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Household demand for improved piped water services: evidence from Kathmandu, Nepal ☆

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Abstract

We examine households' demand for improved water services in Kathmandu, Nepal, where the government is considering the possibility of involving the private sector in the operation of municipal water supply services. We surveyed a randomly selected sample of 1500 households in the Kathmandu Valley and asked respondents questions in in-person interviews about how they would vote if given the choice between their existing water supply situation and an improved water service provided by a private operator. The results provide the first evidence from South Asia that households' willingness to pay for improved water services is *much higher* than their current water bills. We find substantial public support among both poor and nonpoor households for a privatization plan that would improve water supply and require all participants to pay regular and higher monthly bills.

1. Introduction

In this paper we examine households' demand for the improved water services to be provided by a private operator before a privatization deal is concluded Pattanayak et al. (2001). The Government of Nepal is considering the possibility of involving the private sector in the operation of municipal water supply services in the Kathmandu Valley. In March and April, 2001, we

☆ Detailed discussions of the materials presented in this paper are reported in Pattanayak et al. (2001).

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surveyed a randomly selected sample of 1500 households in the Kathmandu Valley and asked respondents questions in in-person interviews about how they would vote if given the choice between their existing water supply situation and an improved water service provided by a private operator. Respondents were told, however, that the improved services provided by the private operator would entail substantially higher water bills. By presenting different subsamples of randomly selected households different typical monthly water bills, we were able to estimate how support for the improved, privatized water services would decrease as the cost of the new services increased.

We also asked households with different existing water supply situations what they would do if the new private water service were installed and water tariffs were increased. For example, would currently unconnected households decide to connect if service improved and tariffs increased? How many currently connected households would disconnect from an improved water distribution system managed by a private operator if prices were raised a specified amount? Because we collected considerable information on the socioeconomic status of households in the sample, we can determine the preferences of both poor and nonpoor households for such changes in service levels. Our results show that there is strong support among both poor and nonpoor households for a plan that would result in improved water services and higher water tariffs. We estimate that approximately 70% of the population would be willing to pay a fivefold increase in the current average water bill for improved water services provided by a private operator.

This paper is organized as follows. In the Section 2 of the paper, we describe the existing municipal water supply situation in the Kathmandu Valley. Section 3 presents the research design, while Section 4 describes the fieldwork and sampling strategy. In Section 5, we present the findings of the research, and in Section 6 we offer some concluding remarks.

2. Background: the existing municipal water situation in the Kathmandu Valley

To better understand why sample respondents answered our questions the way they did, it is necessary to briefly describe the current condition of the municipal water supply distribution system in the Kathmandu Valley. The Nepal Water Supply Corporation (NWSC) supplies piped water services to the five main municipalities in the Kathmandu Valley–Kathmandu, Lalitpur (Patan), Bhaktapur, Kirtipur, and Madhyapur (Thimi). The total population in the NWSC's service area is approximately 1 million people.

During the dry summer months, the population of the Kathamndu Valley currently faces chronic water shortages. The NWSC produces about 120 million liters per day during the wet season, but only 80 million cubic meters per day during the dry season due to limited water storage. Much of the water that is produced is lost before it reaches the NWSC's customers. Because many households have unmetered connections or connections with broken meters, it is difficult to estimate precisely how much of the water produced actually reaches NWSC's customers, but estimates of unaccounted for water are on the order of 40%. What is certain is that hydraulic pressure in the distribution system must be kept very low in many parts of the city to avoid massive leakage. The secondary and tertiary piped distribution system is in such poor condition in some neighborhoods that it is questionable whether the capital stock would have any residual value to a private operator; much of the distribution system must simply be replaced.

About 70% of the population within NWSC's service area has a private connection to the distribution system, but the quality of service provided is very low. Most households only receive water for a few hours a day. The intermittent water service means that the distribution system is subject to negative pressures and chronic contamination from groundwater infiltration. Because the water service from the piped distribution system is poor, many households with private connections also rely on alternative sources of water, such as private wells, and public taps and wells.

Households without their own private connection may obtain water from a variety of sources. Some collect water from an ancient system of stone conduits and public taps (called "stone spouts") that delivers water from nearby mountain springs to selected central locations in the five cities. Tanker trucks operated by the NWSC serve some outlying areas, filling household storage tanks for a nominal fee. Many unconnected households have dug private wells on their property; water from these is used largely for washing and bathing. A few households collect water from neighbors with private connections, for which they may pay a fee.

The ability of households to continue to rely on private wells is in doubt. The total sustainable yield of the groundwater aquifer is approximately 26 million liters per day. Total groundwater extraction is currently about 59 million liters per day. As a result the groundwater table is falling, and contamination is increasing.

In summary, it is not hard to see why households in the Kathmandu Valley would want improved water services. The existing system delivers low volumes of poor quality water on an irregular basis. The only appealing aspect of the existing service from the households' perspective is that at least they do not have to pay much for it: average monthly water bills are on the order of NPR 100–158 (US$1.39–2.19) per month.[1] But even this is somewhat misleading. Because the water supply is unreliable, if they can afford the expense, many households install overhead water tanks to store water. And because the water is often of poor quality, many households are forced to treat their water before drinking or cooking. What is not known is how much households would be willing to pay for improved piped water services.

3. Conceptual framework and study design

To explore household demand for water, a survey was designed to gauge households' reactions to a possible plan to engage a private sector operator in order to improve several attributes of the service provided by the piped distribution system. Because households in the Kathmandu Valley are currently obtaining their water from a variety of different sources and have different housing arrangements, it did not make sense to ask all households in the sample precisely the same questions about whether they would support a plan to improve water services, and what they would do if a new, improved water service were available. We thus designed different versions of the questionnaire for various groups of households.

There are two main groups of households in the Kathmandu Valley: (1) households with connections to the existing NWSC piped distribution system; and (2) households without connections to the existing NWSC distribution system. A third group uses shared connections to

[1] The exchange rate used throughout the study is NPR (Nepalese Rupees) 72 to US$1.

the NWSC distribution system. Each of these three groups received different versions of the survey instrument. However, because the number of households relying on shared connections is quite small (about 0.8% of the sample population), in the remainder of this paper we focus only on the first and second groups.

Respondents were told about a plan that would engage the private sector to improve the water supply system. They were asked to suppose that the improved system would provide 24-hour service, that water would be safe to drink from the tap, and that the private operator would provide accurate billing of the water they received. Households with connections to the existing distribution system were then told ...

> I want you to suppose that the improved water service for households in the Kathmandu Valley with a private NWSC connection would result in a total monthly water bill for a typical household like yours of (200/400/600/800/1000/1300/1600/2000 NPR). Let's assume that a water bill of this size would entitle a typical household to about 500 liters of water per day.

Respondents were then asked whether they would vote for the water supply improvement plan. Ideally, we could have asked one subsample of respondents how they would vote if the improved services were provided by a private operator, and another subsample how they would vote if the improved services were provided by a public agency such as the NWSC. In this way, we could have attempted to conclusively determine whether households were positively disposed to having a private operator take over the operation of the municipal water system, or whether respondents were simply willing to go forward with the privatization plan if this was the only way that they could receive improved services. However, we did not have a sufficient sample size to carry out this experiment. We chose to focus on the provision of improved water services by a private operator (rather than by a public entity) because this is the most politically relevant and plausible CV scenario to offer to respondents (Whittington, 1998, 2002).

The eight different amounts of monthly water bills were randomly assigned to subsamples of respondents with private connections (i.e., some sample respondents received one monthly water bill, and other subsamples received different monthly water bills). Respondents were then asked to explain their reasons for voting for or against the plan.

Next, respondents were told ...

> Now, I want you to suppose that in fact most people did vote for the plan to improve the water supply system. Assume that the typical household's monthly water bill for 500 liters of water per day increased to [200/400/600/800/1000/1300/1600/2000 NPR]. What do you think your household would do?
>
> Stay connected and pay the higher water bill
>
> Disconnect and find water elsewhere
>
> Don't Know

Respondents were then asked to how confident they were of their answer.

Households currently without connections were also asked how they would vote on the plan, but they were told that they could choose to have either a private or a shared connection with improved water service. Respondents were told to assume that the monthly cost of a shared connection would be half the cost of a private connection. The crowded housing conditions in a

city like Kathmandu may, in fact, preclude an unconnected household from obtaining a private metered water connection. For example, if a household lived in a single room in a multi-storey building, or a single room with no space outside for a yard tap, it might not be realistic to imagine that a private water connection could be installed; there would simply be no place for the tap, or for wastewater to drain. In such cases, it makes little sense to ask a respondent whether he or she would be willing to pay a specified price to have a private water connection installed. Instead, we just asked such households about their willingness to pay for a shared connection. (In fact, it turned out that there were few households in the final sample who felt that it was not feasible for them to have a private connection, and these households are not included in the results presented in this paper).

Households without private connections who felt that it was technically feasible for them to have a private connection were further subdivided into owners and renters. We could not ask renters without connections precisely the same contingent valuation questions as owners because renters without connections would have less incentive to pay the connection charges associated with a shared or private connection. We thus asked renters to suppose that the landlord would pay the connections charges, and the renter would face an increase in his monthly rent in exchange for the improved water service provided by the private operator.

Fig. 1 summarizes the research design used in this study. As shown eight different versions of the questionnaire were administered during the survey. For the remainder of the paper we focus on (1) the households who currently have a private connection (both owners and renters); we term these Group I households; and (2) households without private connections who felt that it was technically feasible for them to have a private connection (both owners and renters); we term these Group II households.

The two main valuation questions actually pose complex choices and require careful consideration on the part of the respondent. The first question asks about the respondent's

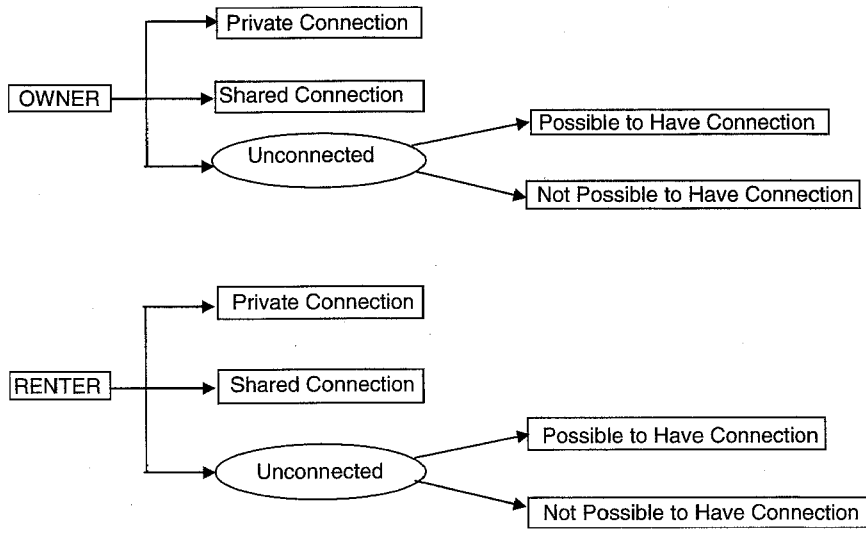

Fig. 1. Research design.

Table 1
The decision problems created for the respondent by the two CV questions

Current situation (status quo): Choice set 1	First CV Question: Would you vote to have Choice set 1 or Choice set 2?	Second CV Question: Suppose you had to choose between the options in Choice set 2 (i.e., the majority voted for the plan). What would you do?
Connection to NWSC connection with poor service and low water bill vs. Not connect; rely on public taps, private wells, and other sources *Comment:* We know the decision the respondent's household made regarding this choice.	Choice set 1 (status quo): vs. Choice set 2: Connect to improved private water system at specified price vs. not connect; rely on public taps, private wells, and other sources *Comment:* Respondent tells the enumerator which choice set he/she prefers by indicating whether he/she would vote for the plan	Connect to improved private water system vs. Rely on public taps, private wells, and other sources *Comment:* Respondent tells the enumerator whether he/she would connect to the improved water system *if* having a connection with a low water bill and low quality was no longer an option

willingness to support (vote for) a public action (in this case the involvement of a private sector operator in the implementation of service improvements); the second question asks about private behavior (what the respondent's household would actually do if confronted with a choice to connect to the new system). We felt that it was necessary to ask both questions because they mirror the political economy of water service improvements in a region like the Kathmandu Valley.

The *status quo* decision problem for most households in the Kathmandu Valley is a choice between (1) a connection to the distribution system that provides poor service at a low cost, and (2) relying on water sources other than a private connection. The two CV questions effectively create two new decision problems for the respondent. As depicted in Table 1, the first CV question asks the respondent to choose between *two choice sets*:

(1) Status quo [no plan]: A connection to the distribution system that provides poor service at a low cost vs. relying on water sources other than a private connection.
(2) Change [plan implemented]: A connection to an improved distribution system that provides good service at higher cost vs. relying on water sources other than a private connection.

The first CV question does not ask the respondent to indicate what he would actually do, only from which of the two choice sets he would prefer to choose.

A household with a private connection has a strong incentive to reject the plan (i.e., answering NO to this first CV question) if he prefers the existing system to the improved system because the implementation of the plan would remove the option of having a connection to the existing system. On the other hand, for a household without a private connection, the main reason to

Table 2
Possible rankings of household water supply "states of the world" (most preferred to less preferred)

Ranking 1	Ranking 2	Ranking 3	Ranking 4	Ranking 5	Ranking 6
A. Connected to new private system at specified price (high quality, high prices)	A. Connected to new private system at specified price (high quality, high prices)	B. Connected to existing system (low quality, low prices)	B. Connected to existing system (low quality, low prices)	C. Disconnected; rely on other sources	C. Disconnected; rely on other sources
B. Connected to existing system (low quality, low prices)	C. Disconnected; rely on other sources	A. Connected to new private system at specified price (high quality, high prices)	C. Disconnected; rely on other sources	A. Connected to new private system at specified price (high quality, high prices)	B. Connected to existing system (low quality, low prices)
C. Disconnected; rely on other sources	B. Connected to existing system (low quality, low prices)	C. Disconnected; rely on other sources	A. Connected to new private, system at specified price (high quality, high prices)	B. Connected to existing system (low quality, low prices)	A. Connected to new private, system at specified price (high quality, high prices)

reject the plan is that the option of connecting to the existing system in the future is removed.[2] Presumably this is not likely to be perceived as a large cost because the respondent's household has the option of connecting to the existing system now and decided not to do so.

The second CV question restricts the respondent's options by asking him to imagine that the plan to improve water services was indeed approved and implemented, and that the first choice set above was removed from consideration: his household no longer had the option of having a connection that provided poor service at a low price. This restriction of the respondent's options to the second choice set could reduce his household's welfare, even if he indicated that his household would stayed connected and pay the higher price for the improved service.

Table 2 shows the six alternative ways a respondent might rank three possible "states of the world": (A) connected to a new private system with high quality and a higher monthly bill; (B) connected to existing system with low quality and a low monthly bill, and (C) disconnected from piped distribution system, rely on other sources. What can a respondent's answers to the two CV questions and his choice of water sources in the current situation tell us about his household's preferences?

Consider first a household that already has a private connection (Group I). We can rule out rankings 2, 5, and 6 because in these three rankings being disconnected from the existing system

[2]Households without a private connection that relied on water from neighbors with piped connections might be concerned that the price of water that their neighbors charged them would increase if the plan for the new improved system were implemented.

(C) is preferred to having a private connection to the existing system (B), but in fact we know the household chose B over C. What can the answers to the two CV questions tell us about the respondent's preferences among the remaining rankings (1, 3, and 4)?

The two CV questions yield four possible patterns of responses (Table 3). For example, consider a household that currently has a connection to the piped distribution system. Two of the possibilities are straightforward. First, such a respondent could vote for the plan and then agree to stay connected to the distribution system at the new, higher tariff (Pattern 1 in Table 3). We propose to interpret a "yes/yes" response to the two CV questions as indicating that the respondent holds ranking 1, not ranking 3 or 4. That is, if the respondent voted for the plan and said his household would connect to the new system at the offered monthly bill, we assume he prefers a connection to the new system at the specified monthly bill to his connection to the old system, and experiences a welfare gain from the implementation of the plan and paying the higher tariff.

Second, a respondent could vote against the plan, and, if the plan were implemented, decide to disconnect from the piped distribution system (Pattern 4 in Table 3). We interpret such a "No/No" response to the two CV questions as indicating that the respondent holds ranking 4, not ranking 1 or 3. That is, if the respondent (whose household is already connected to the existing system) voted against the plan and said that his household would disconnect from the existing system if the plan were implemented, we assume that he prefers a connection to the existing system to the new system, and would experience a welfare loss if the plan were implemented and his household chose to disconnect from the system.

Third, a respondent could vote against the plan, but then indicate that if the plan were implemented, her household would decide to stay connected to the new system (Pattern 3 in Table 3). In other words, she preferred the status quo situation, but if this option were removed from her choice set, her household would choose the new system and higher tariff rather than disconnect from the piped distribution system. We interpret such a "No/Yes" response to the two CV questions as indicating that the respondent holds ranking 3, not ranking 1 or 4. That is, if the respondent (whose household is already connected to the existing system) voted against the plan, but said that her household would stay connected to the distribution system if the plan were implemented, we assume that she prefers a connection to the existing system to a connection to

Table 3
Possible responses to the two CV questions

Answer to 1st CV Question:	Answer to 2nd CV Question (Connect to improved system?): YES	Answer to 2nd CV Question (Connect to improved system?): NO
Vote for the plan? YES	Pattern 1: YES/YES (Vote for the plan and connect to the new system)	Pattern 2: YES/NO (Vote for the plan, but not connect to the new system)
Vote for the plan? NO	Pattern 3: NO/YES (Vote against the plan, but connect to the new system)	Pattern 4: NO/NO (Vote against the plan and not connect to the new system)

the new system, but prefers a connection to the new system to being disconnected. In this instance the household would be made worse off as a result of the implementation of the plan for improved water services, even though it would decide to remain connected and pay the higher price.

Fourth, a respondent could vote "Yes" for the plan and then decide not to stay connected to the piped distribution system (Pattern 2 in Table 3). A respondent might value the option of connecting to an improved distribution system in the future, but know that his household could not afford it now. Conceivably a respondent could vote for the plan for altruistic reasons (e.g., because he believed that it would improve the health of his neighbors and school-age children), knowing that his household could not afford the new water service. We interpret a "Yes/No" response to the two CV questions as indicating that the respondent holds ranking 1, not ranking 3 or 4.

For households that are not currently connected to the distribution system (Group II), we can rule out rankings 1, 3, and 4 because in these three rankings B is preferred to C, but in fact we know the household chose C over B. We again attempt to interpret the four possible patterns of responses to the two CV questions, but in this case a household that votes for the plan may prefer either a private connection or a shared connection to the new system. If a respondent without a private connection votes for the plan and then says that his household would connect to the improved system (a "Yes/Yes response), we interpret this as an indication of ranking 2. We interpret a "No/No" response as an indication of ranking 5 or 6 (we cannot determine how the unconnected household ranks a connection to the new system vs. a connection to the old system).

A "No/Yes" response for an unconnected household might seem to be an inconsistent answer; it is, however, conceivable that the respondent is worried about the implications of the plan for others (perhaps the poor) and votes against it. But once the plan is passed, the respondent is free to indicate his personal preference to connect his household to the new system (either a private or shared connection).

We interpret a "Yes/No" response for an unconnected household as an indication that the respondent holds ranking 5. We interpret a "YES" vote to the first CV question as an indication that the respondent prefers a connection to the new system to a connection to the old system, ruling out ranking 6. A "No" vote to the second CV question indicates that the respondent prefers being disconnected to having a private connection to the new system. Note that in this case being connected to the new system is preferred to being connected to the existing system, and the "Yes" vote to the first CV question might indicate a willingness on the part of the respondent to pay for having this option in the future.

4. Field implementation

4.1. Sampling strategy

Households were selected using a multi-stage cluster sampling procedure. Clusters were located using aerial maps provided by the Central Bureau of Statistics for the 1996/97 World Bank Living Standard Measurement Survey for Kathmandu. In three of the five municipalities in the Kathmandu Valley (Kathmandu, Lalitpur, and Bhaktapur), we used a previously conducted complete enumeration of all households as our sample frame (SILT-DRTC, 1999). In Kirtipur and Madhayapur we used the 1991 population census as the sampling frame.

Wards were selected from the sampling frame on the basis of a probability-proportional-to-size sampling approach that ensured households had an equal opportunity of being included in the sample (Babbie, 1990, Chapter 5). After a ward was selected for inclusion in the sample, sub-wards were drawn randomly. The final sample consisted of 60 clusters of 25 households each covering all five municipalities in the Kathmandu Valley. If a cluster was selected for inclusion in the sample, then a respondent in all 25 households in that cluster was interviewed for this study. Because probability-proportional-to-size sampling depends on the size of the population, some wards had more than one cluster in the final sample.

4.2. Questionnaire development

The design of the household questionnaire was based on the World Bank's Living Standard Measurement Survey (LSMS) guidance manual (Grosh & Glewwe, 2000). The LSMS modules for water supply conditions were modified to suit local conditions in the Kathmandu Valley based on purposive open-ended discussions with 17 households, two focus groups, and a pretest of 150 households.

Some participants in the focus groups and respondents in the purposive discussions did express reservations about private sector participation in the municipal water supply sector because they regarded water service as an entitlement that should be provided free by the government. These views were not, however, strongly held by most respondents, and group discussion of these issues convinced most participants that (1) improvement in current conditions was only possible through increased investments that should at least in part be financed by higher monthly water bills, and (2) private sector participation was more likely to result in improvements in service quality than government provision. Focus group participants currently not connected to NWSC were particularly concerned that opportunities be provided to finance the connection charge to the distribution network. Based on the concerns participants expressed in the focus group discussions, the contingent valuation scenario emphasized three aspects of the proposed improved service: longer hours of service, reduced health risk, and regularity of billing.

The final questionnaire consisted of the following eight sections: (1) introduction, household location, (2) urban environmental priorities, (3) priorities for networked infrastructure services, (4) existing water sources, (5) water treatment and storage practices, (6) sanitation conditions, (7) contingent valuation questions, and (8) socioeconomic profile.

For households in which both a husband and wife were living at home, interviews were conducted with either the head of household or his spouse. For female-headed households, only the senior female adult was interviewed. The interviews lasted 45–60 min.

5. Empirical findings

5.1. Socioeconomic profile of respondents

Table 4 presents a socioeconomic profile of the sample respondents. The *typical* respondent in the sample was a 37-year old Newari male head of household. He had a spouse and four children less than 18 years of age living at home. He had 10 years of education and could read a newspaper

Table 4
Social profile of survey respondents

Number of respondents surveyed	1500
% Male respondents	63%
% Male household head	86%
% with Newar background	61%
Median age of respondents	34
Average years of education	10
% Read newspapers with ease	77%
% Have more than 3 children who are less then 18 years old	57%
% Have more than 3 children who are 18 or older	13%
Median monthly income (NR)	9000
Median monthly expenditure (NR)	8000
% Own the house respondent's family reside in	88%
% Live in single family—multiple storey building	59%

easily. He owned his house, which was a single-family, multi-storey building that had at least four rooms, and he rented out one room. The floor, walls, and roof of his house were made of concrete. He had electricity and telephone service, for which he paid about NPR 520 and 690 (US$7.22 and 9.58) per month, respectively. He also had a private water connection and water-sealed toilet for the exclusive use of his household members (and any renters).

The typical respondent reported household income of NPR 16,351 (US$227.10) and monthly expenditures of NPR 10,868 (US$150.94) (almost half of which was spent on food). The typical household owns one television and one radio, and more than one kerosene stove, pressure cooker, and electric fan. The typical household does not, however, own a videocassette recorder, bicycle, sewing machine, or rice cooker. About 47% of sample households used bottled gas as their primary cooking fuel; 40% used kerosene.

We investigated five criteria to develop a better understanding of the number of poor households in our sample and their living conditions: (1) monthly income, (2) monthly expenditures, (3) housing construction materials, (4) type of cooking fuel, and (5) self-reported socioeconomic status. For the purposes of the analysis presented here, we decided to use self-reported household income to identify poor households. We classified a household as "poor" if its monthly household income was below NPR 5500 (US$76.39). On this basis, we designated 388 households (approximately 26% of the sample) as "poor."

About 40% of the respondents from these poor households had never attended school. Over one-third said that it would not be possible for them to borrow NPR 3000–5000 (US$41.67–69.44) from a moneylender. Kerosene is the most used cooking fuel while 28% cook with wood and dung. Over 50% own a radio and television (11% have neither). The median monthly income and expenditure of these households is about NPR 4000 and 4400 (US$55.56 and 61.11), respectively.

5.2. *The existing water supply of sample households*

Sixty-nine percent of the households in the sample had a private water connection in their own name (i.e., they received the water bill from the NWSC). About 1% used water from a shared

connection to the piped distribution network. The remaining 30% of households were not connected to the piped distribution system and obtained their water from a variety of sources, including private wells, public taps, stone spouts, and water vendors.

Households with a NWSC connection (Group I): Three quarters of households with a NWSC connection report that they have a water meter; most of those who have a water meter say that it is working (94%). The median water bill of a household with a metered connection that was working is NPR 125 (US$1.74). The median water bill of a household with an unmetered NWSC main connection is NPR 176 (US$2.44) and branch connection is NPR 65 (US$0.90).

We asked respondents with private connections what they liked least about their water service from the piped system. Sixty-seven percent said its unreliability. This is perhaps not surprising considering that water is available from their connection on average about 2 h per day in the rainy season and 1 h per day in the dry season. Eighteen percent of respondents said that the thing they liked least was the poor quality of the water. Among households that had private connections, there were no significant differences between poor and nonpoor households regarding the aspect of the water service they liked least.

Given the poor reliability of the piped water supply, many households with private connections supplement the water they receive from the piped distribution network with water from other sources. The majority of households with private connections reported using water from at least one other source—public taps, private wells, vendors, stone taps, bottled water, rainwater, or surface water on a regular basis.

Sample respondents perceive significant differences in the taste, color, and health risk of water from the various sources available to them. Many respondents perceived the quality of water from the stone taps to be significantly better than from other sources. Water from the piped distribution system had a high negative rating. Many people also perceived the quality of water from private wells to be poor. Among households with private connections, there were no significant differences between poor and nonpoor households in their perceptions of the quality of water from different sources.

Because the quality of water from the piped distribution system was widely perceived to be poor, the majority (74%) of both poor and nonpoor households with private connections treat their drinking water in some way (either filtering or boiling it, adding chlorine, or even using more sophisticated technologies). Sixty-four percent of households with private connections have installed overhead water storage tanks to deal with the unreliability of supply (with a median size of about 1 m^3 and a median cost of NPR 4500 [US$62.50] per storage tank). In fact, 45% of the households with private connections have more than one overhead storage tank. The average household with a private connection can store 1050 l (median) of water.

Households without a private or shared connection (Group II): The 411 respondents in our sample who had neither their own private connection nor a shared connection relied on a variety of alternative water sources, primarily public taps, private wells, neighbors, vendors, and stone taps. A significantly higher proportion of Group II households were poor compared to Group I households (49% vs. 22%).

On average, Group II households collected 50 l of water per day per household member. Very few households in Group II pay for water; most relied on neighbors, free public taps, and private wells. Such households did, however, incur indirect (i.e., "coping") costs to collect water. The majority of Group II households relied on neighbors and public taps for their drinking and

cooking water and on water from private wells for bathing and washing. Only 1% purchased water from tanker truck vendors on a regular basis.

Like Group I households, Group II households said that the things they liked least about the piped water system was the unreliable service and the poor water quality. Group II households held similar perceptions of the color, taste, and health risk of the water from alternative sources as Group I households. Among Group II households, there were no significant differences in such perceptions between poor and nonpoor households. Unlike Group I households, most Group II households (approximately 62%) did not treat their water before using it for drinking and cooking.

5.3. Household sanitation conditions

Table 5 shows the percentage of poor and nonpoor households with water-sealed toilets in both Groups I and II households. As shown 92% of the households in our sample have installed a water-sealed toilet (either a pour flush or a flush toilet with a water closet). The vast majority of households are either "very satisfied" or "somewhat satisfied" with their toilet facilities. However, the poor are much less likely than the nonpoor households to have a water-sealed toilet.

5.4. Household demand for improved water services

Households with private connections (Group I): Forty percent of the Group I households had heard of the Government's interest in involving the private sector in the operation of the municipal water supply. In their answers to the first CV question, households with a private water connection expressed strong support for the plan described in the survey that required households to pay higher water bills in exchange for improved service. Ninety-six percent of respondents who received a price of NPR 200 (US$2.78) said that they would vote for the plan if this were a typical household's monthly water bill with the new system and that they would connect to the new improved system (Table 6). Fifty percent of households who received a price of NPR 1000 (US$13.89) voted for the plan and said that they would connect to the new system. About 78% of the respondents with "Yes/Yes" responses to the two CV questions indicated that they were "totally sure" of their answer; 20% said they were "somewhat sure."

Table 5
Sanitation facilities used by households

Sanitation facilities	Survey sample (%) ($n = 1500$)	Group I (%) ($n = 1047$)		Group II (%) ($n = 453$)	
		Nonpoor	Poor	Nonpoor	Poor
Water-sealed toilet	92	80	18	49	30
Pit latrine	1	0	0	1	1
Public latrine	1	0	0	2	2
Neighbor's toilet	2	0	0	3	4
Bush/no facilities	2	0	0	1	4
Other	1	0	0	1	2

Table 6
Responses of Group I households to 2 CV questions vs. offered monthly water bills

Household's current water supply situation	Response to 2 CV questions	If the plan were implemented household would experience a ...	Respondents in Group I who were offered a monthly bill of (%)							
			NPR 200 (US$2.78) (%)	NPR 400 (US$5.56) (%)	NPR 600 (US$8.33) (%)	NPR 800 (US$11.11) (%)	NPR 1,000 (US$13.89) (%)	NPR 1,300 (US$18.06) (%)	NPR 1,600 (US$22.22) (%)	NPR 2,000 (US$27.78) (%)
Group I (connected to existing system)	Yes/Yes (Pattern 1)	Welfare gain	96	79	69	58	46	36	30	20
	Yes/No (Pattern 2)	Welfare gain (due to value of the option of connecting to the improved system in the future)	0	2	1	2	4	7	5	7
	No/Yes (Pattern 3)	Welfare loss	2	9	11	15	15	14	14	21
	No/No (Pattern 4)	Welfare loss	2	10	19	25	35	44	52	52
Total			100	100	10	100	100	100	100	100

Table 7
Response patterns and number of respondents in each pattern (connected households)

Answer to 1st CV question:	Answer to 2nd CV question (Connect to improved system?): YES	Answer to 2nd CV question (Connect to improved system?): NO
Vote for the plan? YES	Pattern 1: YES/YES Number: 334	Pattern 2: YES/NO Number: 126
Vote for the plan? NO	Pattern 3: NO/YES Number: 47	Pattern 4: NO/NO Number: 540

Table 8
Welfare implications of respondent's answers to 2 CV questions (connected households)

Response to 2 CV questions	If the Plan Were Implemented, Household Would Experience a ...
Yes/Yes (Pattern 1)	Welfare gain
Yes/No (Pattern 2)	Welfare gain (due to value of the option of connecting to the improved system in the future)
No/Yes (Pattern 3)	Welfare loss
No/No (Pattern 4)	Welfare loss

About 84% of respondents who voted for the plan and indicated that they would connect said that their main reason was that they "really wanted/needed the improved water service." Among respondents who voted against the plan and said they would not connect, about 90% gave their main reason, as "the increased water bill is too high." It thus appears that the respondents listened carefully to the description of the plan in the contingent valuation scenario, and gave answers that were conditioned on the size of the water bill and that they were confident about their preferences.

In Section 4 we discussed four response patterns to the two contingent valuation questions. Table 7 shows the number of connected households who fell into each of the four response patterns. A majority of our respondents either voted for the plan and chose to stay connected, or voted against the plan and chose to disconnect. However, a nontrivial number revealed either a Yes–No or a No–Yes response pattern. What does this imply about how we estimate the value of improved piped water in Kathmandu Valley for the subsample of households with connections to the existing system? If we were to assume that respondents' answers to the two CV questions were based on purely private motives, the four response patterns suggest the economic welfare or value implications summarized in Table 8.

Households may, however, reveal altruistic or public motives in addition to private preferences in responding to these questions. From our survey results, it is impossible to disentangle respondents' public and private motivations. Therefore, we propose four ways to analyze these data, which are described belows Options 1–4 as follows:

Option 1: Consider private preferences and values as the primary basis for responding to the two CV questions. This would imply that the welfare implications in Table 8 would hold. From an implementation perspective, we would use the responses to the first CV question (vote) in estimating the value of the proposed service.

Option 2: Essentially consider the same motives and pattern as Option 1, except attribute the "Yes–No" responses to ambivalence or confusion. From an implementation perspective, only count the Yes–Yes pattern as a "Yes", and all three other patterns as no. By "reinterpreting" the responses of households who gave YES/NO and NO/YES answers, we will clearly lower our estimate of WTP. Option 2 reflects the most conservative estimate.

Option 3: Include possible public or altruistic values and motives in interpreting the response patterns. This would suggest that we consider only the response to the second CV question (stay connected/disconnect) in estimating WTP.

Option 4: Disregard the households who gave Yes–No or No–Yes responses on grounds of inconsistency and leave them out of the analysis. This effectively reduces the size of the data set. The difference between Option 2 and 4 is that the Yes–No and No–Yes are treated as No in Option 2, where as they are dropped in Option 4. Given that all the response patterns are logical and credible, this reflects that most drastic approach.

The welfare estimates associated with Options 1–4, in terms of mean and 95% confidence intervals are presented in Table 9. As expected Option 2 has the lowest estimate of WTP and Option 4 has the highest WTP. The estimates clearly depend of the approach chosen, but from a policy perspective all four approaches show household WTP to be much higher than current water bills.

Households without private or shared connections (Group II): There was also strong support for the plan among the 411 households currently without a household connection who said it was possible for them to be connected. About 88% of these unconnected households (who were offered a price of NPR 200 [US$2.78] for a private connection and NPR 100 [US$1.39] for a shared connection) voted for the plan and indicated that they would pay for either a private or shared connection (Table 10). As shown in Fig. 2, the proportion of Group II respondents who chose a private or shared connection or neither varied depending on the size of the proposed monthly bill. Fifty-eight percent of the unconnected households who received prices of NPR 800 and 400 (US$11.11 and 5.56) for a private and shared connection, respectively, voted for the plan. About 61% of these said they would choose a private connection; 39% would choose a shared connection.

Like households in Group I, respondents without NWSC connections who voted for the plan gave as their main reason that "they really wanted/needed the improved water service" (about

Table 9
Summary of willingness-to-pay estimates for all response patterns—connected households (NPR [US$] per month per household)

Option	Description	Mean WTP NPR (US$) per month	Lower 95% CI	Upper 95% CI
1	[Yes–Yes & Yes–No] vs. [No–Yes & No–No]	1167 (US$16.21)	1087 (US$15.10)	1257 (US$17.46)
2	[Yes–Yes] vs. [Yes–No, No–Yes & No–No]	1033 (US$14.35)	967 (US$13.43)	1113 (US$15.46)
3	[Yes–Yes & No–Yes] vs. [Yes–No & No–No]	1403 (US$19.49)	1313 (US$18.24)	1513 (US$21.01)
4	[Yes–Yes] vs. [No–No]	1246 (US$17.31)	1168 (US$16.22)	1333 (US$18.51)

Table 10
Responses of Group II households to 2 CV questions vs. offered monthly water bills

Household's current water supply situation	Response to 2 CV questions	If the plan were implemented, household would experience a ...	Respondents in Group who were offered a monthly bill of (%)				
			NPR 200 (US$2.78) (%)	NPR 500 (US$6.94) (%)	NPR 800 (US$11.11) (%)	NPR 1200 (US$16.67) (%)	NPR 2000 (US$27.78) (%)
Group II (not connected to existing system)	Yes/Yes (Pattern 1)	Welfare gain	88	70	58	39	20
	Yes/No (Pattern 2)	No welfare gain, or welfare gain (due to value of the option of connecting to the improved system in the future)	0	1	0	1	5
	No/Yes (Pattern 3)	Inconsistent answer	2	6	6	5	3
	No/No (Pattern 4)	No welfare loss; or minor welfare loss	10	23	35	55	72
Total			100	100	100	100	100

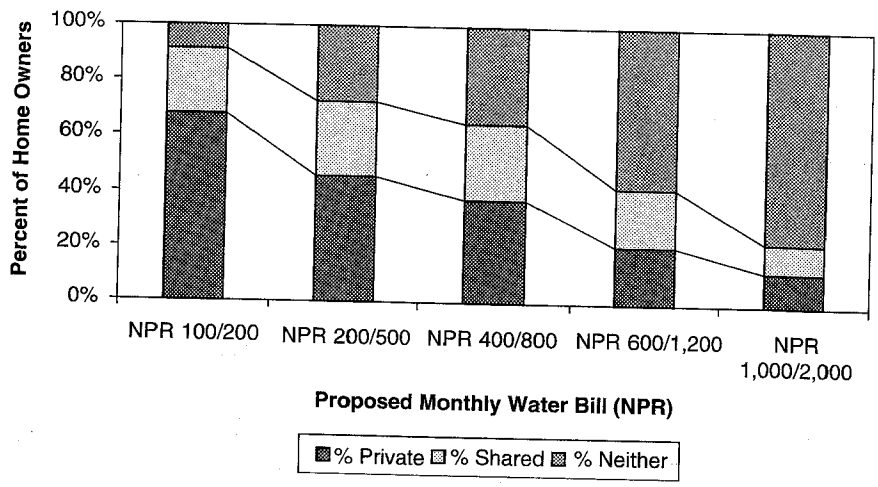

Fig. 2. Inverse demand curve for households without NWSC connection: Percent of home owners willing to connect to private or shared connection or continuing to use existing sources at different levels of proposed monthly water bills (NPR).

Table 11
Response patterns and number of respondents in each pattern (unconnected households)

Answer to 1st CV question:	Answer to 2nd CV question (Connect to improved system?): YES	Answer to 2nd CV question (Connect to improved system?): NO
Vote for the plan? YES	Pattern 1: YES/YES Number: 151	Pattern 2: YES/NO Number: 18
Vote for the plan? NO	Pattern 3: NO/YES Number: 5	Pattern 4: NO/NO Number: 207

93%). Those who voted against the plan gave as their main reason that "the increased bill is too high" (90%). Respondents without NWSC connections were equally sure of their answers and expressed little uncertainty as to how they would vote or what they would do.

Table 11 shows the number of unconnected households who fell into each response pattern (1–4). Almost all the unconnected households either voted for the plan and chose to connect, or voted against the plan and chose to stay unconnected. A very small minority revealed either a Yes–No or a No–Yes response pattern.

If we assume that respondents without connections to the existing system based their answers to the two CV questions on purely private motives, the four response patterns have different implications for economic welfare, and we could develop four options paralleling the structure described above for Group I households (see Table 12). However, the small numbers of households who answered either Yes–No (18 households) or No–Yes (5 households) makes this an unimportant exercise from a practical perspective. We thus considered only the response to the second CV question (connect/stay disconnected) in estimating WTP for unconnected households.

Fig. 2 also describes Group II households preferences for 'private', 'shared' or 'existing sources' at different levels of proposed monthly bills. These inverse demand data show how many people would connect to a private or shared connection at different levels of the proposed monthly bill. The higher the bill, the greater the percentage of respondents stating that they would not prefer either a private or a shared connection. Almost 50% of these households are willing to pay NPR

Table 12
Welfare implications of respondent's answers to 2 CV questions (unconnected households)

Response to 2 CV questions	If the plan were implemented, household would experience a ...
Yes/Yes (Pattern 1)	Welfare gain
Yes/No (Pattern 2)	No welfare gain, or welfare gain (due to value of the option of connecting to the improved system in the future)
No/Yes (Pattern 3)	Inconsistent answer
No/No (Pattern 4)	No welfare loss; or minor welfare loss

500 (US$6.94) for a private connection that includes about 500 l of water a day if the water is potable and the water bills are accurate and regular.

Based on the conditional logit method proposed by McFadden (1976), we estimate the mean monthly WTP for improved piped water from a private connection to be NPR 840 (US$11.67) among unconnected households, with a 95% confidence interval of NPR 700–1010 (US$9.72–14.03). We estimate the mean monthly WTP for an improved water supply from a shared connection, which includes about 500 l of water a day that is risk free and bills that are regular, to be NPR 230 (US$3.19). The 95% confidence interval is NPR 30–380 (US$0.42–5.28).

We can also compute the willingness to pay for the subset of households we defined as "poor". For Group I households (using Option 2), we find that mean monthly WTP of poor households is NPR 830 (US$11.53), with a 95% confidence interval of NPR 680–960 (US$9.44–13.33). For Group II, the mean monthly WTP of poor households is NPR 420 (US$5.83) for a private connection and NPR 260 (US$3.61) for a shared connection. The 95% confidence intervals are reported in Table 13 (note that the WTP for a shared connection is actually higher for the poor than for the nonpoor group).

6. What influences household responses? multivariate regression results

We conducted multivariate regression analysis of the CV data to further understand household preferences for improved water supply services. Theory and intuition suggest that preferences for improved water supply and WTP would differ across population groups with different sociodemographic characteristics, existing water situations, and opinions about water quality and public policy. Multivariate regression analyses were used to (1) test joint hypotheses based on the statistical significance of coefficients, (2) evaluate preferences for improved water supply, and (3) estimate WTP. Specifically, the models allow us to estimate WTP of the poor subpopulation by including a measure of poverty as a regressor. The basic regression equation is as follows:

Probability of choosing improved water source =
α (socioeconomic and demographic factors)+
β (water situation)+
γ (opinion & attitudes)+
Error.

Table 13
WTP by household categories (connected/unconnected) and (all/poor)

	Number of respondents	Mean WTP NPR (US$) per month	Lower 95% CI	Upper 95% CI
Connected				
All	1047	1030	970	1110
		(14.31)	(13.47)	(15.42)
Poor	195	830	680	960
		(11.53)	(9.44)	(13.33)
Unconnected				
All	383			
Shared		230	30	380
		(3.19)	(0.42)	(5.28)
Private		840	700	1,010
		(11.67)	(9.72)	(14.03)
Poor	167			
Shared		260	250	260
		(3.61)	(3.47)	(3.61)
Private		420	350	490
		(5.83)	(4.86)	(6.81)

The choices included private connection, shared connection, or no connection. Examples of socioeconomic and demographic factors include income and age of respondents; examples of water situation include number and extent of public or private water sources; and examples of opinions/attitudes include environmental priorities and perceptions of NWSC water quality. Statistical significance (measured as small p-values) of α, β, and γ allow us to assess the accuracy of our CV data. A larger coefficient typically implies a greater influence on the choice and a larger effect on WTP. That is, households who have higher WTP are more likely to choose a private or shared connection and pay the proposed monthly bill. Consequently, in presenting regression results, we discuss positive coefficients as suggesting that households "are more likely to connect" and/or "have a higher WTP."

In Table 14, we summarize the variables used in the multivariate regression along with our hypotheses about the expected relationship between the variables and the connection choice. We chose this mix of variables based on intuition and practicality. While the primary criterion is the potential influence on household preferences, the choice is also conditioned by the availability of sufficient observations in our data set for the particular variable.

6.1. Influences on household choice to stay connected to improved water supply network: a multivariate probit model (GROUP I households)

Households with NWSC connections were given the choice between staying connected to an improved service or disconnecting from the network. This information can be recorded as

Table 14
Independent variables (regressors)—sociodemographic factors, existing water situation, opinions, and attitudes

Independent (explanatory) variable	Mean		Hypothesized sign for coefficient
	Connected sample ($n = 1047$)	Unconnected sample ($n = 383$)	
Regression constant			
Log monthly income (in NPR)	9.12	8.59	+
Respondent's age (number of years)	37	37	?
Respondent's gender dummy[a] (1 = male; 0 = otherwise)	0.64	0.60	?
Respondent's education (number of years)	9.09	5.90	+
Renter dummy[a] (1 = renter; 0 = otherwise)	0.14		−
Water contamination dummy[a] (1 = most important environmental problem; 0 = otherwise)	0.51	0.50	+
Heard about privatization[a] (1 = heard; 0 = otherwise)	0.40	0.28	+
Dirty private (NWSC) connection water[a] (1 = "dirty" or "very dirty"; 0 = otherwise)	0.76		?
Risky private (NWSC) connection water[a] (1 = "very risky" or "risky"; 0 = otherwise)	0.81	0.39	+
Irregular private (NWSC) connection water[a] (1 = "irregular" or "unreliable"; 0 = otherwise)	0.61	0.26	+
Overhead storage dummy[a] (1 = have overhead storage; 0 = otherwise)	0.64	0.22	+
Water treatment dummy[a] (1 = treat water; 0 = otherwise)	0.74	0.38	+
Only uses community water sources[a] (1 = only community sources; 0 = otherwise)		0.29	−

[a] Mean estimates of dummy variables should be interpreted as percentage. For example, the mean of the respondent's gender is 0.64. This means that 64% of the respondents are male.

dichotomous data (1 = stay connected, and 0 = disconnect) and analyzed using a multivariate probit model as in much of the CV literature (Hanemann, 1984; Cameron, 1988; Cameron & James, 1987). Results are presented in Table 15. We estimated several models using different combinations of variables because many of our variables are, at best, approximations of the factors that we believe influence household preferences and WTP. Out of the 1050 completed surveys in this subsample of households, only 3 were excluded from this analysis because of insufficient response data. We present two models to highlight multicollinearity problems with the

Table 15
Connected households—probit regression model explaining choice to connect or reject improved private connection

Variable	Model 1		Model 2	
	Coefficient	p-value > $\|z\|$	Coefficient	p-value > $\|z\|$
Regression constant	1.093	0.000	0.962	0.002
Log monthly income (in NPR)	0.052	0.057	0.001	0.982
Respondent's age	–0.011	0.000	–0.008	0.020
Respondent's gender	–0.122	0.186	–0.188	0.055
Respondent's education			0.034	0.003
Renter dummy	–0.322	0.009	–0.207	0.103
Water contamination dummy	0.126	0.146	0.142	0.107
Heard about privatization	0.192	0.033	0.057	0.542
Dirty private (NWSC) connection water	–0.195	0.110	–0.151	0.222
Risk private (NWSC) connection water	0.368	0.004	0.349	0.007
Irregular private connection water	0.158	0.074	0.090	0.325
Overhead storage dummy			0.276	0.008
Water treatment dummy			0.194	0.093
Proposed Monthly Bill	–0.001	0.000	–0.001	0.000
No. of observations		1,047		1,047
Likelihood ratio statistic	$\chi^2(10)$	227	$\chi^2(13)$	262
Probability		0.000		0.000
Pseudo-R^2		0.165		0.191
Log likelihood		–573		–556

regressors. Unless otherwise suggested, the following discussion corresponds to Model 1 (reported in columns 2 and 3).[3]

The positive coefficient on the income variable confirms that richer households have a higher WTP for an improved private connection. Income is collinear with several other direct and indirect measures of socioeconomic status. Therefore, it was not surprising that other direct measures such as fuel type, housing time, and monthly expenditure were not statistically significant when included in the model along with income.[4]

Turning to demographic characteristics, we find that older and male respondents are less likely to want to stay connected to the network. All else equal, we find that more educated respondents are more likely to want to stay connected (Model 2). Renters are less likely to stay connected and have a lower WTP in comparison to owners. This is probably because they have a shorter time horizon and are less vested in their current dwelling.

[3] In the tables of model results, the numbers in the column labeled "coefficient" refer to the size of the influence of the particular regressor, whereas the numbers in the columns labeled "p-value" refer to the statistical significance of that regressor. In general, a p-value of less than or equal to 0.15 is considered to be a statistically significant relationship for cross-sectional data sets of this size.

[4] Note that income is not statistically significant in Model 2, which includes education, overhead storage, and water treatment as additional regressors, illustrating the multicollinearity problem.

As expected, households who believed that water contamination is the most important environmental problem have a higher WTP for a service that offers to reduce health risks associated with contaminated water. Households who were familiar with the plan to privatize NWSC are more likely to want to stay connected and pay higher bills. We interpret this to mean that households like what they have heard about the privatization plan.

Households who believe that water from their private NWSC water connection is dirty or very dirty are less likely to want to stay connected. On the other hand, households who believe that water from their private water connection poses health risks and is unreliable and irregular are more likely to want to stay connected and willing to pay more. This is not a surprising result, given that two attributes of the improved supply were 24-hour service and water that would be fit to drink from the tap.

Households who are treating their water and who have overhead storage tanks are more likely to want to stay connected. Typically, averting behaviors such as treatment and storage provide a signal regarding household valuation of improved services, and the positive association is consistent with expectations. These variables are also correlated with income and with perceptions of water quality and therefore negate their statistical power when included in the model.

Finally, the negative coefficient for the proposed monthly bill confirms the downward sloping inverse demand curve. That is, at higher monthly water bills, fewer households want the private connection.

6.2. Influences on household choice to connect to improved water supply network: a multivariate multinomial logit model (Group II households)

Households without NWSC connections were given the choice between a private connection, a shared connection, or existing sources. This information can be recorded as trichotomous data (2 = private connection, 1 = shared connection, and 0 = use existing sources) and analyzed using a multivariate multinomial model (Greene, 1997). The results are presented in Table 16 as two sets of estimates: the first set relates to household choice of shared connection, while the second set relates to household choice of private connection. These are both compared to the choice of continuing with existing sources. This model is the best among several models using different combinations of variables.

Beginning with the choice of shared connections, we find a negative correlation with income. This might seem like a surprising result if we ignore the fact that households had the choice of a private connection and consider just the choice between existing sources and a shared connection. However, it is likely that the private option is influencing this choice because in general richer households prefer either to get a private connection or to use their existing alternatives.[5] Another way of viewing this is that poorer households prefer a shared connection. Thus, we find that poor households have a higher WTP for shared connections than the rest of this sub-sample.

In general, demographic factors do not influence the choice to obtain a shared connection. Similarly, perceptions of water quality/service are statistically insignificant, possibly because households not connected to the network are not intimately aware of water service attributes.

[5] If we re-estimate this model with private connection as the comparison group, we find that richer households are less likely to choose the shared option. This finding confirms the statement in the text.

Table 16
Unconnected (Group II) households—multinomial regression model explaining choice to connect or reject improved private or shared connection

Variable	Shared		Private	
	Coefficient	p-value > $\|z\|$	Coefficient	p-value > $\|z\|$
Log monthly income (in NPR)	–0.140	0.068	0.437	0.008
Respondent's age	–0.012	0.311	–0.004	0.715
Respondent's education	–0.013	0.734	0.034	0.330
Respondent's gender dummy	–0.334	0.272	–0.058	0.837
Water contamination dummy	–0.180	0.532	0.759	0.004
Heard about privatization	0.550	0.134	0.383	0.238
Risky private (NWSC) connection water	–0.309	0.407	0.375	0.239
Irregular private (NWSC) connection water	0.374	0.354	0.171	0.623
Overhead storage dummy	–0.027	0.951	0.583	0.106
Water treatment dummy	1.106	0.002	0.697	0.029
Only uses community sources	–0.482	0.140	–0.661	0.026
Regression constant	1.004	0.218	–4.845	0.002
	Choice "neither" is the comparison group			
Likelihood ratio statistic $R\ \chi^2$ (22)	99.25	0.000		
Pseudo-R^2	0.1215			
Log likelihood	–358.72			
No. of observations	383			

Awareness of the privatization issue appears to increase the likelihood that a household will choose a shared connection. Households who treat their water are more likely to choose a shared connection. Finally, we find that households who use community water resources exclusively—such as public tap, public well, neighbors, stone taps, rainwater harvesting, and surface water sources—are less likely to choose a shared connection. This may be because these households perceive that the water from stone taps is of very high quality.

Turning to the model of private connections, we see that income is positively correlated with a household's choice of a private connection. As in the shared choice model, the coefficients on household demographics and attributes of water quality/services are statistically insignificant, suggesting that these factors do not influence the choice of a private connection for households currently without a private connection. Households who believe that water contamination is the most important environmental problem are more likely to choose a private connection that offers healthy and risk-free water.

Households who engage in substantive averting behaviors—treatment of water and storage—are more likely to choose a private connection. Finally, we find that households who use community water resources exclusively are less likely to choose a private connection.

7. Concluding remarks

The results of this survey provide the first evidence from South Asia that households' willingness to pay for improved water services are *much higher* than their current water bills.

Moreover, our results suggest that households in Kathmandu are positively disposed toward the involvement of the private sector in the effort to improve the quality and reliability of piped water services. We find substantive public support among both poor and nonpoor households for a privatization plan that would improve water supply and require all participants to pay regular and higher monthly bills.

Households' responses to questions about what they would do if the plan were implemented provide a distribution of WTP for the relevant population. These WTP distributions show how many people would connect at different levels of the proposed monthly bill and have the expected downward sloping property that is consistent with demand theory. Almost 70% of the households who are connected to the network are willing to pay a monthly bill of NPR 600 (US$8.33) for improved services, which include 500 l of water a day that is risk free and bills that are regular and fair. Among households who are currently not connected to the network, almost 50% are willing to pay a monthly bill of NPR 500 (US$6.94) for similar services.

Among households connected to the NWSC network, the mean monthly WTP for 500 liters of improved water supply is NPR 1030 (US$14.31). For the poor sub-sample within this group, the mean monthly WTP is NPR 830 (US$11.53). Among household not connected to the NWSC network, the mean monthly WTP for improved water supply from a private connection is NPR 840 (US$11.67). The mean monthly WTP for improved water supply from a shared connection is NPR 230 (US$3.19). For the poor sub-sample within this group, the mean monthly WTP is NPR 420 (US$5.83) for a private connection and NPR 260 (US$3.61) for a shared connection. Such information may help persuade policymakers of the political and financial feasibility of private sector involvement and guide the design of a new tariff structure.

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