About the Paper

Herath Gunatilake, Jui-Chen Yang, Subhrendu Pattanayak, and Kyeong Ae Choe write that beneficiaries' willingness-to-pay estimates provide crucial information for designing water supply and sanitation projects. There are pressing needs to improve the quality of contingent valuation studies conducted in developing countries. This paper recommends good practices in design, survey administration, and analysis in water supply and sanitation sector contingent valuation studies.

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Good Practices for Estimating Reliable Willingness-to-Pay Values in the Water Supply and Sanitation Sector

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and Kyeong Ae Choe

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FOREWORD

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ABSTRACT

Beneficiaries' willingness-to-pay (WTP) estimates provide crucial information for designing water supply and sanitation (WSS) projects. Contingent valuation (CV) method is widely used to estimate WTP in WSS project preparation, and poor quality CV studies is cause for concern. There is a pressing need to improve the quality of CV studies conducted in developing countries because such study findings may provide misleading information on project feasibility. This paper distills knowledge on CV methods generated during the last two decades to provide practical guidelines for skillfully undertaking CV studies. The paper recommends good practices in design, survey administration, and analysis, and provides a quality checklist for team/mission leaders to ensure quality of CV studies in the WSS sector.

I. INTRODUCTION

The water supply and sanitation (WSS) sector is one of the priority sectors for investment in the Asia and Pacific region. The Asian Development Bank (ADB) indicates its continuing support and increased investments for the sector in its Long Term Strategic Framework 2001–2015 (ADB 2001a). ADB's WSS sector operation is also complemented by its Water Policy (ADB 2001b) to promote water as a socially vital economic good that needs increasingly careful management to sustain economic growth and poverty reduction. Existing guidelines (ADB 1993 and 1996) require feasibility studies on WSS projects to examine economic viability, where willingness-to-pay (WTP) data constitute the basis for assessing effective demand and, sometimes, benefits of WSS services.

The WTP concept generally refers to the economic value of a good to a person (or a household) under given conditions. Net economic benefits of improved water services, in simple terms, are estimated as the difference between the consumers' maximum WTP for better services and the actual cost of the services. [1]

Willingness-to-pay values provide crucial information for assessing economic viability of projects, setting affordable tariffs, evaluating policy alternatives, assessing financial sustainability, as well as designing socially equitable subsidies (Brookshire and Whittington 1993, Whittington 2002a, Carson 2003, Gunatilake et al. 2006, van den Berg et al. 2006). However, this study finds that the WTP data gathered under ADB's WSS projects have been rarely utilized for such analyses, except for calculating economic internal rates of return. More often, WTP field surveys of ADB projects were conducted with inadequate knowledge on theoretical background, and generated poor quality data. Poorly designed and conducted WTP studies may provide misleading information on project feasibility and sustainability.

Field practitioners, often lacking relevant training in economics,[2] misconstrue that WTP can be easily estimated by asking a simplistic question, "how much would you be willing to pay for improved water supply?" Poor outcomes are produced under such a simplistic way of conducting contingent valuation (CV) surveys, and have been the root causes cited by many skeptics on the use of the CV method. Whittington (2002b, 323) notes that "findings of many of the contingent valuation studies are inaccurate and unreliable and that there is a pressing need to improve the quality of CV studies in developing countries." An in-house review of recently estimated WTP values corroborates this finding on overall poor quality. For example, of the 35 ADB studies reviewed,

[1] Interested readers may refer to Whittington and Swarna (1994) and Gunatilake et al. (2006) for a more detailed treatment of this topic.

[2] ADB projects tend to use social development specialists to carry out field surveys, categorically classifying WTP surveys as social surveys. Alternatively, one financial expert would cover project economic analysis aspects at a minimum level, including WTP. These tendencies have also contributed to lower data quality, as social development or financial specialists may not be acquainted with the underpinning economic theory or may not be familiar with CV elicitation techniques.

30 reported WTP values, and only 23 of the 30 had relevant CV survey reports. Only two (9%) out of 23 studies met the standards discussed in this paper. [3]

The scope of this paper does not permit a comprehensive review of the vast and growing literature on CV method and its application. From the viewpoint of practical guidance for estimating reliable WTP, Whittington (1988)[4] pioneered work on the application of the CV method in water services in developing countries. Mitchell and Carson (1989) also provided guidelines for CV practitioners, including a list of questions that should be asked by any decision maker who wishes to use the findings of a CV study. Since then, within the WSS sector alone (not to mention the broader field of environmental economics), much research on the CV method has been carried out, improving the knowledge base overall. Whittington's papers (1998 and 2002b) are noteworthy contributions that focus on the practical aspects of conducting CV surveys in developing countries. They also provide valuable insights as to why so many CV studies conducted in developing countries are unreliable. This paper draws heavily on the abovementioned papers on practical guidelines for conducting CV surveys.

Gunatilake et al. (2006) illustrate that a good practice CV study can help in estimating household demand for WSS services, designing tariffs and subsidies, and improving performance of WSS utilities. Using the same source of data, van den Berg et al. (2006) show how a CV study finding can be used to assess the validity of the basic assumptions of public–private partnership in water supply. Over the last two decades, a series of key research papers have generated new knowledge on the CV method. This knowledge has not been tailored for ADB operations staff or practitioners as an easy reference for improving the quality of CV studies. This paper distills the knowledge generated on the CV method in the last two decades and presents in an easily understandable manner how to undertake CV studies skillfully.

The paper is organized as follows. Section II provides a brief update on the overall perception of the economic profession on estimating WTP using the CV method. Section III discusses the design issues at the planning stage of a CV study and Section IV examines implementation issues. Section V demonstrates analytical procedures to extract WTP values, information on effective demand, and other policy-relevant information from a CV study. The final section provides a brief summary of the recommendations and a checklist for mission leaders to examine the quality of CV studies before using WTP estimates for policy purposes.

II. USE OF CV METHOD TO MEASURE WTP

The WTP value of a good or service may be elicited (i) directly by asking consumers, through carefully orchestrated elicitation methods; or (ii) indirectly by examining market prices. The CV method is a survey-based elicitation technique to estimate WTP values of a good that is not traded in the conventional market.[5] The CV method is often referred to as stated preference method, in

[3] This 2% meets all requirements as described in the paper. There are many CV studies that met the standards in a few aspects, such as sample selection, enumerator training, etc. Various details of reviews of PPTA reports on WTP estimations will be presented in this paper as necessary.

[4] The work of Whittington and associates for the World Bank has made a significant impact on the proper application of the CV method for improved WSS projects.

[5] These include public resources (pollution abatement for cleaner air, preserving historical sites, scenic values of natural environment); or nonmarket goods (water supply, sanitation facilities, reduction of traffic jams, or new vaccines for protecting public health).

contrast to revealed preference methods, which use actual revealed behavior of consumers in the market. The CV method directly asks consumers' WTP for a nonmarketed good under a given condition or a prescribed circumstance. To elicit consumers' WTP values for nonmarketed goods, a hypothetical market scenario should be formulated and described to the survey respondents. Thus, the elicited WTP values of a good are "contingent upon" the hypothetical market prescribed in the survey instrument.[6]

Since a CV survey always asks WTP questions, it has been commonly called a "WTP study." Subsequently, the key fundamentals of "contingent" market scenarios are often overlooked by practitioners as the term "WTP" predominates over "CV method." In this paper, WTP and CV method will be distinguished: WTP as a concept referring to the economic value of a good, and CV method (replacing the commonly called WTP study) as the survey-based technique to estimate WTP values.

Despite its wide use for practical policy purposes, the CV method's ability to reliably estimate WTP is not universally accepted. While some economists have expressed skepticism on the use of direct questioning[7] to estimate WTP, one of the early verdicts[8] on the soundness of the CV method came from a group of world-renowned economists: Kenneth Arrow, Robert Solow, Roy Radner, Edward Leamer, and Howard Schumann (Arrow et al. 1993). Their Blue-Ribbon Panel report for the National Oceanic and Atmospheric Administration states:

> CV studies convey useful information. We think it is fair to describe such information as reliable by standards that seem to be implicit in similar contexts, like market analysis for new and innovative products and the assessments of other damages normally allowed in court proceedings (Arrow et al. 1993, 4610).

The CV method has improved significantly during the last 50 years. One of the pioneers in the field of CV surveys, V. Kerry Smith (2006), argues that CV research has witnessed robust progress, enabling better understanding of consumer preferences. More specifically, the progress on econometric analysis, survey research methods, sampling and experimental design, and policy applications in the last 50 years has been remarkable. In Smith's assessment, concerns relating to measurement bias in estimating nonuse values can be excessive. [9] In the case of WSS, however, similar measurement bias is a lesser concern because of estimation of direct use values. As Smith further elaborates, hypothetical bias can also be large because of the nature of CV surveys. Careful development of survey instruments (through initial preparatory work, focus groups, cognitive interviews, and pretests); conscientious implementation of field work; and rigorous econometric analysis that link the data to underlying theoretical models (e.g., utility functions) can help reduce

6 The CV method is a survey technique based on economic theory, originally and most widely used in the area of environmental economics to estimate the public's WTP for improvements in environmental quality (Cummings, Brookshire, and Shulze 1986; Mitchell and Carson 1989).

7 Many cast doubt on the direct questioning method (stated preferences) vis-a-vis the use of more reliable revealed preferences data, i.e., actual market data. The authors endorse this view and encourage the use of revealed preference data whenever possible.

8 Mitchell and Carson (1989) also conclude that the CV method can obtain valid valuation information on public goods, but only if the method is applied in a way that addresses the potential sources of error and bias.

9 Smith (2006) contends that some of the confusion and apprehension on the CV method arises from the misplaced attention on use of the CV method for natural resources damage litigation.

hypotheticality in a CV study.

Another important reason behind the expressed reservations about the CV method is the potential divergence between responses[10] and actual behavior. The emerging evidence shows that predictions from "hypothetical" CV scenarios seem to compare well with actual behavior (Cameron et al. 2002, Vossler and Kerkvliet 2003). Griffin et al. (1995) show similar predictable behavior in the case of WSS improvements. Moreover, Choe et al. (1996) show that WTP values from a stated preference model (CV method) is as robust as those from a revealed preference model (such as travel cost method). Finally, Smith (2006) contends that the CV method will remain a significant part of efforts to assess consumer preferences for nonmarket (and new[11]) goods. Adamowicz (2004), Whitehead (2006), and Whitehead and Blomquist (2006) essentially endorse this view and maintain that CV studies remain a key tool in generating data on new (nonmarket) goods and services for policy analysis.

The above excerpts do not mean to assert that doubts on the CV method among some economists have completely disappeared. Despite significant improvements in methodology, debate on the ability of the CV method to meaningfully measure WTP continues. The authors' view on this matter relies on pragmatism, recognizing the fact that practitioners do not have the luxury of waiting until the academic debate is over to undertake policy analysis. Perhaps due to lack of suitable alternative methods[12] applicable within the resource and time limitations of many project preparatory studies, the CV method is widely applied to estimate WTP. In this context, the pragmatic approach is to use the CV method meticulously, applying the improved methodology to generate reliable estimates of WTP.

III. PLANNING AND DESIGN ISSUES

Any WSS study seeks answers to at least two fundamental questions: what are the costs of, and the benefits from, improvements of WSS services? CV studies are commissioned basically to address the second question. Over the last two decades, the CV method has been used increasingly in developing countries for improvements in WSS services (Whittington 1988). However, applying the CV method in developing countries requires careful adaptation of the method to account for local conditions and cultural differences (Whittington 1998 and 2002b). Whittington (2002b) identifies three major problematic aspects that need to be addressed to improve CV studies in developing countries: (i) poorly crafted CV scenarios (poor study design); (ii) poor survey implementation; and (iii) failure to undertake a variety of tests to examine the validity of responses to different CV scenarios. The rest of this paper is largely devoted to address these three issues.

Planning a CV study involves careful forward-looking thinking, envisioning what the ultimate services the project will deliver. Initial preparatory activities should provide adequate information that will feed into designing a preliminary version of a CV survey instrument. The preliminary CV

[10] CV questions ask about future actions of the respondents for hypothetical scenarios.

[11] "New" in the case of WSS refers to different service quality attributes such as number of hours of service, water quality, customer service, and perhaps service provider (private and public provision, for example). These attributes that make the service a new commodity are easily comprehensible to a CV respondent, therefore the potentially excessive hypothetical biases may not necessarily occur in WSS sector CV studies.

[12] Under certain circumstances, some revealed preference methods such as market data from water vending, avoided coping costs, and avoided cost of illness may be available to assess the benefits of WSS projects.

instrument should have a reasonable CV market scenario that takes into account the specific locality, various WSS sources and conditions, cultural and socioeconomic situations of the communities, as well as payment mechanism for the proposed service improvement. Then, it should be refined using focus group discussions (FGD) and pretesting in the field. This section first describes the preparatory tasks and then discusses specific design issues.

A. Initial Preparatory Tasks

Initial preparatory tasks are important for creating credible and understandable CV instruments and study design. These include:

(i) reviewing project-relevant reports/documents, including available census data, water utility records on supply conditions, and a map of the study area

(ii) teaming up with local institutions for a CV study

(iii) scoping during initial field visits

(iv) preparing a sampling framework

Collectively, these initial tasks will help the economic analyst (the analyst) conceptualize a good survey instrument and sampling strategy by focusing on what questions should be asked, to assess (i) sociodemographic profile of the consumers and communities; (ii) current water use behavior and existing water sources; (iii) characteristics of the existing water sources in terms of quality, quantity, and associated expenditures; and (iv) policies and programs in the study area. Such assessment will help in contemplating appropriate CV market scenarios and relevant issues in delivering water for the poor. The preparatory tasks would be implemented simultaneously, but are discussed sequentially below.

1. Reviewing Relevant Documents

The initial preparation for the study begins with a review of relevant documents. The analyst should have three goals in mind: (i) to better understand the current WSS situation; (ii) to find out how the populations are distributed in the study area and where the poor groups are located, while keeping in mind their current water supply conditions; and (iii) to assess available secondary data on population, housing, poverty incidence, and other associated WSS development initiatives. Toward these goals, the analyst may want to cover three sets of literature:

(i) **Information on current WSS conditions.** This may include demographic profiles of the study area, service connections and coverage, existing tariff schemes and subsidies, supply and consumption levels, service quality, and alternative water sources and services.

(ii) **Information on water distribution network and geographic distribution of population in the study area (with particular attention to the poor).** With recent advances in GIS (geographical information system), location data on the poor is sometimes integrated into maps. Availability of such maps is of great value to the design of the sampling framework. Any literature on potential impacts of current and future WSS policy

decisions on the poor would also be valuable.

(iii) **Census data and other secondary statistics to understand overall sociodemographic composition of the study area.** Data can be gathered from local census departments, the Demographic and Health Surveys (DHS) funded by the United Nations Population Fund (UNFPA), United Nations Children's Fund (UNICEF), United States Agency for International Development (USAID); the Living Standards Measurement Study (LSMS) of the World Bank; the Family Life Surveys (FLS) by the RAND Corporation; and other special purpose surveys commissioned by government or aid agencies.

2. Teaming up for a CV Study

Given that water and sanitation problems are rarely the concern of any one discipline, a multidisciplinary team of collaborators is desirable for the success of a CV study. The following team composition is desirable:[13] an economist with in-depth knowledge and field experience on CV studies, a municipal engineer, a financial specialist, and enumerators for field surveys. The team needs to partner with local collaborators who are experienced in social surveys and handling statistical data in the region and/or study area.[14] Through collaboration, in-country participants will be exposed to the latest methods for assessing people's demand for improved WSS. Besides on-the-project learning and training, in-country participants would be well positioned to advocate for improved water services with adequate water tariff. They also provide excellent local language skills for translating CV instruments and conducting interviews. If local collaborators can provide a statistician for sampling, it could be an additional asset for improving CV data quality. Therefore, there is an element of capacity building for the local counterparts, and partnering with them will be mutually beneficial.

3. Scoping during Initial Field Visits

Together with the in-country collaborators, the analyst should conduct an initial scoping visit to the study area. In preparation for the field visits, the analyst should have reviewed available secondary data from the local or provincial level census data, and should bring the maps (contour map, administrative boundary map, road networks, and even tourist map as available) for the scoping exercise. The initial field visit may include:

(i) Discussions with local government representatives regarding the political and technical feasibility of service options for improved WSS provision. Estache et al. (2002) provide a good summary on this aspect.

(ii) Consultations with nongovernmental or community-based organizations working on

[13] In a PPTA study, most of this expertise, such as municipal engineer and financial specialist, is available in the consultant team. While their inputs can be obtained without additional costs, the PPTA mission leader should look for an economist with a postgraduate degree who has in-depth knowledge and field experience on CV design to undertake the CV study.

[14] Generally, it is beneficial to team up with local academic institutions for CV surveys. In addition to having a large cadre of committed students who can serve as enumerators, these institutions generate goodwill with the local population and provide access to e-mail, library resources, and a community of field-based researchers.

WSS in the study area.

(iii) Conducting rapid appraisals to get an initial grasp on environmental, sociocultural, economic, institutional, and policy issues across zones and different segments of user groups in the study area.

(iv) Consultations with randomly chosen households through open-ended interviews and community participatory meetings to better understand the WSS situation in selected communities and socioeconomic strata of the study area.

4. Preparing a Sampling Framework

During the initial preparation stage, the analyst should investigate potentially feasible sampling frameworks. A sampling frame is a list of possible members of the population of interest, from which respondents (generally households) for the study will be drawn. Selection of a representative sample is very important to ensure that sample findings can be generalized to the whole population with a certain degree of confidence. In the developed country context, the sampling framework could be the local phone directory, social security numbers registered in the study area, or driving licenses, for instance. However, in the developing country context, such comprehensive and detailed listings are rarely available. Sometimes population census may have a list of households that can be updated as a sampling frame. In other occasions, the analyst may find lists of households maintained by community leaders for various purposes. If such reasonable listings of study population are not available, then a map can be used to achieve a pseudo-random sampling framework. If the team decides to use the map as the sampling framework, then understanding geographical distribution of overall water users by market segment (by average income levels of communities, individual vs. public tap users, or distribution networks, etc.) is essential in designing a geographic sampling method. The initial preparatory work should provide a good idea for the study team to decide on the appropriate sampling frame.

B. Study Design Issues

Once the preparatory tasks are completed, the analyst is in a position to proceed with the actual design of the CV study. The following are key design issues.

1. Designing the Sampling Strategy[15]

Sampling entails (i) defining the population, (ii) specifying the sampling frame, (iii) selecting the sampling method, (iv) determining the sample size, and (v) specifying the replacement strategy for nonresponding (including rejection) households.[16] The sampling design generally starts with identification of the study population. In a WSS sector PPTA study, the population consists of the potential beneficiaries of the proposed project. Once the population is known, the next step is to define the sampling frame. A good sampling frame should be (i) reasonably representative

[15] It should be noted that this section is prepared largely to guide practical field work, which involves constraints. For greater detail, see Dalenius (1985).

[16] In CV studies of WSS projects, the household is normally the sampling unit, i.e., a single data point to be observed.

of the study population, and/or (ii) allow sufficient representation of subgroups of special policy interest (Deaton 1997). The best source of information in developing a sampling frame varies from country to country. The analyst must identify proper ways to physically identify the elements of the sampling frame in order to carry out the survey.

After determining the sampling frame, the analyst must decide on the sampling method in order to select the sample randomly from the sampling frame. There are two approaches to sampling: probabilistic and nonprobabilistic sampling. The latter should be avoided. Probabilistic sampling is the preferred method because it allows proper application of statistical inferences, and systematic statistical inferences permit generalizing the sample findings to the entire population.

(i) Sampling Strategies

Sampling strategies depend on local conditions, such as how many variables should be analyzed in the CV study, or how many subsegments of water users exist, and geographic distributions across the study population. Strategies may include simple random sampling, stratified random sampling, cluster sampling, and quota sampling. Of these sampling strategies, stratified random sampling is the most widely used method in CV studies. When the population embraces a number of distinct categories, the sampling frame can be organized by these categories into separate strata (for example, communities with individual connections versus those without). Sample households are then randomly selected from each stratum separately, producing a stratified sample. There is no general rule to guide the selection of strata as it is situation-specific. However, the statistical properties of the strata should ensure that: (i) the means of interstrata variables should be substantially different; and (ii) there exists a minimum variance within a stratum as well as a maximum variance among strata. In a WSS study, typical strata may include different geographic areas or administrative units such as districts or communes, connected and unconnected households, different income groups, etc. Information collected through initial preparatory work is useful in identifying and selecting suitable sets of strata. Once the analyst has decided on the strata, a representative sample from each stratum should be randomly selected. This can be accomplished by using random number tables. [17]

(ii) Staged Sampling Process

While the stratified random sampling method generally provides a suitable approach for sampling in the CV studies, under certain circumstances the analyst may apply another stage of stratification (the upper level sampling unit becomes a cluster). When the number of clusters (such as distinguished boundaries of communities or smaller size districts within the study) are large, there is no compelling reason to include all the clusters; and where the budget and other constraints do not allow inclusion of all the clusters, the analyst may first select clusters randomly. Once the clusters are selected at the first stage, then the sample households are randomly selected within each chosen cluster. This procedure is known as stratified two-stage random sampling because it involves sample selections at two stages, first at the cluster level, and second at the household level. This procedure may be further extended to three-stage or multi-stage sampling.

[17] Interested readers may refer to Kalton (1983) for a simple and practice-oriented discussion on sampling. For a deeper understanding on sampling, readers may refer to Cochran (1977) and Kish (1965).

If the sampling strategy involves stratified sampling, proportional representation of sample strata should be checked against that of the study population. The effectiveness of the stratification depends on the accuracy of prior information about the distribution of the overall population by location, socioeconomic status, or other dimensions of special interest in a particular study. While undertaking the preparatory tasks, the analyst should keep in mind the data requirement for developing a suitable sampling method. The choice of the strata should be guided by both the specific objectives of the study and the characteristics of the study population.

(iii) Sample Size

The size of the sample depends on: (i) whether the elicited WTP values are based on "referendum" question or "open-ended" question; (ii) how many versions of the contingent market scenario will be administered; (iii) how many stratifications are used for sampling; (iv) what is the acceptable margin of statistical error ranges in WTP values; (v) the number of independent variables determining willingness-to-pay values; and (vi) the available budget and time limitation to complete the CV study. The size of the study population is an important element to consider, even as it is not the only key determinant of sample size. Appendix A shows how sample size can be determined based on the size of the population. On one hand, the sample size can be calculated according to the number of CV versions to be tested. The number of bids offered in a CV scenario is also an important determinant of the sample size since each bid should be administered in a minimum number of households. On the other hand, the sample size could also be determined by the study budget.

For instance, suppose a CV study is designed by factoring in (i) two stratifications (individual tap connection versus no taps), (ii) five referendum values to estimate WSS demand, and (iii) two versions of the CV scenarios to test (public provision versus public private partnership). Then, the total sample size required for statistical analysis becomes 600 households (equals 2 x 5 x 2 multiplied by 30 households in each cell).[18] If the calculated sample size is too large given the budget, then the analyst should adjust his/her original decision by tracing back, and considering: (i) what is the feasible sample size given a particular budget and time; (ii) which of the determinant factors should be redesigned[19] to reduce sample size to fit for given resource limitations; and therefore, (iii) what would be the best optimal sample size without sacrificing the reliability of statistical inference.

(iv) Random Selection

Once the analyst obtains a household listing, devises a sampling strategy, and determines the sample size and subsample size from each stratum, he/she should randomly select the specified number of households. These selected households will constitute the survey sample and should be contacted by the enumerators. Randomization, efforts to locate the selected households, and interviewing them are all very important steps that sometimes do not get adequate attention in

[18] Here, the number 30 is a general rule of thumb to protect statistical degrees of freedom in estimating a (demand) function. If the clusters include mutually exclusive variables of importance, the sample size will increase substantially.

[19] For example, if the analyst has adequate information to decide that WSS should be privately provided, the sample size can be reduced to 300.

many surveys. Close supervision of enumerators is critical to ensure that enumerators interview the sampled households, not others at their convenience. In many developing countries, contacting the households to make prior appointments through telephone, e-mail, etc., may not be possible. Therefore, enumerators just walk over to the households to get their consent for the interview. Also, access to households may be difficult because the postal address is not clearly marked in each building, and sometimes households want the enumerator to come some other time. Under such circumstances, enumerators tend to go to households that were not selected as part of the sample. This practice should be prevented through strict and continuous supervision during survey implementation.

(v) Practical Solutions

In many developing countries, complete lists of households to be used for the sampling frame are usually unavailable. Even if such listings are available, it is not easy to locate them as explained above. Therefore, it is more practical for the analyst to use a map as a sampling framework, rather than search for a complete listing of households. The map should be drawn to scale (the more detailed, the better). To do this, first create cells or clusters by drawing grid lines over the map and numbering each cluster. Second, using a random number table, select the number of clusters where enumerators for the survey will be deployed. Third, enumerators should be instructed to go through the neighborhood in a consistent manner with a clear rule for selecting houses to survey; for example, select every 10th house on a given street. Access to selected households may be difficult as households sometimes decline to be interviewed. Under such circumstances, the analyst should devise a geographical replacement rule, such as "the preselected household should be replaced with one of the five neighbors using a counterclockwise rule, or enumerators should proceed to the next 10th house." The selection rules should be strictly observed to assimilate random sampling procedures as much as possible.

Adequate information about the adopted sampling strategy should be reported to add credibility to the CV survey. Among the ADB PPTA reports that claimed to have a CV study, 23 out of 30 submitted reports on the CV study. About 15 of the 23 projects reported their sample sizes, which ranged from 200 to 2,000. In most of the projects, the population was defined, and the sampling method used and the form of data collection were specified. Of the studies reviewed, seven clearly identified the sampling framework and only six discussed how the sample elements were selected. Overall, the sampling strategy was not discussed in detail in most of the studies. Further information on the manner in which the sample elements were selected, how the stratification or clustering was accomplished, and what steps were taken to strictly implement sampling strategy and replacement strategy, if any, will enhance the quality of ADB CV studies.

2. Designing Contingent Market Scenarios

Seven guidelines for designing CV surveys were developed by the NOAA Panel, also known as the "Seven Pillars of NOAA" (Arrow et al. 1993, Portney 1994). The Panel suggests the following practices when designing CV surveys:

(i) Interview in person rather than over the telephone.

(ii) Question about a future hypothetical occurrence rather than a historical event.

(iii) Use a referendum format (as opposed to open-ended questions) in which the respondent "votes" on a benefit with a known price.

(iv) The interviewer should begin with a scenario accurately describing the benefits of a contingent market commodity.

(v) The survey should remind that payment for the new commodity may reduce consumption of other goods.

(vi) The survey should remind that substitutes exist for the hypothetical commodity in question.

(vii) There should be follow-up questions to make sure the respondent understands the choices made.

These guidelines, together with the following other considerations, are recommended as best practices in designing CV studies.

(i) Prior Characterization of the Existing WSS Situation

Regardless of the possible variations in the objectives[20] of a CV study, characterization of the current WSS situation is the first step in developing suitable CV scenarios. As Whittington (2002a, 83–4) contends (referring to the importance of prior characterization of existing WSS services), preparatory activities help avoid the pitfalls of poorly defined and executed CV surveys:

> ...we typically collect information on local water markets, observe water collection practices at sources, interview water vendors, conduct unstructured open-ended interviews, hold participatory community meetings and smaller focus groups, and administer in-person interviews with randomly selected respondents. Conducting a structured, in-person interview (for estimating WTP) is only possible after careful, qualitative (prior) work has been completed.

It would be impossible to develop accurate measures of demand without a good understanding of the background WSS situation because the CV surveys are often trying to measure WTP for improvements in WSS. Improvements are defined taking the current characteristics as benchmark. Conducting an assessment on the improved services should be accompanied by information on: (i) what people are currently using; (ii) what improvements are feasible from an engineering, economic, financial and cultural perspective; and (iii) how people view the role of water and sanitation in their daily lives. This exercise is essential to better understand the household's choice for the proposed change in WSS services. A thorough and detailed characterization of the existing water and sanitation situation is a prerequisite for conducting policy analysis as well. The aspects that need to be covered in characterizing existing services can vary case-to-case. Regardless of these potential variations, the characterization should generally focus on four aspects of the current situation—physical characteristics, economic factors, environmental health indicators, and

[20] There can be a wide variation in the objectives of a CV study even though the main goal is to estimate WTP. For example, associated policy analysis may take different forms depending on the situation. CV studies focus on poverty and affordability, financial sustainability, and other relevant policy issues to different degrees, making them quite different.

institutional features. Additional characteristics should be considered as needs arise.

(i) Physical Characteristics

In characterizing current conditions, it will be necessary to understand the water sources currently used by the household, as well as alternative sources that can potentially be used. The list usually includes household water supply connections operated by public or private entities, private wells, neighbors, public or private tankers, bottled sources, and a variety of public or "free" sources such as public wells, public taps, rainwater, rivers, or streams. Available sources help understand the substitution possibilities in case of a potential tariff increase. For example, Pattanayak et al. (2004) show that households with reasonably good alternative sources such as wells have low WTP and high rejection rates for improved services. In certain cases, quantitative information on water use from different sources is valuable for policy analysis purposes. Similar details on the types and extent of sanitation alternatives will also be useful. The quantitative information on consumption can be used to estimate the price elasticity of demand, which is very useful in accurately forecasting the utility revenues to assess financial sustainability.[21] Finally, the analyst needs some measure of the existing water quality. Traditionally, water quality is measured based on household perceptions of color, taste, and health risk. To the extent that perceptions affect behaviors, subjective water quality measures are useful. Resources- and time-permitting, the analyst may consider more objective measures such as microbiological quality, temperature, turbidity, and chemical contamination (e.g., fluoride, arsenic, etc.).

(ii) Economic Factors

For each WSS alternative, direct monetary costs include utility bills and the household's costs of operation. Households can also have significant indirect or "coping" costs because of inadequate infrastructure services (Choe et al. 1996, Pattanayak et al. 2005). Typically, the time spent on collecting water constitutes the greatest share of the coping costs. Second, as part of the assessment of coping behaviors, the analyst may gather information on household sanitation and hygiene practices such as boiling, chlorination, filtering, water handling and storage, and hand washing that can mediate the impacts of the WSS. From a policy support perspective, it is critical to collect data on existing tariff and network services for typical households from published reports and papers.

(iii) Environmental and Health Factors

Some argue that the most significant benefits of water and sanitation services are improvements in public health (Fewtrell et al. 2005, Bosch et al. 2000). A recent meta-analysis suggests that water, sanitation, and hygiene interventions may generate significant gains in health, reducing incidence of diarrhea by approximately 30% in children in developing countries (Fewtrell et al. 2005). These impacts can be analyzed by collecting data on at least three interrelated factors. First, the analyst would need information on the main forms of water-borne and water-washed

[21] Nauges and van den Berg (2006) used the consumption and other data of Patannayak et al. (2004) to estimate demand elasticity, which helped the analysis on tariff setting and financial sustainability.

health risks in the study area. This information can be gathered from secondary sources and the survey. The analyst would collect data on recent illnesses, including details on disease incidence associated with poor quality WSS such as morbidity and mortality events, medical costs, and lost work days. As part of the validity tests, the analyst can check whether households who have experienced water-related diseases have higher WTP.

(iv) Institutional Factors

Another important feature of the existing situation includes the institutional and policy variables affecting households. Community surveys can be used to elicit information on institutional data including the existence of registered user groups, vitality of such community initiatives, programs for metered standpipes, and cost-sharing schemes. In many occasions, CV studies are undertaken prior to privatizing water utilities. In order to gather the preference of the people on the institutional provision of the service (public, private, or community managed), different CV scenarios may need to be administered. In the characterization of the current services, the analyst can get some initial insights through focus group discussions and open-ended/semistructured interviews.

Information on the existing WSS situation should be first assessed using field observations, semistructured interviews, interviews of key informants and government officials, and small focus group discussions. This information should then be used to initially characterize the existing services to help design CV scenarios. In addition, this characterization should help in formulating correct questions to generate a set of data that formally characterize the existing situation through the structured survey. Overall, the characterization should provide the analyst a good overview of the WSS situation and help understand the specific cultural contexts. The information initially collected through the above-described activities is useful in designing policy and gauging the findings of the CV study against the real WSS situation.

3. Commodity Definition in the CV Market

Lack of adequate attention to precisely describe the commodity in question is one of the reasons for getting unreliable WTP estimates in CV studies. Description of the commodity or scenario development primarily involves: (i) defining precisely the type of WSS services offered; (ii) clarifying how it differs substantively (e.g., quantity and quality) from current options; and (iii) explaining the institutional setting for providing the service. Identifying and defining the appropriate commodity requires a careful review and thorough understanding of existing levels of service and alternatives in the study area. Information collected prior to the survey for characterizing the WSS situation will be directly useful in defining the commodity. For example, if preliminary evidence suggests that a certain percentage of the population is connected to the piped water network, the commodity in question can be "an improvement in existing services" for this subsample, in contrast to "a new service connection" for unconnected households. These two subgroups need different CV market versions as well as elicitation questions, because unconnected households need to pay a connection charge in addition to the water consumption bills.

In general, the preparatory activities and focus groups can uncover important features of the selected service option(s) such as metering, hours of supply, and water quality. In the case of

ADB's PPTA CV studies, where improved service delivery design may already be available, the commodity should be described as it is planned to be offered by the project. However, if certain elements of the scenario, based on the initial qualitative assessments, are expected to substantively affect household demand for improved services, those elements can become design features that vary across the surveyed households. For example, households may have different preferences across private sector provision, reformed public sector, or community provision, despite the fact that the original project idea is to provide the service through the private sector. If the privatization process is viewed as a polarizing feature of service provision, the analyst could define different versions of the commodity corresponding to private, public, and/or community providers of improved services. Surveys with these different versions would be administered to different subsamples, and econometric modeling should be used to detect whether the private versus public institutional context affects household demand and choices. Following is a sample commodity definition:

> "Suppose your household receives 24-hour water supply service (reliability), with water that is safe to drink from the tap (quality), accurate billing of the water with reliable and responsive customer service (customer service quality) by a private service provider (service provider). But your household would have to pay higher water bills (cost)."

Note that the commodity is accurately defined with a number of attributes such as reliability, water quality, customer service quality, service provider, payment mechanism, and cost before asking whether the respondent is willing to pay a given amount to get the improved services. This detailed and clear definition of the commodity reduces the cognitive demand on the respondent in synthesizing his/her answer to the elicitation question. Moreover, this type of precise definition makes it easy for the respondent to compare the improved service with the existing service before accepting or rejecting the proposed CV scenario. Of the ADB WTP studies[22] reviewed, none had provided a complete account of the improved services before administering the elicitation question. Asking people's WTP without properly describing the commodity for which they are expected to agree to pay defeats the purpose of the CV survey. Therefore, commodity definition is one of the very important aspects that need to be improved in future ADB CV studies.

4. Payment Method

The payment method or the payment vehicle—how individuals are asked to pay for the services—is also an important design issue in CV studies. In certain CV studies that deal with unfamiliar goods such as biodiversity protection or prevention of climate change, the payment vehicle (voluntary contribution or taxes) could be a potential source of hypothetical and other biases. In the WSS sector, this is of lesser concern because of familiar payment vehicles, i.e., water bills and connection charges.[23] The usual approach is to ask the valuation question(s) from an *ex-ante* perspective in the form of increments to current bills or new bills. For households that are already connected to the WSS system, the elicitation question would target the maximum amount

[22] From the 30 WTP studies reviewed, the CV survey instruments of only 13 studies were available. Few studies (5 out of 13) have attempted to describe the service improvement but these studies have provided only a partial description. In three studies, the improvement was described vaguely.

[23] However, if one administers a CV study in a community that has never paid water bills, using the bill as the payment vehicle can cause considerable hypothetical responses. Moreover, if the community is politically charged against water billing and considers water as a free good, using it may result in a higher number of protest responses.

the household would pay in addition to current monthly bills to have this improved service. For households without a connection, the payment method may be a connection charge plus monthly bills. Water bills and connection charges are reasonable payment vehicles, particularly in study areas where they already exist. The ADB WTP studies reviewed reveal that most (11 out of 13) have used the appropriate payment vehicle.

5. Elicitation Method

CV elicitation questions can be of two basic forms: open-ended or closed-ended. In an open-ended question, the respondent is asked to state the maximum amount that he or she is willing to pay for the good that is being valued. With a closed-ended CV question (also referred to as a "dichotomous choice" or "referendum" question), the respondent is asked whether he or she is willing to pay a specified amount presented as the value of the improved service (see Appendix B for a sample closed-ended question). The respondent is expected to answer "yes" or "no." Closed-ended questions have been the preferred form of elicitation question since it was introduced by Bishop and Heberlein (1979). On the other hand, open-ended questions provide more information than closed-ended questions; and do not require econometric modeling to analyze, as the mean WTP values of respondents can be readily estimated by simple arithmetic. However, answering an open-ended question on a new commodity requires a higher level of cognitive demand on the part of respondents, because individuals are typically not accustomed to performing such tasks in daily life decision making. Open-ended questions also lead the respondents to base their answers on their knowledge on cost of provision of WSS and sometimes on their political beliefs, such as whether water should be free of charge. Such type of anchoring may underestimate the true benefit of WSS. Moreover, validity testing, which is vital to provide credibility to estimate WTP, still requires econometric modeling. Therefore, a closed-ended approach is preferred to elicit WTP for improved WSS services. There is a variety of elicitation questions available now, which are largely some modification of the basic two types. A summary of the strengths and weaknesses of different elicitation methods by Boardman et al. (1996) can be found in Appendix C.

The NOAA Panel initially recommended the closed-ended format as a suitable elicitation method. Although easier for respondents to answer than open-ended questions, a closed-ended question does not directly reveal the respondent's WTP. The mean WTP values of respondents should be estimated using econometric models (Hanemann 1984, Cameron and James 1987, Cameron 1988). As Gunatilake et al. (2006) illustrate, econometric modeling allows undertaking a number of validity tests that adds credibility to the WTP estimates. Furthermore, an econometric model can be used to predict the uptake rates with different policy levers such as tariff and connection charges in WSS studies. Also the closed-ended format information provides direct answers to questions related to demand for improved WSS (see Section IVB). These additional uses help design suitable tariff and pro-poor WSS services, estimate revenues of the water utility, and provide answers to basic questions on effective demand in WSS project designs.

There were two commonly used elicitation methods in the ADB WTP studies. Six of the 13 studies used the payment card method to elicit WTP, while five used open-ended questions. Cameron et al. (2002) conclude that closed-ended elicitation questions are far superior to open-ended and payment card methods when compared to welfare estimation from actual choices. We recommend the closed-ended format following the emerging evidence and considering the added advantages

described above.[24] Shifting from the other formats to use the closed-ended format in future ADB WTP studies will constitute an important improvement in CV studies.

6. Bid Distribution

In the closed-ended format, the household is presented with a specific amount as an increment to the bill or a new bill. The elicitation question asks whether the respondent is willing to pay the specific amount to acquire the improved service. In order to facilitate the econometric modeling of the responses, a range of values (bids) will be presented to different households. Selection of the bids may have some influence on the WTP values, because respondents may anchor to these initial values in answering the CV question. A number of factors should be considered in deciding the range of bids. First, they should be realistically close to the actual costs and current bills. If some prior knowledge is available on future tariff increases, these new rates should be within the range of bids. The ranges of the connection charge and monthly bill should be sufficiently wide to assess demand and to capture relevant policy alternatives. The number of bids included in the study is usually dictated by the study budget because more variations in the bids require larger sample sizes. Moreover, too many bids and too large samples may also be logistically challenging during survey implementation. Typically, background information and focus group discussions would help determine the range of the bid values. The rule of thumb is that the lowest bid should be low enough that most of the respondents will accept it, while the highest bid should be high enough that most respondents will reject it (Whittington 1998). Same rules apply to the connection charge.

7. Designing the Survey Instrument

Survey instruments vary from study to study depending on the specific context. In general, a survey instrument should have the following modules:

Module I: An introductory section, briefly describing background and purpose of the survey

Module II: Questions on demographic, socioeconomic profile of the households, and socioeconomic profile of the respondents interviewed

Module III: Questions on current water supply conditions and consumption behaviors

Module IV: CV market scenarios followed by questions eliciting WTP values

Module V: Debriefing questions

Module I introduces the purpose of the survey, seeks the consent of respondents for the interview, and instructs respondents on the interview procedure. All interviews must comply with government regulations on human rights protection, and must be consistent with survey research protocol for seeking consent, ensuring confidentiality, and minimizing risk to respondents.[25] The first module should include household identification numbers, cluster identification (if clustered sampling was used), and contact address for follow-up information, if need arises.

[24] In case of some uncertainty in using econometric methods to estimate mean WTP, the analyst may also include an open-ended question as a precautionary measure. However this practice may also lead to certain types of biases.

[25] See Whittington (1998 and 2002b) for discussions of ethical problems in conducting CV surveys in developing countries.

Module II focuses on compiling basic social demographic and households' economic information, such as family size, education, occupation, number of breadwinners, asset ownership, income levels, and expenditure patterns. Also, this module clearly identifies which member of the family responded to the survey (or more precisely, checks that the interview is consistently administered with a household head), and gathers socioeconomic information on that particular respondent, including age and gender. The analyst should ensure that the survey instrument includes a set of necessary variables to estimate a WTP function and, subsequently, to carry out validity tests as described in Gunatilake et al. (2006). Basic household information is important at a later stage in analyzing what factors influence WTP values on improved WSS services, thus illuminating grounds for policy formulation.

Module III focuses on current water supply situations, consumption patterns, and use behaviors. This involves eliciting information on existing physical conditions; water sources, associated quality (taste, odor, safety, regularity); estimated consumption volumes; any supplementary equipment used by individual households; time and money invested to improve existing water conditions; reliability of water meters; and monthly bills. It is important to collect information on both primary source and alternative sources (i.e., those available in the community but may/may not be used by the household) such as public piped water, water vendors, public or private trucks, bottled sources, standpipes, wells, and rivers. After presenting the characterization question, the same module may ask about averting and mitigating activities such as boiling, chlorination, filtering, and hand washing, as well as household coping behaviors in general such as time spent walking to and waiting at public sources, pumping, and storing in a tank.

Module IV describes the CV market scenario before eliciting the WTP values in the fifth module. As discussed previously, the improved service should be described prior to asking the elicitation question. The questions in the third module thus should be a platform for the respondents to compare what the current WSS situation is and what it would be like with the improved services. This recollection process is important because having a meaningful comparison of the current situation with the precisely defined new service enables the respondents to provide truthful answers to the elicitation question. The CV market scenario should be written and every enumerator should be instructed to read the same CV market information to all the interviewees consistently. After this, the enumerator can question respondents on their WTP values on the commodity described in the CV market.

Module V seeks to further verify why a particular response is given to the WTP elicitation question. Here, the respondent is given an opportunity to further explain why he/she answered "yes" or "no" to the elicitation question. Asking the debriefing question from the respondent who said "no" to the elicitation question is of particular importance. If a respondent provides an answer such as "my family income is not enough to pay for the improved services" or "I am happy with my current service", this implies that the respondent has provided a reasonable answer (no). On the other hand, if a respondent says "I don't know" as the reason to answer "yes" or "no", this is cause for concern. This implies that the respondent may not have understood the question or may not have thought it through properly before answering the CV question. In such cases, going through the elicitation questions once again may lead to different answers. If the respondent repeatedly provides a similar vague response as the reason for his answer, this particular questionnaire should be dropped and the replacement strategy has to be used to interview another household. If a "yes" answer cannot be supported by a valid reason as well, that response cannot

be considered reliable. Properly designed debriefing questions thus provide on-site validity test for the responses given to the elicitation questions. Sometimes, a "yes" answer will be followed by "Yes, but I cannot afford to pay the bill." This should be interpreted as "no." Whittington (1998) provides insightful details as to how the respondent may say "no" politely according to certain cultural norms, starting with a "yes."

The preliminary instrument should be constantly modified throughout the design stage, based on the findings of the (i) scoping visit, (i) rapid appraisals, (iii) meetings with key informants, (iv) focus group discussions, (v) semistructured interviews, as well as during the (vi) training of enumerators. The recommendation to collect data in addition to CV responses is primarily for validation of the CV responses and the WTP estimates derived from the responses. CV responses must be correlated with theoretically appropriate variables such as income and water scarcity. Similarly, CV responses and WTP estimates must be correlated with and comparable to indicators of demand for WSS revealed through coping, averting, and other "revealed preference" data whenever possible. ADB projects have used questionnaires with varying degrees of quality. None of the questionnaires administered in the selected 15 PPTA reports have all the elements of CV questionnaires described above. Therefore, paying more attention to the questionnaire is certainly necessary to improve the quality of future CV studies. Table 1 provides a summary of the recommended good practices to be used in designing CV studies.

Table 1
Recommended Good Practices for Designing CV Studies

Design Issue	Recommended Good Practices
Commodity Definition	Precise definition including reliability, water quality, customer service quality, service provider, and cost
Elicitation Method	Closed-ended (referendum) format
Payment Vehicle	Connected households: water bill Unconnected households: connection charge and water bill
Survey Method	In-person interviews
Sampling Method	Stratified random sampling or cluster sampling together with proper description of sampling frame and strategy and replacement strategy
Sample Size	Adequate sample size based on the size of population (see Appendix A), number of CV scenarios, number of bids, number of anticipated split samples, etc.
Survey Instrument	Should include (i) an introductory section, (ii) socioeconomic profile of the respondents, (iii) a detailed description of the commodity, (iv) proper elicitation question, and (v) debriefing questions Focus group discussions and pretesting before finalizing the instrument
Reporting	Provide adequate information on the preparatory activities to understand and judge the quality of the CV survey design

Source: Compiled by the authors.

A. Survey Administration

The manner in which the survey is administered is important. As suggested by the NOAA Panel, in-person interviews are the most desirable approach, as opposed to mail-out or telephone surveys. In developing countries, households are generally very cooperative in face-to-face surveys; rejection rates of participation are usually low; and the costs of in-person surveys are not prohibitive. With the increasing availability of cheap computers and computing technology, some argue that it is worth considering the use of computer-assisted surveys. A potential advantage of this approach is in the reduction of data entry and quality assurance costs. However, there is no clear evidence for reasonably low costs of CV surveys in developing countries. Most of the ADB CV studies have used in-person interviews, while in rare occasions, educated respondents were allowed to fill the questionnaire by themselves.

A survey is usually implemented through four interrelated subtasks. These include: (i) enumerator training, (ii) focus group discussion, (iii) pretesting (piloting), and (iv) supervision of survey implementation. Each of these subtasks is discussed in the following section. Before actual implementation of the field survey, it would be good practice to review the measures taken to minimize potential biases in a CV study. This allows the researcher to avoid potential pitfalls before administering the survey. Once the survey proceeds and pitfalls are discovered during survey implementation, the integrity of the whole sample may be comprised, thus requiring a completely new set of random samples for a fresh start. Appendix D discusses different biases and required measures to minimize/avoid these biases.

1. Enumerator/Field Coordinator Training

Enumerator training plays a crucial role in ensuring CV survey quality. Whittington (2002b, 345) elegantly presents the importance of training enumerators for CV surveys in developing countries:

> "The goal of CV researcher is to gauge the attitudes and perceptions of a study population and to listen carefully to respondent's voices. The messages from the respondents to the researcher are filtered through the enumerators. Unless enumerators are well trained and committed it is next to impossible for CV researcher to accomplish her objective."

Well-trained enumerators and field coordinators are critical to the quality of any survey.[26] First, enumerators and selected field coordinators should be thoroughly familiar with the survey instrument such as the intricate details in each module and skip patterns built in the questionnaire design. Second, training sessions serve as an additional focus group discussion to help the analyst refine the wording and flow of the questions. Third, proper training of enumerators is essential in minimizing some of the potential biases in WTP answers. This section briefly summarizes the

[26] It is good practice to create a team of 4–5 enumerators, one of whom is nominated as a field coordinator. The selected field coordinator will coordinate drop-off/ pick-up points of daily field work, and monitor the team members' whereabouts. Every questionnaire should be certified by the field coordinator for accuracy and completeness before submission to the local team leader.

essence of enumerator/field coordinator training.[27]

The training can include a mix of lectures, role-playing, and field trials. Lectures over several days will introduce the enumerators to the basic concepts of the CV method and valuation of nonmarket goods, economic concepts underlying the CV method, and the importance of skillful communication when asking sensitive information such as income and expenditure data. The training should also cover details of data entry with consistent recording of unit of measurement; treatment of differences (between zero value, don't know answer, no answer, or decline to answer); and consistent translation of specific terminology throughout the survey as well as across enumerators. Role playing and mock interview sessions are likely to generate the most intensive learning. Finally, training in field settings, including practice interviews with households, allow the enumerators to get a feel for the study area and the actual interview process. The pretest, as described next, will be part of the final training. Using similar methods, all field coordinators need to be trained separately regarding supervision of enumerators and conduct of community surveys. A sample training agenda is shown below. Due to the complexity and variability of CV studies, the analyst should treat this list only as a basic guide and feel free to add more aspects to the training module depending on the specific needs of the study.

(i) Discuss the purpose of the study.

(ii) Review the structure of the survey instrument.

(iii) Illustrate how survey data will be used in the final analysis.

(iv) Review the structure and purpose of the CV method.

(v) Explain the challenge of presenting hypothetical scenarios in a credible way.

(vi) Conduct mock sessions in which enumerators administer the entire survey to each other.

(vii) Explain ground rules of conducting CV surveys (see Appendix E).

2. Focus Group Discussions

Brainstorming sessions with a few focus groups are an integral part of survey design. They help in securing information for developing the questionnaire prior to its implementation and refining the design features of the CV questions (Rea and Parker 1997). Focus groups generally involve 8 to 15 participants from different segments of the target population,[28] using segmentation criteria such as type of WSS user, employment and socioeconomic status, age, and education. Participants will be provided with information regarding the nature and content of the study. Group discussions should center on their opinions, perceptions, and reactions to this information. Responses from participants can provide vital insights into cultural issues that are important for effectively communicating and discussing water and sanitation problems. Typically, these discussions

[27] Readers interested in more detail may refer to Whittington (2002b).

[28] Note that some **focus group discussions should be conducted at the initial preparatory stage to understand the WSS** situation. However, the focus group participants should be carefully selected after sampling communities/areas have been identified using the sampling framework, so that this group of participants will not contaminate the random sampling process.

are conducted over a period of 1 to 2 hours.

In particular, the focus group discussions will help in identifying (or confirming) what are the major constraints to connecting to network services, such as unaffordable connection charges, or inaccessible credit facilities. In that case, the split sample tests should take into account the effects of the connection charges on WTP values. If the primary complaint about the existing service is reliability (e.g., hours of supply), this item should be considered as a key attribute of the improved services, and should be included in designing the questionnaire. Thus, the focus group discussion helps the analyst revise the design features of the preliminary survey instrument. The focus groups are also likely to identify additional issues that are difficult to specify at this point but may need further examination during pretesting. For example, the analyst may gain insights on data quality issues such as the precision with which to measure volumetric water consumption and consumption expenditures. Therefore, the researchers should innovatively use the focus group discussion to refine the CV scenario and the instrument depending on the issues at hand.

3. Pretesting and Finalizing the Questionnaire

Pretesting is a small-scale implementation of the draft questionnaire (normally for about 20–50 questionnaires, depending on the number of different versions of CV scenarios designed). Its primary purpose is to identify any problems with the content, length, and flow of the questionnaire. After refining the survey questionnaire based on comments from stakeholders, focus group findings, and enumerator training, the instrument is ready for pretesting with respondents drawn from the target population.[29] A verbal debriefing of the pretest participants is crucial to address the following issues related to the CV questions:

(i) understanding of the water and sanitation services that are offered (i.e., effectiveness in conveying the change in WSS attributes and the contingent nature of the product that respondents agree to purchase)

(ii) recognition of how the proposed service is different from current service options (including no service)

(iii) consideration of income constraints and alternate uses of income

(iv) appropriateness of the payment vehicle

(v) appropriateness of the range of bids

(vi) identification of any culturally sensitive element/question in the survey instrument

The pretests provide several benefits, in addition to further training of enumerators. First, they help determine appropriateness of the commodity definition. Second, the analyst can use the pretests to gauge the appropriateness of the bid distribution, the highest monthly consumption charge (i.e., a price that will be rejected by 90–95% of respondents), and the lowest charge (i.e., a price that will be accepted by 90–95% of the respondents). This ensures that the range of bids is appropriate and the survey will provide credible results. Third, participants' responses to open-ended questions identified in the focus groups can be precoded in the survey instrument to facilitate data entry and subsequent analysis. Fourth, the researcher can observe the way enumerators conduct

[29] Again, the participants for the pretesting stage should be carefully selected, so that this group of participants will not contaminate the random sampling process and survey data afterward.

the survey to identify common mistakes. These mistakes should be discussed at the group meeting of the survey team. Video taping the pretest interviews help other enumerators understand some of the common mistakes made by fellow enumerators. A simple enumerator manual, with specific instructions regarding common mistakes and errors, can be prepared based on the overall findings. Furthermore, field coordinators will be instructed to check these common mistakes on a survey-by-survey basis to identify problems early in the implementation process. Finally, the pretests also help finalize survey logistics such as formation of groups, assignment of field supervisors, and transportation of enumerators. Thus, the pretests will finally validate the questionnaire and provide adequate confidence to the researcher that the questionnaire is appropriate and ready to be used.

4. Supervising Survey Implementation

The goal of this subtask is to properly administer the survey to the predetermined sample. Enumerators and field coordinators will be divided into teams. The number of teams and size of each team will be determined by the sample size. In general, one field coordinator can supervise four to five enumerators. The survey should be completed all at once, taking no longer than two or three weeks to complete. Several quality control and quality assurance activities, summarized most recently by Scott et al. (2005), are key elements of field supervision. While field coordinators will be responsible for day-to-day operations, the core study team should constantly monitor survey progress on a daily basis from the beginning to the later phases of the field work. As interviewers and field coordinators gain experience with the survey, supervision and monitoring activities can be reduced, although certainly not ended until the conclusion of the survey. A systematic supervision of the field survey involves: (i) ensuring that the intended sample is interviewed, (ii) detailed review of every completed questionnaire before leaving the location, (iii) assessing the quality of interviews, (iv) random checking of interviews, and (v) implementation of incentive/disincentive scheme corresponding to the performance of enumerators.

At the end of each field day, coordinators should check the returned questionnaires for completeness and accuracy, according to a quality checklist developed by the study team. If any discrepancies are detected, the enumerators should return to the households to correct the errors or fill in the missing information. Recording enumerators' opinions regarding the quality of the interviews will also be useful. A log of returned surveys will provide a quick overview of the progress of survey administration. The core study team and coordinators should also periodically monitor interviews for quality assurance. Collectively, these measures can ensure that mistakes made by enumerators are spotted and corrected at an early stage, thereby setting a standard for quality control and quality assurance as the survey progresses.

In 23 ADB projects reviewed, the PPTA reports indicated that the consultants have gone through enumerator training, pretesting, and field work supervision. Fifteen of the 23 projects reported that training was provided to enumerators who were subject to supervision during the survey process. At least in three of the projects, supervisors were reported to have accompanied the enumerators in some of their visits. In one project (PRC: Jilin Water Supply; see ADB 2005), a manual was developed to guide enumerators when they conduct the survey. The survey instrument was explicitly reported to have been pretested only in five of the 23 projects reviewed. Strengthening enumerator training, focal group discussions, pretesting, and supervision of field work definitely

provide room for improving WTP data of ADB studies.

B. Data Management and Preliminary Analysis

While the survey is progressing in the field, the analyst should also begin developing a coding sheet and template for data entry. Once good quality data is generated through the survey, the analyst should make sure the errors will not creep into the data entry and management stage. The management and analysis of data from the survey could proceed in three sets of subtasks corresponding to: (i) data entry and processing, (ii) calculation of descriptive statistics, and (iii) cross-tabulation of summary statistics.

1. Data Entry and Processing

The data recorded on the paper questionnaires should be transferred by the analyst into the selected data management software (e.g., Microsoft Excel, Access, Fox, or CSPro developed by the United States Census Bureau, Macro International, and Serpro, S.A.) using codes developed during the survey design. Three quality assurance and quality control procedures can be employed: range check, intrarecord check, and final consistency check (Munoz 2003). Range and intrarecord checks should be undertaken during data entry. By building a proper data entry template, the operator is allowed to proceed to the next question if and only if the data for the current question fall within the allowable range of responses for each question. An intrarecord consistency check can be administered immediately after entry of each questionnaire. For example, family size reported by the household head should equal the number of family members listed in the family roster. A final scan for overall consistency should be conducted when all questionnaires have been entered. This final consistency check will ensure that values from one question are consistent with values from another question. In addition, it is helpful to conduct spot checks on the data entry operation, to double-enter 10% of the full survey, and to double-enter 100% of critical modules such as WTP elicitation response to ensure that there are no discrepancies between the hard copies and the electronic data set.

2. Descriptive Statistics

The household and community surveys combined with supplementary administrative data can add up to a big data set. While some variables are of independent interest, others must be combined to produce policy relevant statistics. In general, these data should be described at two levels. First, the analyst should compute descriptive statistics (e.g., mean, median, standard deviations, and range) to understand and describe all of the variables in the data set. Examining the descriptive statistics will serve as an additional quality assurance and quality control measure because the analyst will be able to identify anomalies, outliers, and improbable values. If outliers are found, the analyst should check against the paper questionnaires by matching respondent identification numbers. If necessary, the enumerator who administered that particular questionnaire should be sent again to clarify and to confirm with the respondent.

It would be useful to identify subpopulations of policy interest for further estimation of

descriptive statistics. Typically, these are identified by: (i) WSS user type (e.g., private water connection or public tap); (ii) socioeconomic group (e.g., households in different consumption quintiles); and (iii) physical subregions of the study area (e.g., administrative units). In most cases, the analyst may be particularly interested in the subpopulation of households living in poverty, for which the definition of poverty is critical. Data on household consumption expenditures can be validated against income, wealth and assets, caloric intakes, demographics, and housing quality to generate a statistically robust and economically meaningful poverty indicator. The set of variables one has to use in characterizing will also vary with the study site and specific objectives of a study. (See Appendix F for selected variables summarizing socioeconomic profiles of the sample households by income quintile.)

Cross-tabulations by socioeconomic, geographic, and current use status should be calculated for all important variables including demand for WSS improvements, water quality perceptions, and consumption. This process will provide descriptive statistics on subpopulations of interest such as the poor, the unconnected, and the marginalized zones of the study area. The descriptive statistics will provide a profile of the socioeconomic characteristics of the typical households as well as a typical household belonging to a subgroup, such as poor unconnected households. These cross-tabulations are more than simple descriptions. They offer preliminary evidence on underlying relationships between socioeconomic conditions and types of service needs (Deaton 1997). The story presented by the descriptive statistics should tally with the initial informal characterization of the existing WSS service. Percentage distributions of income and water sources should show similar patterns of distribution with the study population. Cross-tabulations of key selected variables should generally indicate (positive or negative) correlations based on the norm (e.g., the higher the income level, the higher the number of assets owned). A serious disconnect between the initial understanding and the description provided by the data indicates some errors, perhaps during the data entry process. If cross-tabulation of WTP values (or referendum vote) with key variables (to be correlated with WTP values) are generally coherent with hypothesized patterns, and tally to a reasonable extent with initial characterization, the analyst could move forward to the next step: estimation of WTP and policy simulations.

V. WILLINGNESS TO PAY, DEMAND ANALYSIS, AND POLICY SIMULATIONS

Once data quality is assured through the examination of descriptive statistics, the analyst then proceeds to: (i) undertake validity tests and estimate mean WTP using econometric models; (ii) assess effective demand for WSS; and (iii) carry out policy simulation as demanded by the specific context of the CV study. Multivariate regression can be used to: (i) test hypotheses based on the statistical significance of the estimated coefficients to examine validity of WTP data; (ii) estimate mean WTP for the entire sample and interested subgroups; (iii) predict rate of acceptance (uptake rate) of the improved services under different policy scenarios; and (iv) generate a function for predictions to other sites. These types of analyses can help answer some of the policy questions arising in designing tariff and subsidy for a WSS project.

A. Validity Tests and Estimation of Mean WTP

As the first step in developing a regression model, the analyst should select a set of independent variables to specify the model. There are many relevant empirical studies analyzing WTP values through multivariate regression models. Depending on the elicitation technique, the selection of regression models has been extensively studied. In particular, if yes/no binary data were collected through the referendum vote technique, probit or logit models need to be used to estimate WTP. Associated independent variables to explain WTP are reported in many papers, such as Altaf et al. (1993), Cameron (1988), Haneman (1984), Mu et al. (1990), Choe et al. (1996), Gunatilake et al. (2006), Lauria et al. (1999), and Whittington et al. (2002). However, construction of an analytical regression model (and thus selecting independent variables) should be based on economic theory and on the analyst's hypothesis on the relationship between WTP and household socioeconomic characteristics, water consumption patterns, and preferences. Following are the potential variables that can serve as independent variables, though the list is not exhaustive:

(i) bids (monthly bills)

(ii) design features in the CV scenario such as one-time connection fee for those who are not currently connected, service provision by public or private sector, dummy variables for poor and nonpoor, geographic area, etc.

(iii) water source characteristics such as number of water sources accessed and used, price of water from the traditional water source(s), distance (or time) of the household to the traditional water source(s), and household perception of the quality of water from the traditional water source(s)

(iv) household characteristics such as household income or wealth, education of household members, health history of household members, occupation of household head, family size, ethnicity, religion, sex of respondent, age of respondent, etc.

(v) any other location-specific variable that could potentially have an impact on WTP for the WSS

Once the multivariate regression is estimated incorporating the abovestated set of variables, the analyst can undertake the validity tests. Validity tests examine whether an instrument actually measures what it is designed to measure, while reliability tests focus on the precision of the measurement. If the explanatory variables show statistical significance in the hypothesized relationship with the dependent variable, then the WTP values from the CV survey can be considered as valid. More specifically, the following relationships are hypothesized generally, and checked to test validity of responses to the elicitation question:

(i) positive and significant coefficient for income (positive income elasticity)

(ii) negative and significant coefficient for the bid and connection charges (negative price elasticity)

(iii) positive and significant coefficient for the monthly per capita consumption

(iv) positive and significant coefficients for coping costs, education level, and water-related disease incidents

(v) negative and significant coefficient for availability of substitute sources such as wells.

In addition to the above commonly used variables, the analyst can use a number of other variables for validity tests specific to the context. For example, a Sri Lankan study (Pattanayak et al. 2004) used institutional provision (public, private, and community provision) as an independent variable based on the findings of the focus group discussion, and found that private provision negatively affects the acceptance of the improved service. On the other hand, a similar study in Nepal (Pattanayak et al. 2001) hypothesized the opposite direction, and found that private sector involvement increased WTP values, as the Nepalese might have less confidence in government-run water services system. If these tests —more importantly, price- and income-related tests—provide expected results with statistical significance, it shows that the respondents have understood the CV scenarios, and that they have answered the questions truthfully. Therefore, the researcher has estimated what he had intended to estimate. In ADB's PPTA studies, only three projects performed regression analysis to test the validity of the CV scenario. Undertaking validity tests before using the WTP values for policy analysis and/or project economic analysis provides vital opportunities for further improvement in CV studies.

Once the validity tests show that CV data are accurate, the analyst can proceed to estimate mean WTP. Appendix G[30] shows a step-by-step procedure to estimate mean WTP using a Probit regression model. Mean WTP can be estimated for the entire sample as well as for subsamples of policy interest. Table 2 shows the mean WTP estimated for different subsamples. The estimated mean WTP can be directly used in cost–benefit analysis as the gross benefit of the WSS improvement.

Table 2
Summary of WTP Estimates by Group of Interest

Connection Status	Poor Households[a]	All Households
Connected	830	1030
Unconnected		
Shared connection (S)	260	230
Private connection (Pr)	420	840

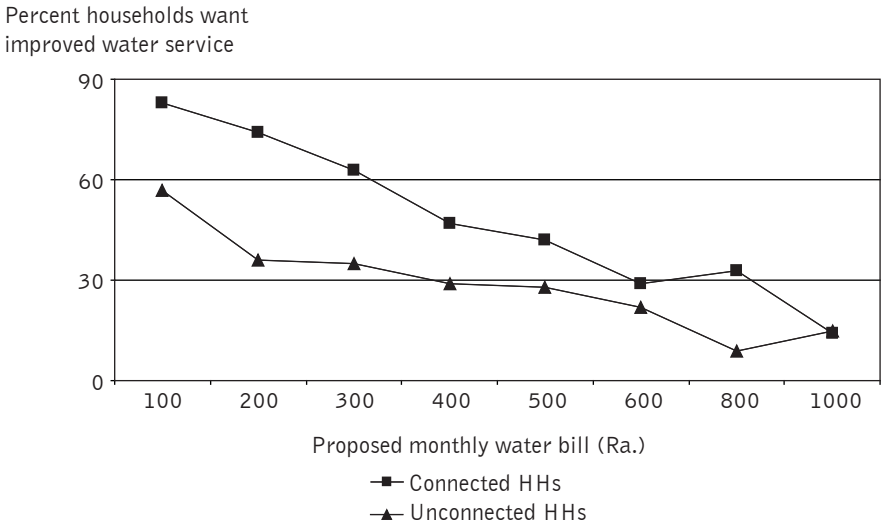
[a]A household is defined as poor if the household monthly income is less than or equal to 5500 Nepalese rupees.
Note: All numbers are reported in 2001 Nepalese rupees.
Source: Pattanayak et al. (2001).

30 Appendix G also explains how to obtain a confidence interval for the WTP and how to use bootstrapping methods to undertake quantitative risk analysis on economic internal rate of return values of the project.

B. Effective Demand

WSS services are generally provided by the public sector. However, public sector goods/services provision is generally decided through political processes rather than as a response to market signals. Politically driven supply of public services frequently shows the characteristic of decoupling of burdens and benefit.[31] Frequently, single-source production (natural monopoly) prevents competition. Moreover, lack of an exit mechanism, as in the case of market-driven economic activities, results in continuation of the provision despite poor performance. These characteristics together make WSS projects prone to huge inefficiencies. Therefore, investigating the effective demand for WSS services is of paramount importance before launching a WSS project.[32] Despite this importance and the recurring finding in retrospective reviews, demand analysis in WSS projects remains weak and needs improvement.[33] This section shows how the CV results can be used to demonstrate the existence of effective demand for WSS service.

Figure 1
Household Demand for Improved Water Service in Sri Lanka



Source: Pattanayak et al. (2004)

If a PPTA project has undertaken a good CV study, establishing the effective demand for improved services is relatively easy. A properly designed and administered WTP study is a good source of information for demand analysis of proposed WSS services. Demand generally shows the relationship between the marginal WTP (price) for different quantities of a good. A similar

31 When users do not pay directly for public services, the cost of provision is borne by taxpayers. Because not everybody may pay taxes in developing countries, beneficiaries may be a different category of people. This leads to decoupling.

32 In highlighting the importance of demand analysis for a project, ADB's Operations Manual (Section G1/OP) states that "A project that does not meet consumer's or user's demand for particular goods or services will not generate benefits and will result in inefficient investment."

33 Successive economic analysis retrospective studies (ADB 2003, 2004, and 2006) found that demand analysis of ADB projects is weak.

relationship as shown in Figure 1 can be directly obtained from the responses to the elicitation question.[34] The information contained in Figure 1 is capable of answering questions related to the demand for the WSS service: Are the beneficiaries willing to pay for access to improved service (effective demand)? How will demand be affected by changes in price? How will demand be affected by income of consumers? Have the changes in price, income, and other variables been properly accounted for in predicting the demand for project output? As shown in Figure 1, the price–quantity relationship can be directly obtained from WTP data. The graph can be a good proxy to understand "what is the effective demand for the CV commodity given price at Rs. 200 per month?" For example, if the monthly water bill is Rs. 200, about one third of those households currently without individual tap will be connected. If the water bill goes up to Rs. 400, then almost 30% of households without individual tap would be connected. With such a simple figure, the analyst can further examine how different tariff settings would affect the cost recovery of investment on newly proposed services as deliberated in the CV market scenario. This could also be a useful tool to predict effective demand on the proposed WSS services with varying price schemes.

In order to understand the impact of income on effective demand, the estimated WTP function can be simulated as shown in Appendix G using different income levels. Sometimes, a proxy for income is incorporated in the regression models when accurate income data is difficult to obtain. For example, the Sri Lankan study uses poverty as a proxy in the regression equation. The number of assets the household currently possesses and the household monthly expenditure can also be used as proxies. When reasonable data about future income or any change in related variables are available, these data can be used to predict future demand for improved services.

Household characteristics of the subpopulation of interest and attributes of a WSS service (reliability, charges, quality, etc.) can be used to predict acceptance of improved services by the respondents. A sample connection simulation exercise is available in Appendix G. This prediction exercise could be repeated for alternative scenarios to generate a series of probability maps of coverage under service alternatives (Pattanayak et al. 2006). Such simulations will help the analyst predict the service coverage and output of the WSS plant with reasonable accuracy under the most probable future scenarios. This information can then be fed back to engineering designs to avoid undercapacity/excess capacity issues in designing water supply plants. Table 3 shows predicted rates of acceptance (uptake rates) for different groups from the Sri Lankan study. The predicted uptake rates with the most plausible policy scenario answer the effective demand question directly and provide additional information on financial sustainability, and overall viability of the WSS project.

[34] Note that the y axis here represents the percentage of households accepting a bid, and is therefore slightly different from the usual quantity. However the percentage of households accepting the bid is a very good proxy for the quantity. If every household consumes the same quantity of water, the curves in the graph become true demand curves.

Table 3
Predicted Uptake Rates of Improved WSS for Different Groups[1]

Service Area	Uptake Rates (percent)	
	Poor	Nonpoor
Greater Negamboo		
Connected	49	64
Unconnected	32	47
Kalutara-Galle		
Connected	44	59
Unconnected	27	42

[1] The predicted rates are for unconnected households with a one-time connection charge of Rs. 7500.
Source: Pattanayak and Yang (2006a).

C. Policy Simulations

Different types of policy simulations can be undertaken in a CV study depending on the objectives. Gunatilake et al. (2006) and van den Berg et al. (2006) show the use of the findings of some policy simulations to make informed decisions about WSS projects. In this paper, the use of predictions based on water consumption regressions combined with administrative data on tariff structure and cost of water supply to compute the amount of water sector subsidy to households is demonstrated. Appendix G.3 provides step-by-step instructions for this exercise. Note that the simulation was undertaken to study four different scenarios: (i) marginal modification to existing tariff, (ii) tariff for full cost recovery, (iii) full cost recovery with 100% metering, and (iv) service network expansion (see Pattanayak and Yang 2002 for details). These four scenarios were evaluated under four alternatives: uniform tariff, modified tariff, geographic targeting, and individual targeting. The combination of scenarios and alternatives generates a large number of different outcomes. Table 4 shows the subsidy incidence under full cost recovery with 100% metering, together with individual targeting. The distributional incidence of these subsidies can be summarized by estimating quasi-gini coefficients and errors of inclusion and exclusion parameters. Table 5 presents the summary results of the simulations for the population clusters, which have over 50% of poor households. These types of simulations can be very useful in designing pro-poor WSS service delivery.

Table 4
Subsidy Incidence by Income Deciles in Kathmandu, Nepal

Decile	Income	Number of Households	Number of New Connections	Percent of Total Subsidies	Subsidies as Percent of Income
1	< 4,500	166	99	19	7
2	4,501–6,000	197	109	21	4
3	6,001–7,000	127	60	12	3
4	7,001–8,500	115	45	9	2
5	8,501–10,000	172	46	9	1
6	10,001–12,000	137	42	8	1
7	12,001–15,000	154	36	7	1
8	15,001–20,000	150	34	7	1
9	20,001–30,000	143	21	4	0
10	> 30,001	139	26	5	0
	Population	1,500	518	100	1

Source: Pattanayak and Yang (2002).

Table 5
Comparison of Alternative Subsidy Schemes in Kathmandu, Nepal[a]

Policy Alternative	Number of Households Receiving Subsidies	Quasi-Gini	Poor Receiving Subsidy (%)	Error of Exclusion (%)	Error of Inclusion (%)	Total Revenue (NPR)
Uniform tariff	330	0.429	12	89	81	642,699
Modified tariff	625	0.288	19	75	76	537,465
Geographic targeting	557	0.167	29	77	75	577,913
Individual targeting	514	0.043	36	73	68	499,796

[a] This set of simulations considers charging households the full cost of water unless they are targeted for subsidies.
Source: Pattanayak and Yang (2002).

VI. CONCLUDING REMARKS

CV studies are widely used in designing WSS projects. The application of the CV method in developing countries is a cause for concern because poorly designed and administered CV studies produce unreliable WTP estimates. Unreliable CV results are largely due to poor study design, poor survey implementation, and failure to undertake a variety of tests to examine the validity of responses to the different CV scenarios. The CV method has undergone significant improvements during the last 20 years. The advances in econometric analysis, survey research methods, sampling and experimental design, and policy simulations in the last two decades have been remarkable. The purpose of this paper is to motivate practitioners of CV studies to use these improved methods to obtain reliable WTP estimates. The paper recommends a number of good practices that can be applied in design, survey implementation, and data management and analysis stages of a CV study. Table 6 provides a checklist that a CV study team and ADB's mission leaders can use in examining whether a CV study has applied state-of-the-art methodology to estimate WTP. If answers to the questions in the table are satisfactory, the CV study findings may be used for policy purposes.

Table 6
Quality Checklist for Mission Leaders

Attributes/Procedures	Relevant Questions
1. Design Issues	
1.1 Precharacterization of WSS	1.1 Has the study team undertaken adequate precharacterization activities?
1.2 CV scenario	1.2 Does the study use a realistic CV scenario?
1.3 Commodity definition	1.3 Does the commodity definition provide a complete and precise account of improved WSS?
1.4 Elicitation method	1.4 Does the study use referendum elicitation format?
1.5 Bid distribution	1.5 Does the study use reasonable bids with adequate range to understand demand?
1.6 Sample	1.6a Is the sample size adequate? 1.6b Is the sampling frame and method reasonable? 1.6c Has the study team strictly implemented the sampling strategy? 1.6d Was there a replacement method?
2. Survey Instrument	
2.1 Focus Group Discussions	2.1 Has the team undertaken enough focus group discussions and have they been used to refine the instrument?
2.2 Pretesting	2.2 Has the team undertaken enough pretests and have the findings been used to refine the instrument?
2.3 Quality of Survey Instrument	2.3 Is the overall quality of survey instrument satisfactory?
3. Potential Biases	3. Has the team considered bias-minimizing measures in designing and conducting the study?
4. Survey Implementation	
4.1 Enumerator Training	4.1 Have the enumerators been given adequate training emphasizing the accuracy of the data and minimizing biases?
4.2 Field Supervision	4.2 Has there been adequate effort to ensure quality of data through supervision of field work?
5. Data Management	
5.1 Quality Checks	5.1 Have adequate quality checks been incorporated while entering data?
5.2 Preliminary Analysis	5.2 Do the descriptive statistics tally with the secondary administrative data?
6. Validity Tests	6.1 Has a validity test been undertaken? Do results confirm positive income elasticity, negative price elasticity, and other theoretical expectations?
7. Estimation of Mean WTP	7.1 Has appropriate econometric modeling been undertaken to estimate mean WTP? 7.2 Does the estimated value fall within similar previous estimates?
8. Demand Analysis	8. Does the analysis demonstrate that there is effective demand for proposed improved WSS services?
9. Reporting	9. Does the CV study report contain adequate information to answer the above questions?

APPENDIX A
DETERMINING MINIMUM NUMBER OF SAMPLE SIZE BASED ON POPULATION SIZE

	Sample Size	
	Continuous Data (margin of error=.03)	Categorical Data (margin of error=.05)
Population Size	α=.05, t=1.96	p=.50, t=1.96
1,000	106	278
1,500	110	306
2,000	112	323
4,000	119	351
6,000	119	362
8,000	119	367
10,000	119	370

α refers to significance level and t refers to critical t value at the 0.05 level of significance.
Note: The table shows the minimum sample size to ensure good statistical properties given the size of the population and acceptable margin of errors. In a CV study, many categorical data variables can be used. The Probit model itself uses a categorical data variable as dependent variable. As explained in the text, a larger sample size may be needed when split sample tests, range of bids, and various other design features demand large subsamples.
Source: Bartlett et al. (2001).

APPENDIX B
SAMPLE CV MARKET SCENARIO AND ELICITATION QUESTIONS[1]

As you know, the piped water supply system in your area has some problems. Many households do not have private water connections. A large proportion of the water that could be supplied to people in your area is lost before it reaches people's homes because the water pipes are old, many leak badly, and require frequent repairs. In many places, the pressure in the water distribution network is often low. Many people spend time and money in bringing water from outside and/or invest in wells (hand pumps, tube wells, and dug wells) for storage in their homes. Low pressure can cause groundwater to leak into the pipes, which, combined with inadequate wastewater collection, can contaminate the piped water supply, causing health risks. Sometimes, meters do not function properly, and households with essentially the same water service may receive quite different water bills. Some people in your area incur the expense of boiling and treating their water before they drink it. Unless something is done, the water supply situation in your area is likely to get worse. This is because the population is increasing, and the physical condition of the water system continues to deteriorate. It is possible to improve the water supply condition in your area through public sector reforms, private sector participation, or small scale community initiatives.

Suppose that this new provider is successful in (i) stopping leakage from the system, (ii) providing efficient repair and customer support service, (iii) maintaining and installing new meters so that bills are fair, and (iv) generally improving the overall performance of the system. However, any improvement to the water supply system will cost money and the provider would expect to be paid for the investment it put into the system, presumably through higher monthly bills. I want you to suppose that it was possible for the improved system to provide customers a level of service with the following features: *(Enumerator: Show respondent Card)*

(1) 24-hour service with good pressure; 7 days a week

(2) Prompt repair and efficient customer service

(3) Water that is safe to drink from the tap

(4) Meters that would function accurately and be read properly

Q.a. Now, I want to ask you a series of questions about how much such improved water service would be worth to you. Let me start by determining whether you have a connection in your house or yard for the exclusive use of your household members.

(1) Yes, I have such a connection. (GO TO A.1.1)

(2) No, I do not have such a connection.

(Enumerator: This category includes public taps, tubewells, borewells, purchase from vendors and tankers, etc.)

Q.b. What is the main reason for your not having connected to the network?

(1) Cost of connection is too high

(2) Monthly bill is too high

1 The examples shown in this Appendix are from the authors' Sri Lankan and Kathmandu studies. The conversational style of presentation has been preserved. The questionnaires used in these studies are too long to be presented in the paper, therefore, only selected, important sections are presented. Full questionnaires are available from the authors upon request.

(3) My application is still pending

(4) My house is too far from the network

(5) I am satisfied with my current water sources

(6) Other (please specify): _____

(GO TO A.1.2)

A.1.1 Households with Connection

One can consider several improvements to the water supply service. Suppose all households receive 24-hour service, water that is safe to drink from the tap, accurate billing of the water they receive, reliable and responsive customer support. But people would have to pay higher water bills. Suppose a private water company provides this service. Such a company will have different investment options, operational autonomy, flexibility in pricing to recover costs, and oversight from a regulatory authority (e.g., to check overcharging). It would expect to raise revenues to cover the cost of improvements. Some people say they would stay connected to the improved water supply system because they really want the improved service and they can afford the higher water bill. Other people say they would disconnect because they are not really bothered very much by low water pressure, and they cannot afford the higher water bill. There are no right-or-wrong answers. We really want to know what you think.

Q.1. Now, I want you to assume that the improved water service would entitle a typical household like yours to about 500 liters per day. This would cost your household (100/200/300/400/500/600/800/1000) Rupees per month. What do you think your household would do? *(Enumerator: Read choices 1 and 2, not the third)*

(1) Stay connected and pay the higher water bill

(2) Disconnect and find water elsewhere

(9) Don't know (END OF THE SURVEY)

Q.2. How sure are you of your decision?

(1) Totally sure

(2) Somewhat sure

(3) Equally sure or unsure

(4) Somewhat unsure

(5) Totally unsure

(Enumerator: For those who chose to stay connected, GO TO QUESTION #3; for those who chose disconnected, GO TO QUESTION #4)

Q.3. Could you explain to me your main reasons for staying connected to the network? *(Enumerator: Allow them to answer on their own. If no answer, then prompt with the following)*

(1) I really want/need the improved water service

(2) The increased water bill is not too high

(3) I am worried about the health risks of the existing water service

(4) I like the idea of having a private company involved in managing the water supply system

(5) Other (please specify): _____

(9) Don't know/not sure

(END OF SURVEY)

Q.4. Could you explain to me your main reasons for disconnecting from the network?

(1) I do not really want/need the improved water service

(2) The increased water bill is too high; I cannot afford it

(3) I am not worried about the health risks of the existing water service

(4) I do not want a private company involved in water supply system

(5) Other (please specify): _____

(9) Don't know/not sure

Q.5. If you disconnected from the water system, where do you think your household would obtain your water supplies?

(1) Public taps

(2) Private well

(3) Neighbors

(4) Community schemes

(5) Vendors and tankers

(6) Other (please specify): _____

(9) Don't know/not sure

A.1.2 Households without Connection

One can consider several improvements to the water supply service. Suppose all households receive 24-hour service, water that was safe to drink from the tap, accurate billing of the water they received, reliable and responsive customer support. But people would have to pay higher water bills. Suppose a private water company provides this service. Such a company will have different investment options, operational autonomy, flexibility in pricing to recover costs, and oversight from a regulatory authority (e.g., to check overcharging). It would expect to raise revenues to cover the cost of improvements. Some people say they would stay connected to the improved water supply system because they really want the improved service and they can afford the higher water bill. Other people say they would disconnect because they are not really bothered very much by low water pressure, and they cannot afford the higher water bill. There are no right-or-wrong answers. We really want to know what you think.

Q.1. Now, I want you to assume that the improved water service would entitle a typical household like yours to about 500 liters per day. This would cost your household (100/200/300/400/500/600/800/1000) Rupees per month and one time connection charges of SLR (6000/8000/10000/12000). What do you think your household would do? *(Enumerator: Read choices 1 and 2, not the third)*

(1) Get a private connection

(2) Continue as is

(9) Don't know (END OF SURVEY)

Q.2. How sure are you of your decision?

(1) Totally sure

(2) Somewhat sure

(3) Equally sure or unsure

(4) Somewhat unsure

(5) Totally unsure

(Enumerator: For those who chose "stay connected," GO TO QUESTION #3; for those who chose "disconnected," GO TO QUESTION #4)

Q.3. Could you explain to me your main reasons for connecting to the network?

(Enumerator: Allow them to answer on their own. If no answer, then prompt with the following)

(1) I really want/need the improved water service

(2) The increased water bill is not too high

(3) I am worried about the health risks of the existing water service

(4) I like the idea of having a private company involved in managing the water supply system

(5) Other (please specify): _____

(9) Don't know/not sure

(END OF SURVEY)

Q.4. Could you explain to me your main reasons for not connecting to the network?

(1) I do not really want/need the improved water service

(2) The increased water bill is too high; I cannot afford it

(3) I am not worried about the health risks of the existing water service

(4) I do not want a private company involved in water supply system

(5) Other (please specify): _____

(9) Don't know/not sure

Q.5. Would you change your mind and connect to the network if it was possible to modify this plan and allow you to pay off the connection charge in monthly installments collected along with your monthly bill for consumption?

(1) Yes

(2) No

Q.6. If you did not connect to the water network, where do you think your household would obtain your water supplies?

(1) Public taps

(2) Private well

(3) Neighbors

(4) Community schemes

(5) Bowsers, vendors and tankers

(6) Other (please specify): _____

(9) Don't know/not sure

APPENDIX C
SUMMARY OF STRENGTHS AND WEAKNESSES OF DIFFERENT CV ELICITATION METHODS

Elicitation Method	Major Strengths	Major Specific Weaknesses	Generic Weaknesses
Open-ended WTP method	No starting point bias. May directly measure exactly what researcher wants to know. A good check when used in conjunction with other methods.	High information complexity leads to unrealistic responses in hypothetical situations.	Applicable to most survey methods: sample selection bias; nonresponse bias; outliers; unintended interviewer bias. Applicable especially to CV methods: hypotheticality bias; payment vehicle; noncommitment bias; order bias; embedding bias; strategic bias.
Closed-ended iterative bidding method	Bidding provides "thinking time" to elicit maximum WTP, as desired.	Sensitive to starting value. "Bidding frenzy" may lead to some very high valuations.	
Contingent ranking method	Ordinal ranking requires low information complexity. Links quantities to prices, reducing hypothetically.	Ordinal responses cannot be aggregated. Requires analyst to have statistical skills. Anchoring bias and highly dependent on the specified alternatives. Requires fairly large sample sizes.	
Dichotomous-choice method	"Take it or leave it" choices reduce hypotheticality and approximate the market. Small strategic bias; very small starting point bias.	Less information per respondent, so large samples are needed. Requires analyst to have statistical skills.	
Payment card with comparative tax-prices	Encourages realistic assessment of WTP, thus reducing hypotheticality and noncommitment bias.	Moderate to high information complexity. May be too sensitive to particular comparisons. Anchoring bias, often requiring personal interviews.	
Payment card with a range of prices for the good	Moderately low complexity. Low interview bias.	Anchoring bias, often requiring personal interviews.	

Source: Boardman et al. (1996).

APPENDIX D
MEASURES TO REDUCE BIASES

In general, CV surveys are subject to various biases, like any other surveys. Much of the early experiment literature focused on testing for and identifying biases such as item nonresponse, non-neutrality, compliance bias, noncommitment bias, starting point bias, etc. (Smith 2006). In the last 25 years of methodology development, these have not not been deemed to be unique to CV surveys per se. As Griffin et al. (1995) contend, the CV method may be particularly prone to hypothetical bias, strategic bias, and compliance bias. These biases are addressed throughout the preparatory tasks, sample selection, survey question design, enumerator training, and econometric analysis discussed in this paper. Appendix Table D.1 below provides a summary of the biases and potential measures to reduce them. See Gunatilake et al. (2006) for more discussion on the biases. Readers are requested to use the information in this table with caution because the risks of biases can vary from one study site to another, and are only indicative. Minimizing biases should be at the back of the mind of the analyst throughout the design, implementation, and analysis of the CV study. However, this table may be referred to as a checklist to guide a researcher before undertaking field work, and to ensure that necessary steps have been taken to minimize biases. ADB's PPTA studies do not explicitly report or may have omitted discussions on potential biases. Concerted effort to reduce bias, as well as careful reporting to add credibility are required to improve ADB WTP studies.

Appendix Table D.1
Potential Biases in WSS CV Studies and Measures to Minimize Them

Bias	Risks in WSS Studies	Measures for Minimizing Bias
Sampling bias: Sample may exclude particular subgroup from the population	Medium	Strict implementation of sampling strategy, proper replacement strategy, large sample, split sample analysis. If there is a systematic pattern of nonresponse, some analysis on the excluded subcategory may be required.
Non-neutrality: Researchers influence the choice. Respondents attempt to please.	High	Enumerator training on neutrality, questionnaire pretesting, focus group discussions, and supervision during survey implementation. See Whittington (1998 and 2002) on training urban enumerators who may look down and or coach their respondents who are already inclined to give an answer that pleases the enumerator.
Hypothetical: Respondents provide hypothetical answer to value a commodity offered in the future	Medium	Formative research (focus groups, key informant) discussion to understand the context and the commodity. Proper CV scenario design, appropriate and credible payment vehicle, debriefing questions, CV scenario with minimum uncertainty of the provision of the commodity.
Starting point: Respondents anchor to the initial values given to them.	High	Proper elicitation question, proper bids with adequate range. Closed-ended questions may have very small starting point bias. Iterative bidding method is especially prone to this bias.
Strategic behavior: Respondent purposely eliciting choices with the objective of future free-riding	Medium	Proper elicitation question, proper debriefing questions, removal of the questionnaire if there is clear evidence of strategic answers. Closed-ended format reduces the strategic bias. Enumerator training to pay attention to strategic bias during the interviews.
Nonresponse: Respondent refuses to answer the question	Medium to high	Preparatory work on phrasing and content should reduce this response. Refusal should be probed with follow-up questions to gauge "protest" intentions. Informed consent is necessary before starting surveys. Well-mannered and neutral enumerators can minimize this risk.
Embedding effect: WTP does not vary with the quantity of the good	Low	May not be serious in WSS CV studies. Common in valuation of public goods such as biodiversity in which quantification is difficult. Quantity (or service quality) can be incorporated to check whether WTP is sensitive to the quantity consumed. Conjoint analysis can also help in identifying this bias.

Source: Compiled by the authors.

APPENDIX E
RULES OF GOOD INTERVIEW PRACTICE: DOS AND DON'TS FOR ENUMERATORS

Rule	Advice	Comment
1	Read every question exactly as written in the questionnaire. - Do not improvise.	Research on the art of asking questions shows that the precise wording of questions may significantly affect a respondent's answers. If each enumerator develops her own way of asking questions, one can never be sure that the same question is being asked. Ensure that each respondent is answering the same question. Reading the question exactly also makes the interview shorter.
2	Read the question slowly enough so that the respondent can understand.	An enumerator has seen each question hundreds of times before. It is natural for the enumerator to want to go quickly over a question that he knows so well, but it is the first time for the respondent. The enumerator thus needs to speak slowly.
3	Wait for the respondent to answer.	Some enumerators will read the question once, then look up and repeat the question, and sometimes even start a lengthy explanation, before letting the respondent answer. Ask once very clearly, and let the respondent think.
4	If the respondent cannot answer, repeat the question.	The respondent may not have been paying attention the first time. If, after the second reading the respondent still cannot answer, go to the next question.
5	Remain absolutely neutral about the respondent's answers.	Never express surprise, approval, disapproval, judgment, or doubt about a response. Do not let your facial expression change. Just record the answer. For example, if a respondent says that they would be willing to pay a very large amount for a good or service, the enumerator should not say, "wow!" If a respondent gives an answer that is factually wrong, the enumerator should not reveal that he knows the answer is incorrect.
6	Do not act embarrassed about a respondent's answers to sensitive questions.	This will increase the embarrassment of the respondent, not reduce it. Be very matter of fact.
7	Never suggest an answer unless the instructions say to read the answers to the respondent.	For example, if the respondent is having difficulty estimating what he will pay for a good or service, do not prompt him with suggestions like..."would you pay more than US$xx? Less than zz?"
8	Do not repeat the respondent's answers.	This is repetitive and wastes time.
9	Conduct the interview in private.	This means that the interview should not be within earshot of other people in the household. If someone does not want to leave, the enumerator should offer to interview him or her separately. If they still would not leave, then the enumerator should explain to the respondent that he will have to return later.
10	Do not give advice to respondents on personal matters.	Enumerators should refer respondents to the appropriate authorities for answers to questions that may arise that are outside the scope of the interview.

Rule	Advice	Comment
11	Answer directly any questions the respondent may have about the purpose of the survey.	Respondents are entitled to know the purpose of the survey and how they have been selected to be interviewed. The enumerator should not be reluctant to take time to provide clear, detailed answers to such questions.
12	Listen carefully to the respondent's answer.	It is very off-putting to the respondent if the enumerator is inattentive. Moreover, the respondent may be offering an answer that is in fact different than it first appears to be. In such cases the enumerator needs to be listening carefully to hear what is actually being said.

Source: Whittington (2002b).

APPENDIX F
SELECTED DEMOGRAPHIC AND SOCIOECONOMIC VARIABLES OF SAMPLE HOUSEHOLDS (SRI LANKA)

Demographics and Socioeconomics	First Quintile (n=365)	Fifth Quintile (n=362)	Overall (n=1818)
Family size	5.8	3.7	4.8
Sinhalese (percent)	85	91	89
Buddhist (percent)	65	56	62
Household head's education attainment (years)	8	10	10
Housing conditions			
Single family and single storey (percent)	79	90	86
Multi family and single storey (percent)	18	2	10
Monthly consumption (Rs.)	11,883	32,308	21,615
Monthly per capita consumption (Rs.)	2,614	10,310	5,294
Living on less than US$-1-a-day (percent)	67	0	13
Distance to infrastructure			
Piped water network (kilometers)	0.25	0.1	0.2
Main road (kilometers)	0.2	0.1	0.1
Total water consumption (m3)	19	27	22
Have private tap (percent)	28	43	38
Have private well (percent)	59	69	66
Use water-sealed toilet (percent)	90	99	96
Use pit latrine (percent)	3	0	1
Use neighbor's toilet (percent)	6	0	3

Source: Pattanayak et al. (2004).

APPENDIX G
STEP-BY-STEP PROCEDURE FOR MEAN WTP ESTIMATION AND EXAMPLE OF POLICY SIMULATIONS

Estimation of Mean WTP

Step 1: Run a simple Probit regression in any statistical software of your choice (e.g., SPSS, SAS, STATA, LIMDEP, etc.). The sample results below are generated using STATA and fabricated for illustration purposes only.

Command:

probit wat_cv bid confee

Results:

Iteration 0: log likelihood = -1136.7511

Iteration 1: log likelihood = -1005.9242

Iteration 2: log likelihood = -1003.814

Iteration 3: log likelihood = -1003.812

Probit regression: Number of obs = 1735

LR chi2(2) = 265.88

Prob > chi2 = 0.0000

Log likelihood = -1003.812 Pseudo R2 = 0.1169

wat_cv	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]
bid	-.0015376	.0001229	-12.51	0.000	-.0017785 -.0012967
confee	-.0000555	7.04e-06	-7.88	0.000	-.0000693 -.0000417
cons	.6576825	.0714707	9.20	0.000	.5176026 - .7977625

where

wat_cv = household responses to the CV question:

1 = households want the improved service

0 = households do not want the improved service

bid = proposed monthly consumption charge (Rs.)

confee = proposed one-time connection fee (Rs.)

cons = regression constant

Step 2: To calculate the mean WTP, divide the coefficient on _CONS (i.e., 0.6576825) by the coefficient on BID (i.e., -0.0015376) and multiply by –1. You should get a value of about Rs.428, which is the mean WTP for the overall sample.

Step 3: To calculate the confidence interval around the WTP estimate, use the confidence interval of the coefficient of constant and the bid variable. Following the same method described above, the mean WTP values of 291.03 and 615.22 can be obtained.

Step 4: Look for a command that relates to bootstrap sampling and estimation in the statistical software. Once the command is found, set it up to repeat Steps 1 and 2 by resampling households with replacement for 100 times. Save the statistics produced. After this is done, there should be 100 mean WTP estimates. Sort these in ascending order. These different mean WTP estimates may be used to undertake quantitative risk analysis on the EIRR.

Connection Prediction

Step 1: Generate summary statistics and run the Probit regression of interest in any statistical software of choice (e.g., SPSS, SAS, STATA, LIMDEP, etc.). The sample results below are generated using STATA and fabricated for illustration purposes only.

(a) summary statistics

```
. summarize wbid wconnfee private head_edu2 owner poor1 roaddist
```

Variable	Obs	Mean	Std. Dev.	Min	Max
wbid	1818	487.35	284.75	100	1000
wconnfee	1818	5533.55	4734.24	0	12000
private	1818	.55	.49	0	1
head_edu2	1818	8.94	3.06	0	20
owner	1818	.94	.24	0	1
poor	1818	.200	.400275	0	1
roaddist	1818	.32	.46	0	2.5

(b) regression results

```
. Probit wat_cv wbid wconnfee private head_edu2 owner poor1 roaddist

Iteration 0:   log likelihood = -1136.7511
Iteration 1:   log likelihood = -991.89478
Iteration 2:   log likelihood = -988.92451
Iteration 3:   log likelihood = -988.91978
Probit regression    Number of obs =        1735
   LR chi2(7) =    295.66
   Prob > chi2 =   0.0000

Log likelihood = -988.91978        Pseudo R2 = 0.1300
------------------------------------------------------------------------------
wat_cv     Coef.           Std. Err.       Z       P>|z|  [95% Conf. Interval]
-------------+----------------------------------------------------------------
wbid       -.001559        .000124        -12.57  0.000   -.001802 -      .001316
wconnfee   -.0000536       7.16e-06       -7.49   0.000   -.0000677-      .0000396
private    -.1290851       .0659277       -1.96   0.050    -.2583011 -    .0001308
head_edu2 .0227382         .0115323       1.97    0.049   .0001352 -      .0453412
owner      -.2866908       .1379495       -2.08   0.038   -.5570669 -     .0163148
poor       -.3165037       .0916355       -3.45   0.001   -.496106 -      .1369015
roaddist   .0494128        .072121        0.69    0.493   -.0919418 -     .1907674
_cons      .8342576        .193991        4.30    0.000   .4540421 -      1.214473
------------------------------------------------------------------------------
```

where,

wat_cv = household responses to the CV question:
- 1 = households want the improved service
- 0 = households do not want the improved service)

wbid = proposed monthly consumption charge (Rs.)

wconnfee = proposed one-time connection fee (Rs.)

private = private sector will provide improved service:
- 1 = yes;
- 0 = public sector will provide

head_edu2 = education of household head (years)

owner = household owns the house (1 = yes; 0 = no)

poor = household is poor (1 = yes; 0 = no)

roaddist = distance to main road (kilometers)

_cons = regression constant

Step 2: Input mean values of and coefficients on variables in the regression in an Excel worksheet as follows. Enter variable descriptions in the second column, mean values in the third, and regression coefficients in the fourth.

Appendix Table G.2.1
Variables for Predicting Connections

Item	Variable Description	Mean	Coefficient
1	Regression constant	1	0.834
2	Proposed monthly consumption charge (Rs.)	487	-0.002
3	Proposed one-time connection fee (Rs.)	5534	-0.00005
4	Private sector will provide improved service (1 = yes; 0 = public sector will provide)	0.55	-0.129
5	Education of household head (years)	8.94	0.023
6	Household owns the house (1 = yes; 0 = no)	0.94	-0.287
7	Household is poor (1 = yes; 0 = no)	0.20	-0.317
8	Distance to main road (kilometers)	0.32	0.049

Step 3: In the fifth column, enter the policy scenario to be evaluated and simulated. For example, predict what percent of the poor, unconnected households would have a household connection if the public sector provides the improved service, and connection fee for unconnected households is Rs.9000. In other words, key in 9000 for item #3, 0 for item #4, and 1 for item #7. For the rest, enter the same values shown in the third column.

Appendix Table G.2.2
Variable and Policy Scenario Values for Predicting Connections

Item	Variable Description	Mean	Coefficient	Policy Scenario
1	Regression constant	1	0.834	1
2	Proposed monthly consumption charge (Rs.)	487	–0.002	487
3	Proposed one-time connection fee (Rs.)	5534	–0.00005	9000
4	Private sector will provide improved service (1 = yes; 0 = public sector will provide)	0.55	–0.129	0
5	Education of household head (years)	8.94	0.023	8.94
6	Household owns the house (1 = yes; 0 = no)	0.94	–0.287	0.94
7	Household is poor (1 = yes; 0 = no)	0.20	–0.317	1
8	Distance to main road (kilometers)	0.32	0.049	0.32

Step 4: In the sixth column, simply multiply the values in columns four and five for each variable.

Appendix Table G.2.3
Variables and Policy Scenario Coefficients for Predicting Connections

Item	Variable Description	Mean	Coefficient	Policy Scenario	Coefficient * Policy Scenario
1	Regression constant	1	0.834	1	0.834
2	Proposed monthly consumption charge (Rs.)	487	–0.002	487	–0.759
3	Proposed one-time connection fee (Rs.)	5534	–0.00005	9000	–0.482
4	Private sector will provide improved service (1 = yes; 0 = public sector will provide)	0.55	–0.129	0	0.000
5	Education of household head (years)	8.94	0.023	8.94	0.203
6	Household owns the house (1 = yes; 0 = no)	0.94	–0.287	0.94	–0.269
7	Household is poor (1 = yes; 0 = no)	0.20	–0.317	1	–0.317
8	Distance to main road (kilometers)	0.32	0.049	0.32	0.016

Step 5: Sum up the values in the sixth column. A value of –0.774 should be obtained.

Step 6: Apply a function called "NORMSDIST" in Excel to the value obtained in Step 5.2 You should get a value of 22% which is the predicted connection rate for this particular policy scenario.

Subsidy Simulation

Step 1: Estimate a regression function for quantity of water consumed by households. Estimation of this equation provides a tool for different purposes. Here, this function is used to predict water consumption when the meters are not available or they are malfunctioning. The analyst can estimate water consumption of a household by substituting appropriate values of independent variables.[3]

$$Q = \beta_O + \beta_S * S + \beta_W * W + \beta_O * O\ \beta_D * D + \varepsilon_1$$

[2] The use of NORMSDIST in Excel is to obtain the predicted probability given a set of variable means and coefficients. The transformation is needed because (i) the Probit regression is a linear function of variables that produces the coefficients, not the change in probability; and (ii) probability is a nonlinear and S-shaped function. Basically, the sum of variable means (x) times coefficients (beta) from a probit regression is a linear combination/index (i.e., y = beta1 * x1 + beta2 * x2 + beta3 * x3 + etc.) that has to be put in probability terms in order to get uptake rates, and "normsdist" translates that linear combination into a probability/percentage term.

[3] See Pattanayak and Yang (2002) for an example of an OLS model for water consumption in the Kathmandu Valley of Nepal. They found that water consumption was positively correlated with income, family size, total number of water sources accessible, storage capacity, perception regarding regularity of network supply, and exclusive reliance on private water sources. This model was used to impute water consumption for households without water meters.

where Q is the total monthly consumption of water,

S is a vector of socioeconomic factors,

W is a vector of current WSS type,

O is a vector of opinions and attitudes,

D is a vector of demographic characteristics,

$\varepsilon 1$ is the regression error, and

βs are regression coefficients to be estimated.

Step 2: Collect supply-side information from the water utilities: average cost of water provision (C, Rupees/m2) and existing tariff structure.

Step 3: Input household level data from the survey into an Excel worksheet. Ensure that monthly water expenditure and monthly water consumption are available for each household.

Step 4: Calculate financial subsidies for each household using Equation G.1.

$$S_i = Q_i * C - UC_i \qquad [G.1]$$

where

S_i is the subsidy for the ith household,

Q_i is water consumption from the water utilities by the ith household,

UC_i the utility charge to each household i, and

c is the cost recovery tariff per unit of unpaid service.

If a household is not connected to the water network, it will receive zero subsidy. Note that Step 1 provides data on Qi for unmetered households or households with malfunctioning meters.

Step 5: Calculate errors of exclusion and inclusion using Equations G.2 and G.3.

"Error of Exclusion" is defined as the following ratio:

$$\frac{\sum Number\ of\ Poor\ Households\ Not\ Subsidized}{\sum Total\ Number\ of\ Poor\ Households} \qquad [G.2]$$

"Error of Inclusion" is defined as the following ratio:

$$\frac{\sum Number\ of\ Non\text{-}Poor\ Households\ Receiving\ Subsidies}{\sum Total\ Number\ of\ Households\ Receiving\ Subsidies} \qquad [G.3]$$

Step 6: To simulate different policy scenarios, either manipulate the existing parameters (e.g., tariff structure) or create new parameters that are of interest (e.g., targeting poor communities or

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