefore, the marginal value of change in wastewater treatment program attribute can be calculated as follows:

$$WTP = -2\left(\frac{\beta_{attribute}}{\beta_{localtax}}\right). \quad (9)$$

This part-worth (or implicit price) formula represents the marginal rate of substitution between payment (increase in monthly tax) and the wastewater treatment program attribute in question, or the marginal welfare measure (that is, WTP) for a change in any of the attributes. Since all three of the wastewater treatment program have two levels (that is, are binary), the WTP is multiplied by two (Hu et al. 2004).

Using the Wald procedure (Delta method) in LIMDEP 9.0 NLOGIT 4.0., citizens' valuation of wastewater treatment program attributes are calculated for the CLM and NLM for comparison purposes and are reported in Table 5.

Table 5. Marginal WTP for wastewater treatment program attributes from CLM and NLM (Rs/household/month) and 95 percent confidence interval

Attributes	CLM	NLM
Quality of treated wastewater	9.1 (8.1–10.1)	8.6 (7.6–9.6)
Quantity of treated wastewater	5.6 (4.7–6.5)	5.5 (4.6–6.4)
Regeneration of the Park	–5.8 (–6.7– –4.9)	–5.5 (–6.5– –4.6)

Source: River Ganga Wastewater Treatment Choice Experiment Survey, 2008.

According to the t-tests, compared with the better-fitting NLM, the CLM overestimates citizens' WTP for all three attributes at 1 percent significance level. The estimated WTP values for the NLM indicate that an average household values the improvement in water quality the most and is willing to pay Rs 8.6 more in monthly municipal taxes to ensure that the wastewater is treated with secondary treatment and that the quality of the water discharged to the river is high. These households are willing to pay about 40 percent less than this amount to increase the treatment capacity of the STP to treat all the wastewater generated by the municipality with primary treatment. The citizens, however, derive negative values from investment in the regeneration of the park, given that they are already satisfied with the present facilities (status quo) provided. The significant discrepancy of WTP values across the two models reveals the importance of capturing the two-stage decision-making process that is modeled in the NLM.

5. DISCUSSIONS, CONCLUSIONS, AND POLICY IMPLICATION

Water supply and sanitation hold a very important place in urban services. India's urban water supply and sanitation sectors face several resource- and management-related problems and require a huge investment for revamping (Singh 2006). Several municipalities in India cannot deliver these services to the full population of their municipalities; the services they deliver are often of low quality, and they are unable to maintain available services without extensive subsidies (Singh 2006).

One of the reasons for low quality or unreliable service delivery is no doubt corruption. The corruption study conducted by Transparency International India (2005) was the largest corruption survey ever undertaken in the country, with a sample of 14,405 respondents spread across 20 states. The results of this study showed that (1) about 17 percent of households interviewed stated to have interacted with municipalities to get water supply or sanitation services or both during 2004–2005, (2) nearly one-fourth of those who interacted with the municipalities had actually paid bribes, (3) more than one-third had visited municipalities more than four times in 2004–2005, (4) nearly three-fourths opined that there was corruption in the municipality, and (5) two-fifths had taken recourse with alternative methods such as paying a bribe or using influence to get their work done. As also put forward by Alley (2002), the cycle of allegations about corruption and admissions about public alienation runs through wastewater management issues. Citizens, and in some cases industrialists, allege that they do not trust government institutions to provide services without bribes, while civic institutions do not get the public support they need to improve services legitimately (Alley 2002).

This paper presented a choice experiment study we conducted to understand whether or not the citizens of the Chandernagore municipality, located on the banks of the Ganges River in West Bengal, are willing to pay higher municipality taxes for an intervention that proposes to improve the quantity and quality of wastewater treated by the local STP and to invest in the management of the Wonderland Park, a recreational site around the STP. The findings reveal that even though almost all (98 percent) of the citizens value the quality of the water and the environment in the Ganges River, a great majority (90 percent) protested the intervention by not choosing the improved STP scenario in at least one of the eight hypothetical markets in which they were asked to participate. When asked their reasons for not preferring the improved scenarios, 92 percent of them agreed with the statement that they do not trust the authorities to efficiently and effectively manage the funds generated through additional taxes. Even though this statement cannot be translated into citizens' concerns about corruption in the local authorities, nor does it measure the level of distrust or perceived corruption explicitly, it points to a lack of trust in local authorities' ability and willingness to deliver services. When the protest responses are accounted for with the use of the NLM, however, the results reveal that the citizens are willing to pay significant amounts to ensure that the intervention takes place and that the improved STP treats larger amounts of wastewater to a higher quality before discharging it to the Ganges.

These finding are in line with the findings of Alley (2002) and Transparency India International (2005), as well as previous water supply provision studies conducted by Anand (2002). Even though in this study we did not measure the impact of distrust on citizens' WTP, we showed that this distrust affects citizens' valuation. Therefore, to improve the wastewater management services, which are directly related to water and environmental quality in the water bodies into which treated wastewater is deposited, the municipalities could rely on their citizens' WTP for provision of such improved services. To be able to capture this WTP, however, the performance, trustworthiness, and accountability of municipalities, as well as citizens' perceptions of these, should be improved.

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