Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Surveys in Southern Haiti*

Dale Whittington
University of North Carolina at Chapel Hill

John Briscoe
World Bank

Xinming Mu
Asian Development Bank, Manila, Philippines

William Barron
OXFAM, Cambodia

Progress in improving the quality and quantity of water used by people in rural areas of the developing world has been unsatisfactory in two respects: (1) supplies that have been built are frequently neither used correctly nor properly maintained and (2) extension of improved service to unserved populations has been slow. Though this poor record is not the result of a single factor, a major impediment to improved performance is inadequate information on the response of consumers to new service options. The behavioral assumptions that typically underlie most rural water supply planning efforts are simple. It is commonly assumed that so long as financial requirements do not exceed 5% of income, rural consumers will choose to abandon their existing water supply in favor of the "improved" system. Several reviews by the World Bank, bilateral donors, and water supply agencies in developing countries have shown, however, that this simple model of behavioral response to improved water supplies has usually proved incorrect.[1] In rural areas many of those "served" by new systems have chosen to continue with their traditional water use practices.

0013-0079/90/3802-0008$01.00

If rural water projects are to be both sustainable and replicable, an improved planning methodology is required that includes a procedure for eliciting information on the value placed on different levels of service, and tariffs must be designed so that at least operation and maintenance costs (and preferably capital costs) can be recovered. A key concept in such an improved planning methodology is that of "willingness to pay." If people are willing to pay for the full costs of a particular service, then it is a clear indication that the service is valued (and therefore will most likely be used and maintained) and that it will be possible to generate the funds required to sustain and even replicate the project. Most attempts to incorporate willingness-to-pay considerations into project design have, however, been ad hoc, in large part because of the absence of validated, field-tested methodologies for assessing willingness to pay for water in the context of rural communities in developing countries.

Two basic theoretical approaches are available for making reliable estimates of households' willingness to pay, but neither has been adequately tested in the field. The first, "indirect" approach, uses data on observed water use behavior (such as quantities used, travel times to collection points, perceptions of water quality) to assess the response of consumers to different characteristics of an improved water system. Several modeling approaches are possible candidates here, among them varying parameter demand, hedonic property value, and hedonic travel cost models.[2] The second, "direct" approach, is simply to ask an individual how much he or she would be willing to pay for the improved water service, for instance, a public standpost or yard tap. This survey approach is termed the "contingent valuation method" because the interviewer poses questions within the context of a hypothetical market.

The focus of this article is on this second approach, the contingent valuation method. Conventional wisdom has been that contingent valuation surveys are unreliable because of "the pervasive feeling that interrogated responses by individuals to hypothetical propositions must be, at best, inferior to 'hard' market data, or, at worst, off-the-cuff attitudinal indications which might be expected to reflect efforts by individuals to manipulate the survey to their selfish ends."[3] In the specific case of rural water supplies, the World Bank concluded more than a decade ago that "the questionnaire approach to estimating individuals' willingness to pay has been shown to be virtually useless."[4] There was, however, little empirical evidence to support this conclusion. Our research objective was to see if contingent valuation surveys could, in fact, be used in developing countries to develop useful estimates of willingness to pay for water services. A village in southern Haiti was the field site of our study.

After describing the specific research area in Haiti, we summarize

its existing water supplies and the water use practices of the population. We then describe our research design and field procedures. The results of our analysis of the sample population's contingent valuation bids lead to general conclusions and remarks on policy implications of the research.

The Study Area

In August 1986 the research team conducted a contingent valuation survey and source observations in Laurent, a village in southern Haiti. One reason that southern Haiti was selected as the research area was that the United States Agency for International Development was funding a rural water supply project there. The project was designed to provide services to about 160,000 individuals in 40 towns and villages. The project was executed by CARE, which as the implementing agency was responsible for site selection, construction, and community organization. The CARE project's standard village water supply project was a gravity-fed system supplied with water captured from a mountain spring, feeding a few public standposts in a rural community. CARE provided experienced enumerators for our household surveys, logistic support, and valuable advice on a wide range of issues, from questionnaire design and translation to data on local water use customs. The affiliation of our research effort with the ongoing CARE project provided us with access to villages and justified our presence to the local population.[5]

The village of Laurent is located about 15 kilometers from Les Cayes, the provincial capital of southern Haiti. The population of Laurent is about 1,500. The region is mountainous, with numerous streams draining into the Caribbean Sea. The rainy seasons are October–January and May–June; our study was conducted during the middle of the July–September dry season.

The population of Laurent consists primarily of small farmers who cultivate sorghum, beans, corn, rice, manioc, sweet potatoes, plantains, yams, coconuts, mangos, and vetiver (a crop used in the production of essential oils for perfume). Few people have regular wage employment, and remittances from relatives and friends living abroad or in Port-au-Prince are common. Eighty percent of the population of Haiti are illiterate; the illiteracy rate in our study area is probably even higher. Malnourishment is widespread among children in Laurent. The typical family lives in a three-room mud house with plastered walls and a thatched or tin roof.

Water Sources and Water Use Patterns and Customs

Inhabitants of Laurent have access to several sources of fresh water. There are seven sources within approximately 2 kilometers of most of the population: one protected well and six springs in dry river beds.

The springs provide only modest amounts of water, and individuals often wait more than an hour to draw supplies. The average 3-kilometer round trip to a water source can sometimes take several hours.

The population of Laurent expresses strong preferences for clean drinking water and sometimes will walk considerable distances past alternative sources to collect drinking water from sources that are considered pure. Water for drinking and cooking is usually collected by women and children and carried home in relatively standard-size containers (about 20 liters for adults). Although children under 5 years old are usually bathed at home in basins, adults and older children have a strong preference for bathing in rivers. Clothes washing is usually done in rivers. Some individuals actually pay for public transport to make the roughly 10-kilometer round trip to the nearest river in order to do laundry.

Research Design

Our research design was developed to test whether contingent valuation surveys could be used to estimate water demand relationships suggested by consumer demand theory, and thus used reliably to estimate individuals' willingness to pay for improved water services. Economic theory suggests that an individual's demand for a good is a function of the price of the good, prices of substitute and complementary goods, the individual's income, and the individual's tastes, usually measured by the individual's socioeconomic characteristics. In CARE's water supply project, the characteristics of the good—public standposts or private connections—are the same for everyone. There is no volumetric charge for water from public standposts; an individual can use as much water as desired. Whether or not a household demands water from the public water system thus depends on the price charged for access to the new system or for participation in the project. If the charge is higher than a given household's maximum willingness to pay (WTP), the household will elect not to use the new water system. Maximum willingness to pay will vary from household to household and should be a function of all of the variables in the demand function except the price of the good itself. The households' WTP bids should thus be positively related to income, the cost of obtaining water from existing sources, and the education of household members, and negatively correlated with the individual's perception of the quality of water at the traditional source used before the construction of the improved water supply system. We would hypothesize that the WTP bids of women respondents would be higher than those of men because women carry most of the water, but alternative interpretations are certainly possible.[6]

Our research design attempted to test whether WTP bids are systematically related to the variables suggested by economic theory. If the variation in bids cannot be explained by such variables, three logical explanations can be offered. First, economic theory may not be an appropriate conceptual framework for explaining the behavior and preferences involved. Second, economic theory may be correct, but the contingent valuation method may not be a sound method for collecting information to estimate the water demand relationships suggested by such theory. Third, errors in execution of the research, such as poor questionnaire design, could lead to invalid inferences about the relationship between the WTP bids and the independent variables.

Because contingent valuation surveys have seldom been attempted in developing countries, our research design was constructed to test for the existence and magnitude of several types of threats to the validity of the survey results. The major problem with the contingent valuation method is that for a variety of reasons, respondents may not answer willingness-to-pay questions accurately and thus not reveal their "true" willingness to pay.[7] The question format itself may affect the bids.[8] In our pretest of the questionnaire we tried different ways of asking the willingness-to-pay questions. We tried both open-ended, direct questions—for example, "What is the maximum you would be willing to pay per month to have a public standpost near your house?"—and two forms of bidding games in which we asked a series of yes-no questions—for example, "Would you be willing to pay $X per month for a public standpost near your house?" The Appendix presents an example of the sequence of questions used in one of these bidding games.

We also attempted to test for the existence and magnitude of three types of biases in contingent valuation surveys that have been of particular concern in the literature: strategic bias, starting point bias, and hypothetical bias.

Strategic Bias

Strategic bias may arise when an individual thinks he may influence an investment or policy decision by not answering the interviewer's questions truthfully. Such strategic behavior may influence an individual's answers in either of two ways. Suppose the individual is asked how much he would be willing to pay to have a public standpost near his house. If he thinks the water agency or donor will provide the service if the responses of individuals in the village are positive, but that someone else will ultimately pay for the service, he will have an incentive to overstate his actual willingness to pay. On the other hand, if he believes the water agency has already made the decision to install public standposts in the village, and the purpose of the survey is for the water

agency to determine the amount people will pay for the service in order to assess charges, the individual will have an incentive to understate his true willingness to pay.

Most attempts to estimate strategic bias have been highly structured experiments in which one group of respondents is told one set of factors about a situation that minimizes their incentive for strategic behavior, and another group receives a different set that maximizes their incentives for strategic behavior.[9] In fact most of the available evidence from the United States and Western Europe fails to support the hypothesis that individuals will act strategically in answering contingent valuation questions, but there is no evidence with respect to developing countries.

Because we were conducting our surveys within the context of CARE's ongoing rural water supply project, it was impossible to construct a counterfactual situation (it would have entailed deceiving the study population about CARE policies). We attempted instead to estimate the magnitude of strategic bias in the following way. We divided our study population into two groups. One group was read the following statement that was intended to minimize strategic bias:

> *Opening Statement A:* I am going to ask you some questions in order to know if you or someone from your household would be willing to pay money to ensure that the CARE Potable Water Project will be successful in Laurent. We would like you to answer these questions at ease. There are no wrong answers.
>
> The water system is going to be managed by a committee of people from Laurent. This committee will be chosen by the people of Laurent. CARE has decided to help Laurent by constructing a water system in this community. Your answers cannot change the fact that CARE has decided to build this water system. CARE never demands money from those people who collect water from public fountains. You will not have to pay money at the public fountains. We need you to tell the truth in order for CARE to construct the best water system for Laurent.

The second group was read another statement that was accurate but left more questions about the purpose of the study unanswered:

> *Opening Statement B:* I am going to ask you some questions in order to know if you or someone from your household would be willing to pay money so that the CARE Potable Water Project will be successful in Laurent. The water system is going to be managed by a committee of people from Laurent. This committee will be chosen by the people of Laurent. The committee will decide the amount each household will have to pay to operate and maintain the water system.

Our hypothesis was that if individuals acted strategically, then bids from those who received the second statement would be lower than bids from those who received the first, because the former would fear

that a high bid would result in a higher charge by the community water committee.[10]

Starting-Point Bias

In the bidding-game question format, the interviewer starts the questioning at an initial price. A respondent who is unsure of an appropriate answer and wants to please the interviewer may interpret this initial price as a clue as to the "correct" bid. Starting-point bias exists if this initial price affects the individual's final willingness to pay. To test for starting-point bias we distributed three different versions of our questionnaire, each with different initial prices in the bidding game. The questionnaires were randomly distributed in the sample population.

Hypothetical Bias

Hypothetical bias may arise from two kinds of reasons.[11] First, the respondent may not understand or correctly perceive the characteristics of the good being described by the interviewer. This has been a particular problem when the contingent valuation method has been used to measure individuals' willingness to pay for changes in environmental quality because it may be difficult for people to perceive what a change, for example, in sulfur dioxide or dissolved oxygen means in terms of air or water quality. This source of hypothetical bias is not likely, however, to be significant for most public services in developing countries. Many rural water systems have already been built in southern Haiti; our respondents were all familiar with public water fountains and private water connections and readily understood the possibility that their community would receive a new water system. Moreover, we showed each respondent two color photographs of public standposts CARE had built in nearby villages. Household members usually studied these with great interest.

Second, it is often alleged, particularly in the context of developing countries, that individuals will not take contingent valuation questions seriously and will simply respond by giving whatever answer first comes to mind. Where this type of hypothetical bias is prevalent, bids will presumably be randomly distributed and not systematically related to household characteristics and other factors suggested by economic theory. Our test for hypothetical bias was thus the same as our test for the applicability of consumer demand theory: were bids systematically related to the variables suggested by economic theory?

Field Procedures

Fieldwork in the village consisted of two parts: household surveys and source observations. Eight CARE health education promoters and two local college students were trained for 2 days to carry out the household interviews. Prior to field-testing the questionnaire, we held a

"focus group" in which individuals from a nearby community discussed community water use practices and attitudes. Particular attention was paid in our focus group to household decision making on water-related matters and to community expectations about operation and maintenance costs. The focus group was not intended, however, to substitute for a pretest of the questionnaire. The Creole questionnaire was pretested extensively in a nearby village before the CARE enumerators were trained, and another day of pretesting was carried out by CARE staff after training. Because microcomputers were available, revisions to the questionnaire could be incorporated literally overnight, and new copies made for fieldwork the next day.

The majority of households in Laurent were interviewed. Enumerators were instructed to try to interview someone in every house. If no one was at home, a follow-up visit was usually arranged.

The household interview consisted of four sections. The first dealt with basic occupational and demographic data for the family members and summary information on where the family obtained its water. The second section consisted of additional questions on the location of each water source that the family used, perceptions of the water quality at each source, the average number of times each family member went to each source per day, and the number of containers they carried home (the enumerator asked to see the containers used to carry water and estimated their volume). In the third section of the questionnaire, the enumerator read one of the statements used to test for strategic bias and showed the respondent photographs of public standposts CARE had built in other villages. The respondent was then asked for (*a*) a WTP bid per month for public standposts (assuming no private connections) and (*b*) a private connection (assuming public standposts were already installed). The fourth section was a series of questions on the health and education of family members and the household's assets (such as whether the household had a radio or a kerosene lamp). The principal investigators and the enumerators had agreed that it was not possible to obtain accurate information on household income through interviews (in fact, the enumerators simply refused to ask either income or expenditure questions because of the antagonism such questions aroused). As a substitute, the enumerator recorded a series of observations about the construction of the house itself, such as whether the house was painted, whether the roof was straw or tin, and whether the floor of the house was dirt or cement.

A detailed map of the village was prepared that indicated the location of all houses and major structures, as well as all water sources. Enumerators who could read maps were given a copy of the village map and asked to assign a number to each household interviewed and to record that number on the map. The enumerator also gave each respondent a ribbon and an index card with the corresponding house-

hold number on it and asked the respondent to wear the ribbon or bring the index card on a designated day to the water source used. Enumerators who could not read a map were given a set of ribbons with preassigned numbers, dropped at specific points in the villages, and instructed to interview households in clearly specified areas and assign a number to each household interviewed; one of the senior members of the research team then recorded on the map which households were located in the specified areas. Data from household interviews were generally entered into the microcomputer on the same day the interviews were conducted, and processed with dBase III programs. Summary statistics were continually compiled during the course of the fieldwork, and discrepancies in the data and problems with the survey implementation could be quickly detected.

The second part of the fieldwork consisted of observing the quantities of water collected by individuals at all the sources used by the population of the village. The objective of these observations was to verify the information individuals provided in household interviews on the sources they used and the quantities of water collected. Local residents were hired to serve as source observers; they were typically secondary school students on summer vacation. All source observers received one day of training in estimating the volumes of various containers and in recording data in their notebooks. Each time an individual arrived at a source, the source observer recorded household number, name, gender, relative age (adult or child), time of arrival, quantity of water carried away, and whether the individual bathed or did laundry. All sources were observed on the same day from sunrise to sunset. Two shifts of source observers were used for each source. The source observers were monitored closely by the principal investigators to ensure the quality of the data collected.

Analysis of the Source Observation Data

The analysis of the source-observation data for Laurent increased our confidence in the quality of the water-use data obtained from the household interviews. In Laurent we recorded data on 119 trips to water sources by individuals (or groups of individuals from the same household) who identified themselves to our source observers either by wearing a ribbon or displaying an index card with their household number. We compared the sources these individuals said they used for drinking and cooking in the interview with the source they actually went to on the day of our source observations. Out of the 119 observations, the interview responses were consistent with the source observations for 101 households (85%). In the econometric analysis of the contingent valuation bids, we used the water source selection data from the household interviews in order to calculate the distance from the household to its primary source of drinking and cooking water.

TABLE 1

TEST FOR STRATEGIC BIAS

	Opening Statement A		Opening Statement B
Willingness to pay for public standposts:			
Total observations	77		73
Mean WTP bid[a]	6.0		5.4
Standard deviation	3.8		3.9
Overall mean		5.7	
Standard deviation		3.8	
t-statistic		1.1	
Willingness to pay for private connections:			
Total observations	67		65
Mean WTP bid[a]	7.5		6.7
Standard deviation	9.0		9.8
Overall mean		7.1	
Standard deviation		9.4	
t-statistic		.5	

NOTE.—Null hypothesis that the two samples are from the same population cannot be rejected at any acceptable confidence level.

[a] Mean WTP bid in gourdes per month. 5 gourdes = US$1.

Analysis of the Contingent Valuation Bids

In Laurent, 170 questionnaires were completed out of approximately 225 households in the village. Our impression from sitting in on many of the household interviews is that respondents took the contingent valuation questions, and indeed the entire interview, quite seriously. Fourteen percent of the households gave an answer of "I don't know" in response to the WTP question for public standposts; there was a 25% nonresponse rate for the WTP question for private connections. The mean of the bids in Laurent for the public standposts, 5.7 gourdes per month (US$1.14; US$1.00 = 5 gourdes) seemed realistic to us. In our opinion, we never received wildly unrealistic or "protest" bids. Based on the pretest, we felt that the bidding-game question format worked better than the direct, open-ended questions. People generally felt more comfortable with the bidding games, and, in fact, our enumerators remarked that the bidding game format was very familiar and easily understood because it was similar to the ordinary kind of bargaining that goes on in local markets of rural Haiti. Hence in Laurent we used only the bidding-game question format.

In this section we discuss the results of the statistical analysis of the data obtained from the household surveys in Laurent. Table 1 presents the results of our tests for strategic bias for the WTP questions both for public standposts and private connections. The 150 total re-

TABLE 2

TEST FOR STARTING-POINT BIAS

	STARTING POINT		
	2 gourdes[a]	5 gourdes	7 gourdes
Willingness to pay for public standposts:			
Number of observations	56	47	47
Mean WTP bid[b]	5.4	6.0	5.7
Standard deviation	3.8	3.9	3.9
F = .32			
Probability = .73			
	STARTING POINT		
	5 gourdes	10 gourdes	15 gourdes
Willingness to pay for private connections:			
Number of observations	48	41	43
Mean WTP bid[b]	6.7	7.4	7.1
Standard deviation	8.3	8.8	11.0
F = .06			
Probability = .94			

NOTE.—Null hypothesis that the three samples are from the same population cannot be rejected at any acceptable confidence level.

[a] 5 gourdes = US$1.

[b] Mean WTP bid in gourdes per month.

sponses for public standposts were relatively evenly divided between statement A (77 responses) and statement B (73 responses), as were those for the private connections. As anticipated, for respondents who received statement A, the mean bids both for public standposts and private connections were higher than for those who received statement B, but the difference is not statistically significant. On the basis of this test, we cannot reject the hypothesis that respondents were not acting strategically when they answered the WTP questions.

Table 2 presents the results of a similar statistical test for starting-point bias. If starting-point bias were a problem, we would expect that the low starting point (2 gourdes for public standposts; 5 gourdes for private connections) would result in a lower bid, and that the high starting point (7 gourdes for public standposts; 15 gourdes for private connections) would result in higher bids. The mean bids in table 2 do not appear to vary systematically with the starting point. The null hypothesis that the three samples are from the same population (that there is no difference in the responses from individuals who received different starting points) cannot be rejected, although the confidence intervals are wide.

On the basis of these results, there was no reason to attempt to adjust the WTP bids for strategic or starting-point bias. The mean of WTP bids for the public standposts was 5.7 gourdes per household per month. Assuming an average annual household income in Laurent of 4,000 gourdes (US$800), the mean bid is about 1.7% of household income and is significantly lower than the 5% rule of thumb often used in rural water-supply planning for maximum "ability to pay" for public standposts. The mean of WTP bids for private connections, 7.1 gourdes, was not much higher (2.1% of household income), but these bids are based on the assumption that the public standposts are already in place.

We next modeled the variations in the bids for public standposts and private connections as a function of the variables that were the primary focus of our research design. To measure income we developed an ordinal measure of the value of household assets, based on eight questions and observations about the quality of housing construction and household possessions (WLTH), and supplemented it with two other indicators of income: (1) whether the household received remittances from relatives living abroad and (2) the occupations of the principal members of the household. In the model remittance data were simply treated as a dummy variable (FINC). Occupation data were used to group households into two categories (farmers and nonfarmers) and were also represented by a dummy variable (IOCP). Education was measured as the sum of the years of school of up to two adults in the household (HHED). From the village map we measured the distance of each household to its drinking water source (DIST); these distances served as a measure of the cost of obtaining water from the existing source, which we viewed in the model as the "price" of the close substitute of the improved water service. Our measure of water quality (QULT) was based on the respondent's answers to seven questions concerning taste, odor, healthfulness, reliability, color, dirt, and conflict (quarrels) at the source.

Although the value households place on the proposed water system is a continuous variable, we believe the most reliable data generated from the bidding game are the set of yes/no responses to questions about specific, discrete prices. Thus, the observed dependent variable obtained from the bidding game procedure is not the maximum amount the household would be willing to pay but, rather, an interval within which the "true" willingness to pay falls. Linear regression is not an appropriate procedure for dealing with such an ordinal dependent variable because the assumptions regarding the specification of the error term in the linear model will be violated.[12] We have therefore used an ordered probit model, discussed below, to explain the variations in WTP bids.

Let V_h be the maximum willingness to pay of household h for the

proposed water system. Based on consumer demand theory, we hypothesize that V_h is a function of the attributes of the new and existing water sources and the household's socioeconomic characteristics

$$V_h = a + X_h B + e_h, \tag{1}$$

where X_h is a vector of the household's characteristics and the attributes of the sources, a and B are parameters of the model, and e_h is a random term with a standard normal distribution. Since V_h is not observable from the bidding game, equation (1) cannot be estimated. However, from the interview responses we know the ranges within which V_h will fall. Let $R_1, \ldots, R_m$ be the m prices which divide the range of WTP space into $m + 1$ categories, and let y_h be a categorical variable such that

$$y_h = \begin{cases} 1 \text{ if} & V_h < R_1, \\ 2 \text{ if} & R_1 < V_h < R_2, \\ M + 1 \text{ if} & V_h > R_m. \end{cases} \tag{2}$$

Let $i = 1, \ldots, \mathrm{M} + 1$. From equation (1), we have $y_h = i$ if

$$R_{i-1} < a + X_h B + e_h < R_i \tag{3}$$

$$\text{or } R_{i-1} - a < X_h B + e_h < R_i - a \tag{4}$$

$$\text{or } (R_{i-1} - a - X_h B)/\sigma < e_h/\sigma < (R_i - a - X_h B)/\sigma, \tag{5}$$

where σ is the standard deviation of e_h. Assuming e_h follows a standard normal distribution, then

$$\begin{aligned} P(y_h = i) &= P(R_{i-1} < V_h < R_i) \\ &= P(u_{i-1} - X_h B < e_h < u_{i-1} - X_h B) \\ &= F(u_i - X_h B) - F(u_{i-1} - X_h B), \end{aligned} \tag{6}$$

where $u_i = R_i - a$ and $F(\cdot)$ is the cumulative standard normal density function. (Equation [6] is the ordered probit model we have used to explain the variations in WTP bids.) The maximum likelihood estimates of u_i and B are consistent.[13]

The results of the estimations are presented in tables 3 and 4. The chi-square statistics illustrate that the overall models are highly significant. The adjusted likelihood ratio $(1 - \{[\mathrm{L(B)} - \mathrm{K}]/\mathrm{L(0)}\})$ is 0.142 for the model of bids for public standposts and 0.177 for the model of bids for private connections, where K is the number of independent variables in the model. The coefficients for all the independent variables are in the direction expected (e.g., households with higher education or wealth tend to bid higher). The t-statistics indicate that the

TABLE 3

WILLINGNESS-TO-PAY BIDS FOR PUBLIC STANDPOSTS

	Coefficient	*t*-ratio
Dependent variable:		
Probability that a household's willingness to pay for a public standpost falls within a specified interval		
Independent variables:		
Intercept	.841	1.350
Household wealth index (WLTH)	.126	2.939
Household with foreign income (FINC = 1 if yes)	.064	.232
Occupation index (IOCP = 1 if farmer)	−.209	−.848
Household education level (HHED)	.157	2.113
Distance from existing source (DIST)	.001	5.716
Quality index of existing source (QULT = 1 if satisfactory)	−.072	−2.163
Sex of respondent (male = 1)	−.104	−5.41
Log-likelihood	−206.01	
Restricted log-likelihood	−231.95	
Chi-square (freedom = 7)	51.878	
Adjusted likelihood ratio	.142	
Degrees of freedom	137	

TABLE 4

WILLINGNESS-TO-PAY BIDS FOR PRIVATE CONNECTION

	Coefficient	*t*-ratio
Dependent variable:		
Probability that a household's willingness to pay for a private connection falls within a specified interval		
Independent variables:		
Intercept	−.896	−1.344
Household wealth index (WLTH)	.217	4.166
Household with foreign income (FINC = 1 if yes)	.046	.194
Occupation index (IOCP = 1 farmer)	−.597	−2.541
Household education level (HHED)	.090	1.818
Distance from existing source (DIST)	.000	1.949
Quality index of existing source (QULT = 1 if satisfactory)	−.099	−2.526
Sex of respondent (male = 1)	−.045	−.207
Log-likelihood	−173.56	
Restricted log-likelihood	−202.48	
Chi-square (freedom = 7)	57.831	
Adjusted likelihood ratio	.177	
Degrees of freedom	120	

TABLE 5

DEMAND SCHEDULES FOR NEW WATER SOURCES, DERIVED FROM THE ORDERED PROBIT MODELS (Price vs. Number of Users)

	PRICE (Gourdes per month)			
	2	5	7	10
Number of users: Public standposts (N = 145)	138	97	68	40
	PRICE (Gourdes per month)			
	5	10	15	20
Number of users: Private connections (N = 127)	78	62	40	17

variables for household wealth, household education, distance of the household from the existing water source, and water quality are all significant at the 0.05 level in both models. The sex of the respondent was statistically significant in the model for public standposts, but not in the model for private connections. The results clearly indicate that the WTP bids are not random numbers but are systematically related to the variables suggested by economic theory.

Policy Applications

This ordered probit model can be used to predict the number of households in a community which will use a new source if various prices were charged. Since the interval for each category is known, y_h (the category into which household h falls) may be predicted from inequality (4) by calculating X_hB. Summing the number of households in each category in Laurent yields the demand schedules presented in table 5. Such demand schedules are precisely the kind of information needed by planners and engineers to make sound investment decisions, and we believe this ordered probit model, estimated with WTP bids obtained from a contingent valuation survey, is a promising approach to modeling village water demand relationships.

Summary and Conclusions

The results of this study suggest that it is possible to do a contingent valuation survey among a very poor, illiterate population and obtain reasonable, consistent answers. There does not appear to be a major problem with either starting point or hypothetical bias. The evidence with regard to strategic bias is less conclusive, but neither the admit-

tedly limited test for strategic bias nor the experience of the enumerators indicated that it was a problem.

From this research we cannot, of course, judge whether individuals in the villages would in fact pay the amounts they indicated in the contingent valuation survey if a water agency actually tried to collect the money. To do so we would need to conduct a contingent valuation survey in a village before a water system is built, then resurvey after the system is completed and collection efforts are made, and compare the prior bids with actual behavior.

Nevertheless, we believe that the preliminary results of this research strongly suggest that contingent valuation surveys are a feasible method for estimating individuals' willingness to pay for improved water services in rural Haiti. This has important policy implications for rural water supply projects such as CARE's because it seems to show that going into a village and conducting a relatively simple household survey can yield reliable information on the population's willingness to pay for improved water services. The implications of these preliminary research findings are not, however, limited to the rural water sector. Our research suggests that contingent valuation surveys may prove to be a viable method of collecting information on individuals' willingness to pay for a wide range of public infrastructure projects and public services in developing countries.

Appendix

Example of Bidding Game

Here are pictures of CARE public fountains set up in Rosier and Port-à-Piment.

(*a*) Do you think your household would be willing to pay 5 gourdes each month to use a public fountain located in your neighborhood?

Yes____	Go to (*b*)
No____	Go to (*c*)
I don't know____	Go to (*f*)

(*b*) We do not know how much the water committee will decide for each household to pay for using the public fountain each month. If the decision is for each household to give 10 gourdes each month, would your household be willing to pay this?

Yes____	Go to (*f*)
No____	Go to (*d*)
I don't know____	Go to (*f*)

(*c*) We do not know how much the water committee will decide for each household to pay for using the public fountain each month. If the decision is for each household to give 0.50 gourdes each month, would your household be willing to pay this?

Yes____	Go to (*e*)
No____	Go to (*f*)
I don't know____	Go to (*f*)

(*d*) Would your household be willing to pay 7 gourdes each month to use a public fountain located in your neighborhood?

Yes____	Go to (*f*)
No____	Go to (*f*)
I don't know____	Go to (*f*)

(*e*) Would your household be willing to pay 2 gourdes each month to use a public fountain located in your neighborhood?

Yes____	Go to (*f*)
No____	Go to (*f*)
I don't know____	Go to (*f*)

(*f*) Think for a moment, what is the largest amount of money your household would be willing to pay each month to use a public fountain? If it would cost your household more than this amount, your household could not afford to pay and would not be able to use the public fountain.

Amount of money:	____
I don't know:	____

Notes

* This research was carried out as part of the Water and Sanitation for Health (WASH) project, sponsored by the Office of Health, Bureau for Science and Technology, U.S. Agency for International Development. We would like to thank our project manager, Dr. Dennis Warner, for his assistance during the course of this work. We would like to express our appreciation to the following members of the CARE staff for their support during the fieldwork: Scott Faiia, Jonathan Mitchell, Ann Raposa, and Louis Jasmine. We would also like to thank Tom Bourgeois and Jean-Maurice Duval for their assistance with the fieldwork and David K. Guilkey and Raymond Burby for their comments on an earlier draft of the article. An earlier version of this article was presented at the annual meeting of the North American Regional Science Association, November 13–16, 1986, Columbus, Ohio.

1. See, e.g., Canadian International Development Agency, in World Health Organization, *Catalogue of External Support,* International Drinking Water Supply and Sanitation Decade Publication no. 3 (New York, April 1983), p. 218; IBRD, Water Supply and Urban Development Department, *Improving the Effectiveness of Investment in the Water Sector,* UNDP Water Decade Program (Washington, D.C.: World Bank, June 1986); Anthony A. Churchill, with the assistance of David de Ferranti, Robert Roche, Carolyn Tager, Alan A. Walters, and Anthony Yazer, "Rural Water Supply and Sanitation: A Time for Change," World Bank Discussion Papers 18 (Washington, D.C., 1987); R. Saunders and J. Warford, *Village Water Supply* (Baltimore: Johns Hopkins University Press, 1977).

2. For the varying parameter demand model, see W. J. Vaughn and C. S.

Russell, "Valuing a Fishing Day: An Application of a Systematic Varying Parameter Model," *Land Economics* 58, no. 4 (November 1982): 450–63. For the hedonic property value model, see, e.g., A. M. Freeman, "The Hedonic Price Approach to Measuring Demand for Neighborhood Characteristics," in *The Economics of Neighborhood,* ed. D. Segal (New York: Academic Press, 1979); A. D. Witte, H. J. Sumka, and H. Erekson. "An Estimate of a Structural Hedonic Price Model of the Housing Market: An Application of Rosen's Theory of Implicit Markets," *Econometrica* 47 (1979): 1151–73. For the hedonic travel cost model, see, e.g., C. J. Cicchetti, V. K. Smith, J. L. Knetsch, and R. A. Patton, "Recreation Benefits Estimation and Forecasting: Implications of the Identification Problem," *Water Resource Research* 8, no. 4 (August 1972): 840–50; T. A. Deyak and V. K. Smith, "Congestion and Participation in Outdoor Recreation: A Household Production Function Approach," *Journal of Environmental Economics and Management* 5, no. 1 (1978): 63–80; J. A. Sinden, "A Utility Approach to the Valuation of Recreational and Aesthetic Experiences," *American Journal of Agricultural Economics* 56, no. 1 (February 1974): 61–72.

3. R. G. Cummings, D. S. Brookshire, and W. D. Schulze, *Valuing Public Goods: The Contingent Valuation Method* (Totowa, N.J.: Rowman & Allanheld, 1986).

4. Saunders and Warford.

5. Another reason southern Haiti was selected was that decisions about the level of service and the choice of technology for water supply systems are particularly difficult in Haiti. Per capita incomes in Haiti are the lowest in the Western Hemisphere: in 1980 more than two-thirds of the population of 5 million people had per capita annual incomes less than US$155. Most individuals simply cannot afford the costs associated with private connections. Haiti thus provides a field setting similar to the situation in much of Africa and some parts of Asia, and conditions where an accurate understanding of the willingness of the population to pay for rural water services is likely to be particularly important for sound investment decisions.

6. For example, a survey in Zimbabwe showed that women were willing to pay 40% more than men for an improved water supply; see Ministry of Energy and Water Resources Development, *Water Tariff Study,* National Master Plan for Rural Water Supply and Sanitation, Republic of Zimbabwe (December 1985), vol. 3, pt. 4.

7. See, e.g., Cummings, Brookshire, and Schulze; R. C. Mitchell and R. T. Carson, "Will Respondents Answer Honestly? Observations on Strategic Bias and Contingent Valuation Surveys," in "Using Surveys to Value Water Quality Benefits: The Contingent Valuation Method," draft manuscript for USEPA Resources for the Future (Washington, D.C., January 29, 1985), chap. 3, and *Using Surveys to Value Public Goods: The Contingent Valuation Method* (Washington, D.C.: Resources for the Future, 1989).

8. See A. Randall, B. Ives, and C. Eastman, "Bidding Games for the Valuation of Aesthetic Environmental Improvements," *Journal of Environmental Economics and Management* 1 (1979): 132–49; A. Randall, J. P. Hoehn, and G. S. Tolley, "The Structure of Contingent Markets: Some Results of a Recent Experiment" (paper presented at the American Economic Association annual meeting in Washington D.C., 1981).

9. P. Bohm, "Estimating Demand for Public Goods: An Experiment," *European Economic Review* 3 (1972): 111–30; see also Mitchell and Carson, *Using Surveys to Value Public Goods.*

10. This is not in fact a strong test for strategic bias because the differences in the two statements are quite subtle. In an ongoing field test in Brazil

we are testing for strategic bias by comparing WTP bids from two different villages, one in which the water utility has already promised to construct a new water system and another in which the water utility has not yet determined whether to build a new system. A comparison of WTP bids from these two villages should be a more conclusive test for strategic bias, assuming it is possible to control for other differences between the two villages. In future research it would also be useful to have follow-up interviews with selected repondents to see whether the differences that we wished to suggest were understood. An in-depth anthropological research effort might also elicit information on what types of strategic "thoughts" passed through respondents' minds during the interview process. If strategic behavior is found to exist, anthropological research might also yield insights into how to minimize it during the interview.

11. Cummings et al. (n. 3 above).

12. See G. S. Maddala, *Limited-Dependent and Qualitative Variables in Econometrics* (New York: Cambridge University Press, 1983); D. McKelvey and W. Zavorina, "A Statistical Model for the Analysis of Ordinal Level Dependent Variables," *Journal of Mathematical Sociology* 4 (1975): 103–20.

13. See Maddala.