ECO 499: Thesis Research

Valuation of the Benefits of Improving Drinking Water Quality for Households in Dhaka

November 2011

Submitted by:

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Program: Bachelor of Social Science (BSS) in Economics

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This thesis is submitted to the Department of Economics and Social Sciences (ESS) of BRAC University in partial fulfilment of the requirements for the degree of Bachelor of Social Science (BSS) in Economics.

Date of Submission: 15 November 2011

Submitted to:

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Acknowledgements

Firstly, I would like to thank my advisor Dr. A. M. Tanvir Hussain for useful suggestions and guidance which helped me accomplish this thesis. I am grateful to my teacher M. Jahangir Alam, ex-senior lecturer, ESS, BRAC University, for being a source of inspiration and motivation when I was having difficulty in choosing my research topic. I am indebted to Fahim Subhan Chowdhury, Sumaiya Rahman, Waris Al-Majid, Mahnaz Nazneen and Adnan M.S. Fakir for providing me with peer advice and suggestions for conducting my research. I would particularly like to express gratitude to Md. Mafijul Islam, who helped me in selecting appropriate econometric model for my study. I appreciate the time and energy devoted by all the interviewees, who participated in the survey and helped me gather relevant data for analysis.

Finally, I sincerely acknowledge the role of all lecturers, namely, Iftekharul Haque, Dr. Manjur Karim, Dr. Minhaj Mahmud, Dr. M. Alauddin, Haydori Akbar Ahmed, Takrima Sayeda and Dr. Shahidur Rahman, along with the ex-department head, Dr. Anwarul Haque, and the department head, Prof. Syed M. Hashemi, for believing in my potentials and encouraging me to work hard.

Valuation of the Benefits of Improving Drinking Water Quality for Households in Dhaka

Abstract

Consumption of contaminated drinking water brings about economic losses to households in Dhaka. Hence, this study attempts to appraise the social benefits of improving drinking water quality by estimating the monthly WTP for improved quality of drinking water using the contingent valuation method. Thirty households in Dhaka were surveyed, of which 70% were willing to pay for safe drinking water, and the mean monthly WTP was found to be BDT 4066.04. The study finds that disease averting behavior and exposure to information media have a positive effect on the WTP. Therefore, the paper emphasizes the importance of public campaigns using mass media to inform people about water quality, purification methods, hygiene and safe storage of drinking water, and encourage them to share such information with other household members in order to improve their perception of drinking water quality and influence coping behavior.

Contents

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1. Introduction

Water quality and quantity are being degraded globally due to reasons such as growth in population, rapid industrialization and urbanization, expansion of business activity, adverse climate change effects, and undue extraction of groundwater aquifers. According to the Global Water Supply and Sanitation Assessment 2000 Report (World Health Organization & UNICEF Joint Water Supply and Sanitation Collaborative Council, 2000), 1.1 billion people worldwide do not have access to improved water supply. Improving water supply and water quality can reduce incidence of diarrheal diseases by 25 per cent and 31 per cent respectively, while approximately 10 per cent of the global burden of disease could be prevented by improving drinking water, sanitation, hygiene and water resource management (Prüss-Üstün et al., 2008). The burden of disease can be up to 240 times higher in developing regions in comparison to developed regions (Prüss et al., 2002). Hence, improvement in the quality and quantity of drinking water in the developing world is a major public health policy concern.

Dhaka, capital city of the developing country Bangladesh, faces enormous challenges in meeting the public demand for safe water. The mega city has had an annual population growth rate of 4.9% during 1995-2000 and accounts for about 38.9% of the total urban population (Talukdar, 2006). Currently, the water supply coverage by the Dhaka Water Supply and Sewerage Authority (DWASA) is 75%, of which 82% comes from groundwater sources while the rest of the 18% is obtained from surface water sources (Rahman & Hossain, 2008). Rapid population growth has caused a surge in the demand for water while the city remains greatly constrained by its 'hydrological context' due to reasons such as depletion of groundwater tables and distribution losses from the water supply and sewerage system (Talukdar, 2006). As a result, the city must increasingly switch to feasible alternative sources such as surface water to manage the scarcity of water arising due to growing demand and restrained supply. However, the surface water sources are highly polluted due to discharge of municipal and industrial wastewaters, resulting in the progressive aggravation of water quality (Rahman & Hossain, 2008). In other words, water scarcity is being instrumental in exacerbating water quality, and hence, the quality of the water supply availed by consumers in Dhaka is increasingly deteriorating over time.

Households in Dhaka consume approximately 94% (including distributional losses) of the water supply and often face unsatisfactory water quality (Asian Development Bank, 2005). Contaminated water brings about adverse health impacts including incidence of diarrheal diseases, and loss of leisure and work time due to illness. Drinking water often lacks aesthetic qualities, for instance, in case of water characterized with poor taste, smell and/or odor.

Design of viable solutions to the potable water crisis in Dhaka requires economic analysis of the social costs and benefits of alternatives. Thus, it is imperative that people's demand for safe potable water is considered when valuing social benefits. Therefore, this paper will attempt to assess household willingness to pay for potable water in Dhaka city.

The objectives of this paper are:

- To estimate the household willingness to pay for improving quality of drinking water
- To identify the factors that determine the willingness to pay

The paper has been organized as follows. A review of related literature is presented in section 2. Section 3 includes the conceptual model for the study and the econometric model. Section 4 illustrates the sampling procedure, study area and descriptive statistics of the surveyed households. Section 5 provides the results of econometric estimation. Finally, section 6 concludes the paper and proposes policy recommendations.

2. Review of Related Literature

Considering the demand side is essential for economic valuations of projects and policies related to water supply services (Pattanayak et al., 2005). Many studies have used non-market valuation techniques to estimate how consumers value improved quality of water service. The direct or stated preferences method uses *contingent valuation* to elicit people's preferences for a described hypothetical scenario and is proper when accounting for the total economic value, i.e., use and non-use values, which is more appropriate for decision-making (Gunatilake, 2003). The indirect or revealed preferences method scrutinizes consumer behavior for avoiding the costs from consumption of poor quality water services using the *averting behavior model*, and accounts for the burden of diseases and the maximum potential gains or losses resulting from the prevention of the diseases caused by poor water quality using the *cost of illness method.*

The contingent valuation method simply asks an individual how much he/she is willing to pay for improved water quality based on a hypothetical scenario. Certain studies emphasized only on the quality of water (Sukharomana and Supalla, 1998; Adamowicz et al., 2005; Tanellari et al., 2009), while other studies have taken a more holistic approach and estimated the willingness to pay for improved water services (Calkins et al., 2002; Fujita et al., 2005; Genius et al., 2008; Mehrara et al., 2009; Olajuyigbe and Fasakin, 2009). The monthly willingness to pay values were obtained as 7.85 CFA in Mali (Calkins et al., 2002), USD 9.72 in the U.S.A. (Sukharomana and Supalla, 1998), NPR 126.11 in Nepal (Katuwal and Bohara, 2007), 10.64 Euros in Greece (Genius et al., 2008).

According to the averting behavior model, households alter behavior and expenditure allocations with respect to perception of risk (Rosado, 1998; Dupont, 2005; Pattanayak et al., 2005; Aftab et al., 2006; Rosado et al., 2006; Haq et al., 2007; Sattar and Ahmed, 2007; Katuwal and Bohara, 2008; Roy, 2008; Jessoe, 2010). Averting expenditures are theoretically considered a lower bound of willingness to pay (Pattanayak et al., 2005). However, a few studies have come across the contradictory finding that averting expenditures are higher than the willingness to pay (Katuwal and Bohara, 2008). Coping costs/averting expenditures per month have been calculated to be NPR 81.54 (Katuwal and Bohara, 2007) and USD 2.94 (Pattanayak et al., 2005) in Nepal, BDT 1873 per year for slums in Dhaka, Bangladesh (Alam and Pattanayak, 2009), and INR 283 (Chen, 2010) in India.

The cost of illness method includes the costs of treatment of the illness and the opportunity cost of sick time spent. The cost of illness is also a lower bound of willingness to pay as per Berger (1987). The cost of illness was estimated to be INR 143 per month in India (Chen, 2010). The total cost of illness due to outbreak of the water-borne cryptosporidium outbreak was USD 96.2 million in 1993 in Milwaukee, Wisconsin (Corso et al., 2003), which emphasized failure to maintain safe drinking water.

The level of awareness, risk perception and incidence of disease due to exposure to poor environment are significant determinants of the value to consumers of environmental goods such as drinking water. Abdalla et al. (1992) emphasized that averting behavior was determined by awareness factors such as information about water quality and perceived health risks. Sukharomana and Supalla (1998) found that the willingness to pay for safer water was positively correlated with risk perception of the respondent. Pattanayak et al. (2005) found that households who believed drinking water contamination to be the most serious environmental problem in Kathmandu were more likely to adopt coping activities. Whitehead et al. (1998) demonstrated that awareness about adverse health impacts resulting from consumption of contaminated drinking water and perceived quality of present drinking water increase the probability of opting for safe drinking water. Similarly, Jalan et al. (2003) stressed that reading newspaper and listening to radio increased the probability of adopting safe drinking water practices. Haq et al. (2007) accentuated that the general public perception towards the opportunity cost of consuming unsafe water was largely determined by the quality of drinking water and the level of awareness. Sattar and Ahmed (2007) showed that the effect of awareness through newspaper and/or television media would be higher than that of formal education on willingness to pay for water quality improvement. Genius et al. (2008) demonstrated that households that value water quality as important, drink bottled water and drink water from a spring or another municipality exhibit a higher willingness to pay for drinking water quality and quantity. Alam and Pattanayak (2009) estimated the cost of coping with unsafe water supply in the slums of Dhaka and found that listening to radio and hand-washing (proxy for hygiene awareness) had a positive effect on the coping cost to slum households. Aftab et al. (2006) underscored awareness of arsenic-related negative health consequences and government and/or non-government intervention in terms of safe drinking water option installation as important determinants of averting behavior. Jalan et al. (2010) confirmed in their study that the demand for environmental quality could be increased through awareness rather than through wealth.

Household water usage, and water quality and supply characteristics play a crucial role in determining household demand for improved water services. Haq et al. (2007) found that there is a strong effect of water quality such as taste/smell for taking averting action. Genius et al. (2008) demonstrated that households who had higher water consumption, faced chlorine smell in water and had run out of water revealed relatively greater willingness to pay for drinking water quality and quantity. Aftab et al. (2006) illustrated that number of times households collected drinking water determined their whether they would adopt coping activities to consume safe drinking water.

Many studies have identified socio-economic and behavioral factors that affect household coping strategies and willingness to pay for improved water supply. Household income and wealth index are key socio-economic factors that account for higher demand for safer water (Rosado, 1998; Calkins et al., 2002; Katuwal and Bohara, 2007; Genius et al., 2008; Haq et al., 2007; Sonia et al., 2009). Female decision makers increase the probability of adopting coping strategies (Sattar and Ahmed, 2007). Family/household size has a positive impact on willingness to pay as emphasized in Calkins et al. (2002), Katuwal and Bohara (2007), and Alam and Pattanayak (2008).

Given the lack of access to proper sanitation and water services in rural regions and the incidence of arsenic in groundwater, most studies on willingness to pay for improved water services in addressed the issue of arsenic contamination in rural Bangladesh (Ahmad et al., 2002; Aziz, 2007; Madajewicz, 2007). Cost of illness and coping cost studies were conducted in slum areas of Dhaka (Alam, 2007; 2009), but the problem of contaminated water in urban regions has little been considered for the non-slum urban households. This paper contributes to the domain of existing literature by studying the demand for improved drinking water quality in this mega city of the developing world by combining the averting behavior model, cost of illness method and the contingent valuation method.

3. Methodology

3.1 Conceptual Model & Theoretical Framework

The theoretical framework for the study can be modeled with reference to Freeman (1993), Dasgupta (2004), Pattanayak et al. (2005), Roy (2008), and Pattanayak and Pfaff (2009). The standard neo-classical model of consumer behavior is assumed, i.e., households make rational choices given constraints. The utility function of the household is defined as follows:

$U = U(X, L, S)$ ... (I)

Here, X = composite good, L = leisure time and S = time spent sick.

The household derives utility from consuming X and L, while it derives disutility from S. Hence, $U_X > 0, U_L > 0, U_S < 0$.

The time spent sick is a function of exposure to poor quality water (W), mitigating or adaptive activities such as medical treatment expenditure (A), and stock of health capital (H). Therefore, the household health production function is:

$S = S(W, A, H)$ ... (II)

The health production function is increasing in exposure to poor quality water because ($S_W > 0$), while decreasing in mitigating activities ($S_A < 0$). The effects of exposure to poor quality water and mitigating activities on the household health are taken to be non-linear, and hence, the second order derivatives of the health production function with respect to poor water quality and mitigating activities are assumed to be non-zero ($S_{WW} \neq 0, S_{AA} \neq 0$). The health production function is decreasing in the stock of health capital ($S_H < 0$).

The exposure to poor water quality is determined by the level of contamination (C), and the averting or defensive strategies adopted by households to avoid or diminish exposure to poor water quality (D), and therefore:

$W = W(C, D)$ ... (III)

Here, exposure to poor water quality is increasing in level of contamination while decreasing in defensive strategies: $W_C > 0, W_D < 0$.

The defensive strategies adopted by households is a function of the time devoted to defensive strategies (T_D), market goods purchased for such activities (M_D) and educational attainment, awareness and knowledge about water contamination and adverse health effects of unsafe water (E):

$D = D(T_D, M_D, E)$ ... (IV)

Defensive strategies are increasing in T_D, M_D and E: $D_{T_D} > 0, D_{M_D} > 0, D_E > 0$.

Mitigating or adaptive activities are a function of defensive strategies (D) and market goods/services devoted to such activities[1]:

$$A = (D, M_A) \ldots \text{(V)}$$

$$A_D < 0, A_{M_A} > 0.$$

Substituting Eq. (IV) in Eq. (III) and Eq. (V), the following are obtained:

$$W = W(C, T_D, M_D, E) \ldots \text{(VI)}$$

$$W_C > 0, W_{T_D} < 0, W_{M_D} < 0, W_E < 0.$$

$$A = A(T_D, M_D, M_A) \ldots \text{(VII)}$$

$$A_{T_D} < 0, A_{M_D} < 0, A_{M_A} > 0.$$

Substituting Eq. (VI) and Eq. (VII) in Eq. (II), the following is obtained:

$$S = S(C, T_D, M_D, M_A, H, E) \ldots \text{(VIII)}$$

$$S_C > 0, S_{T_D} < 0, S_{M_D} < 0, S_A < 0, S_H < 0, S_E < 0.$$

Here, H and E are taken to be exogenous.

The household will maximize utility by choosing the optimal levels of X, L, T_D, M_D and M_A subject to time and budget constraints. The time constraint is used in the full-income budget constraint (Freeman, 1993; Roy, 2008):

$$I + w(T - L - S - T_D) - X - P_D \cdot M_D - P_A \cdot A = 0 \ldots \text{(IX)}$$

The Lagrangian for this utility maximization problem has been set out below with λ as the Lagrange multiplier, which shows marginal utility due to an increase in total income:

$$\text{L} = U\big(X, L, S(C, T_D, M_D, A, H, E)\big) + \lambda\big(I + w(T - L - S - T_D) - X - P_D \cdot M_D - P_A \cdot A\big) \ldots \text{(X)}$$

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[1] Adaptive activities are also a function of the time spent sick: the longer a person remains sick, the greater the probability that he/she will undertake adaptive actions to recover good health. Nevertheless, time spent sick is again

Solving the optimization problem gives the optimal values of X*, L*, T_D*, M_D* and M_A* in terms of the exogenous variables C, H, E, w, I, P_D and P_A, which can subsequently be used to obtain the optimal values D*, W*, A* and S*.

The study wishes to determine how changes in the quality of water affect the utility of the household, from which the willingness to pay for safe drinking water can be derived. The dual problem of the Lagrangian above can be used to account for the willingness to pay.

Let, U* be the level of utility compatible with the optimum levels of X*, L*, T_D*, M_D* and M_A*, and e* be the minimum expenditure required to achieve U*. Now, let there be a cost function characterizing the minimum level of non-wage income required to attain the utility level of U*. This is known as the variation function (McConnell, 1990) and is utilized in order to value changes in environmental resources (Whitehead, 1995; Pattanayak et al., 2005):

$$\Omega = w(L + S + T_D) + X + P_D \cdot M_D + P_A \cdot A - wT + \mu\{U^* - U(X, L, S(C, T_D, M_D, M_A, H, E))\}$$

... (XI)

Applying the envelope theorem, the total derivative of Eq. (X) is taken to obtain the following:

$$\frac{\delta \Omega}{\delta C} = w \cdot \frac{\delta T_D}{\delta C} + P_D \cdot \frac{\delta M_D}{\delta C} + w \cdot \frac{\delta S}{\delta C} + P_A \cdot \frac{\delta A}{\delta C} - \mu \frac{\delta U}{\delta S} \cdot \frac{\delta S}{\delta C} \quad \text{... (XI)}$$

Here, the first term represents the minimum amount of exogenous income that could be taken away from the household for equilibrating for the increase in the utility due to consumption of safe drinking water. Therefore, it is the willingness to pay of the household. The second and third terms on the right hand side represent the coping costs (and opportunity cost of time devoted to coping, and expenditure on market commodities for defensive strategies).The fourth and fifth terms correspond to the cost of illness (opportunity cost of time for being sick and adaptive or mitigating expenditures after falling sick). Lastly, the sixth term stands for the disutility from the illness caused by the consumption of unsafe drinking water.

Hence, it is apparent that coping costs, cost of illness and willingness to pay can be theoretically associated with the same underling preferences for safe drinking water (Pattanayak et al., 2005). Nevertheless, coping costs and cost of illness correspond to the lower bound for the willingness to pay for improved quality of water.

The willingness to pay will be obtained as stated preferences using the contingent valuation method with iterative bidding. The willingness to pay figures thus will be contingent or conditional upon the described hypothetical situation (Gunatilake, 2003). The hypothetical scenario for the current study is as follows:

The water supplied to residential areas by DWASA does not meet drinking water standards. Consumption of contaminated water causes incidence of water-borne diseases such as diarrhea and cholera. Such diseases cause people to lose to miss work days, school days and leisure time. People also experience disutility from the state of being ill. Besides, unsafe water is characterized by inferior taste, color and/or odor. Hence, households deal with the problems of unsafe drinking water by boiling, filtering, etc. This might be time consuming and troublesome.

One solution to the problem of unsafe water in Dhaka city can be to provide households with clean, piped drinking water supply. Households can use this piped water for drinking and/or cooking activities. You will no longer need to adopt water purification activities such as boiling/filtering. This service will also be more convenient than purchasing bottled water since you do not need to leave home for obtaining the water. This service can be provided by DWASA or any other relevant agency.

Do you understand the scenario explained? Are you willing to pay for safe drinking water? If YES, please consider how much you value safe drinking water and how its consumption will improve your lifestyle with regards to better health, time management, work for home/office/school and leisure/entertainment activities. What is the price per liter of drinking water that you would be willing to pay to avail this service?

To avoid starting-point bias, the respondent will not be provided any price options, and will be simply asked to state the WTP.

3.2 Econometric Model

Following the conceptual model presented in the previous section, econometric modeling will be used to estimate the household willingness to pay for improved quality of drinking water. It should be noted that there might exist households who would not be willing to avail the service stated in the willingness to pay scenario. Therefore, estimation of the willingness to pay will need to consider both the probability of availing the service and the effect of different factors on the willingness to pay amount. The least possible value for willingness to pay will be assumed zero in cases when households are not willing to avail the service. Therefore, a Tobit model can be used to model the willingness to pay. The Tobit model can be used to estimate both changes in the probability of obtaining positive willingness to pay values and changes in the value of the willingness to pay if willingness to pay is positive. The equation to be estimated using Tobit is as follows (Greene, 1989):

$$\begin{aligned} Y_i &= X_i\beta + \varepsilon_i && \text{if } X_i\beta + \varepsilon_i > 0 \\ &= 0 && \text{if } X_i\beta + \varepsilon_i \leq 0 \\ & && i = 1, 2, \cdots, n \end{aligned} \quad (1)$$

Here, n is the number of observations, Y_i is the dependent variable which is the willingness to pay for improved quality of drinking water, X_i is a vector of covariates, β is a vector of unknown coefficients, and ε_i is an independently distributed error term assumed to be normal with zero mean and constant variance σ^2.

The probability of availing the service and the change in willingness to pay values are usually the result of two different stochastic processes. Thus, to account for the total change in the dependent variable the following decomposition is used (McDonald and Moffitt, 1980):

$$\frac{\partial EY}{\partial X_i} = F(z)\left[\frac{\partial EY^*}{\partial X_j}\right] + EY^*\left[\frac{\partial F(z)}{\partial X_j}\right] \quad (2)$$

Here, the first term shows the change in positive Y values weighted by the probability of Y values being positive, and the second term represents the change in the probability of being positive weighted by the mean of the positive Y values.

A detailed explanation about the dependent variable and covariates to be used to estimate Eq. (1) has been provided below. Table 1 shows the expected signs of the coefficients of the covariates.

The dependent variable monthly willingness to pay (WTP) is a non-negative continuous variable. The per liter WTP is multiplied with number of liters of drinking water consumed per day by the household and 30 to approximate the monthly WTP.

The covariates or independent variables consist of monthly defensive and mitigating expenditures, monthly opportunity cost of sickness from water-related diseases, and a number of socio-economic determinants.

The variable monthly opportunity cost is a continuous variable. Monthly opportunity cost refers to the opportunity cost of time computed as the product of the number of work, schooling and/or leisure hours missed due to illness and the hourly wage rate, for both the patient and the caregiver. If the patient or caregiver is a wage-earner, the hourly wage rate is calculated as the individual's monthly income divided by the number of hours worked per month. On the other hand, if the patient or caregiver is a non-earning member, the hourly wage rate is computed as the total monthly household income (income contributed by all members plus fixed periodic income) divided by the total of hours worked by each member of the household per month. Respondents would be asked to recall how many days each member of the household had been sick due to water-related diseases, such as hepatitis, typhoid/paratyphoid, cholera and/or diarrhea in the past one year. If an earning member misses working days, the number of days missed is multiplied with the number of work hours of the member to obtain the hours lost due to sickness. Schooling time per day has been considered as 8 hours, and hence, a sick member missing one day misses out 8 hours of schooling. The leisure hours lost due to care-giving and being sick are also accounted for. The opportunity cost would then be converted into a monthly average. Higher sick time implies that the household will incur higher cost of illness and higher disutility, and hence, the willingness to pay for safer water is expected to be higher.

The variable monthly mitigating expenditure is a continuous variable. The monthly mitigating expenditure accounts for all expenses arising due to mitigating or adaptive measures undertaken by the household when members fall sick due to water-related diseases. The cost of home treatment and treatment at the medical center/clinic including medicine cost, doctor's fees, pathological tests and transportation cost will be considered. If water-related and non-water-related diseases occur to any member at the same time, it might be difficult to separate the cost attributable to only the water-related disease. Hence, the total cost arising due to both types of diseases will be used in the estimation (this can be considered as a shortcoming of the estimation). This variable is expected to be positively related to the dependent variable.

The variable monthly defensive expenditure is a continuous variable. Monthly defensive expenditure will be used as a measure of the cost for purification of drinking water such as straining, using purification tablets, boiling and filtration per month, and the cost of purchasing bottled water (which is perceived to be clean). In case of straining, the monthly straight-line depreciation cost of the strainer will be used. In case of purification using tablets, the respondent will be asked about the monthly expenditure on tablets. For boiling, the monthly straight-line depreciation cost of the boiling container will be used. Households generally pay a fixed subscription for domestic gas supply. Therefore, the cost of gas usage does not vary with the rate of usage. Hence, using gas to boil water for purification has zero opportunity cost to households. However, households who purchase gas cylinders incur cost for boiling water, and for these households, the cost of gas usage will be computed considering the volume of gas used and the cost per unit volume of gas. For filtration, the monthly maintenance cost, straight-line depreciation cost and electricity cost (if filter is run by electricity) will be totaled. Electricity cost will be found by multiplying the number of hours per day electricity is used to power the filter by the cost per hour of using electricity. The opportunity cost of spending time for defensive activities will also be taken into account. The opportunity cost of devoting time to defensive activities will be accounted for as well. If the member undertaking such activities is an earning member, the hourly rate of time cost will be calculated as the hourly wage rate (monthly income earned by a particular member divided by his/her total hours worked per month). On the other hand, if the member is not wage-employed, the hourly rate of time cost will be computed as the household hourly wage rate (total monthly income of all earning members divided by the total hours worked by all earning members per month). The monthly opportunity cost of time devoted to defensive activities will be calculated as the product of the hours devoted per month to such activities and the hourly time cost. In cases where domestic workers conduct defensive activities, the opportunity cost is accounted for as zero. This variable is expected to be positively associated with the dependent variable.

The variable wealth is a dummy variable that takes the value 1 if households have monthly household income greater than the 50^{th} percentile of monthly household income reported by households in the survey; otherwise, the variable takes a value of zero. Wealth is expected to have a positive effect on the willingness to pay bid (Rosado, 1998; Calkins et al., 2002; Katuwal and Bohara, 2007; Genius et al., 2008; Haq et al., 2007; Sonia et al., 2009).

The variable age is a continuous (integer) independent variable. The effect of age on willingness to pay is ambiguous.

The variable gender is a dummy variable, taking a value of 1 if the respondent is female, and 0 if the respondent is male. Gender is expected to have a positive effect on willingness to pay as suggested by previous literature (Sattar and Ahmed, 2007).

The variable education is a discrete continuous variable ranging from 0 to 15, where 0 represents no schooling, 1 to 9 represent grades I to IX, 10 stands for S.S.C., 11 corresponds to H.S.C., 12 stands for diploma, vocational and religious education, while 13, 14 and 15 for graduate, post-graduate and doctoral degrees respectively. It represents the highest level of education attained by the respondent. This variable is expected to have a positive influence on WTP since an educated respondent is more likely to understand the implications of cleaner water, and hence, is expected to value clean water more.

The variables newspaper, radio and TV measure exposure to media, and are each individual dummy variables taking a value of 1 if the respondent reads the newspaper, listens to the radio and watches TV; otherwise, a value of zero each. The higher the level of media exposure of the respondent, the higher is the willingness to pay for improved quality of drinking water expected to be (Abdalla et al., 1992; Sukharomana and Supalla, 1998; Whitehead et al., 1998; Jalan et al.,2003; Pattanayak et al., 2005; Haq et al., 2007; Sattar and Ahmed, 2007; Alam and Pattanayak, 2009; Sonia et al., 2009).

The variable considering bottled water is a dummy variable that assumes a value of 1 if the respondent would consider buying bottled water for total drinking consumption needs, else a value of 0. If the respondent would consider meeting drinking consumption needs by purchasing bottled water, it is likely that the respondent would be willing to switch to the situation presented in the hypothetical scenario. Therefore, it is expected that this variable would be positively related to the willingness to pay.

The variable interaction is an interaction term obtained as the product of two dummy variables: satisfied with water quality after purification and consider purification a hassle. Respondents who are satisfied with the quality of drinking water after purification are expected to have lower willingness to pay. However, even though the respondents are satisfied with the quality, if they consider purification activity a hassle, then they are likely to exhibit higher willingness to pay for improved quality of drinking water as per the hypothetical scenario.

The variable consumption is a continuous variable that represents household drinking water consumption in liters per day. Assuming the general law of demand, households with higher drinking water consumption needs are expected to exhibit a lower value for the willingness to pay for improved drinking water. Therefore, this variable is anticipated to negatively influence the willingness to pay.

The variable water supply is a dummy variable, representing 1 if the respondent reports regular and/or continuous water supply, else 0. Contrary to regular and/or continuous water supply, irregular and/or discontinuous water supply may require obtaining water from sources other than the domestic piped water supply, and hence, the risk of contamination of water may be higher. Hence, households with regular and/or continuous water supply are expected to have lower WTP for improved quality of drinking water.

4. Study Area & Description of Surveyed Households

Data for the study has been obtained from residential households in Dhaka city. Given time and financial constraints, convenience sampling procedure has been followed. As per this sampling procedure, only households that were readily available were surveyed. The map of Dhaka city in Appendix B illustrates the various locations of the households surveyed. The sampling covers the areas Badda, Banani, Baily Road, Baridhara, Basabo, Dhaka University Area, Dhanmondi, Eskaton, Gandaria, Gulshan 1, Kafrul, Khilgaon, Mirpur, Mohakhali, New Paltan, Pallabi, Shewrapara and Tejkunipara. The sample size is 30 households.

Households were interviewed using the questionnaire provided in Appendix C. The questionnaire had several sections. The introductory section collected information on the demographic characteristics of the household, which included information about the age, sex educational qualification, profession and income of the members of the household, followed by questions about the household's wealth status. The next section asks questions that reflect the exposure of the respondent to media, and his/her level of awareness about environmental pollution, in particular, water pollution, and water-related diseases. The following section focuses on details about the state of water supply, storage of drinking water and bottled water consumption. The respondent is then inquired about the various steps that the household undertakes for purifying drinking water, and what he/she perceives about the effort required for and the effectiveness of the purification method employed. The subsequent part of the questionnaire deals with the incidence of water-related diseases in the household, the respondent's opinion concerning the preventive measures that can be adopted by the government and the household itself against such diseases, and the medical and opportunity cost of time to both the patient and the caregiver ensuing incidence of such diseases. Finally, the willingness to pay scenario is presented as mentioned previously, and the respondent's willingness to pay is recorded.

The socioeconomic profile of the surveyed households, the respondent's awareness level, the drinking water profile, purification activities undertaken by the households, household health issues and willingness to pay bids are being discussed as follows to study household behavior in greater depth.

The mean household size was about 4 members. The monthly total household income in the sample ranged from BDT 20,000 to BDT 6,55,000 with a mean of 97,900. 30% of the households housed an LCD/plasma TV, 97% owned a fridge, 87% had a computer, 37% had an air conditioner, 67% had access to a generator or instant power supply (IPS) during power outages, 73% owned a telephone, and 53% had private transport in the form or car or two/three-wheeler. Therefore, the households roughly represented the middle/upper middle and rich class of people residing the city.

Thirty per cent of the household heads are businesspersons and 13.33% are retired. 16.67% of the household heads are government/non-government/NGO officers. Government/non-government/NGO workers, teachers/researchers and homemakers each constitute 10% of the household heads, while doctors/engineers/lawyers, students and others each constitute 3.33%.

The respondents varied in their educational qualification. 3.33% of the respondents passed the ninth grade, 10% passed the S.S.C. examination, 16.67% passed the H.S.C. examination, 3.33% were diploma holders, 50% were graduates while 16.67% were post-graduates.

Almost all of the respondents had TV habit, 90% had newspaper habit, while only 50% listened to radio programmes, while 93% of the respondents said that they learned about environmental pollution from the media. Water pollution was regarded as the most serious environmental pollution by 63.33% of the respondents while 33.33% ranked air pollution as most serious. A mere 3.33% considered noise pollution as the most serious form of pollution. When asked to name a water-related disease, 43.33% of the respondents mentioned diarrhea, 20% mentioned cholera, 16.67% mentioned typhoid/paratyphoid, 13.33% mentioned hepatitis while 6.67% mentioned other diseases such a skin problems.

Continuous/regular water supply prevailed in 90% of the households, while the rest 10% reported discontinuous/irregular water supply. On an average, the households consumed 11.83 liters of drinking water per day. The mean of the monthly storage cost was BDT 30.66. All of the households covered their drinking water containers. 6.67% of the households did not wash their drinking water containers, 3.33% washed once every two weeks, 13.33% washed once a week, 53.33% washed once every few days and 23.33% washed their containers every day.

The mean monthly expenditure on bottled water consumption was BDT 170.65. One-fifth of the respondents responded affirmatively when asked if they would consider buying bottled water for total consumption needs. Of the rest who replied negatively, 58.33% said so because they consider bottled water expensive, while 25% did not trust the quality of bottled water.

All the surveyed households adopted some kind of defensive activity, whether be it straining, boiling or filtration. No households reported using purification tablets to treat drinking water.

70% of the households strained drinking water. The mean monthly straining cost was BDT 8.90. of those who strained, 9.52% strained before boiling, 61.90% strained after boiling, 4.76% strained both before and after boiling, 9.52% strained before filtering, and 14.29% strained at source, before boiling & after boiling prior to filtration.

90% of the households purified water by boiling. The mean monthly boiling cost was BDT 5.56. Daily, an average household boiled 12.81 liters of water for 45.92 minutes. All of the households used publicly supplied gas for boiling water.

One-half of the total households engaged in filtration of drinking water. The mean monthly filtration cost was BDT 44.32. None of the households used electric filters.

A third of the respondents considered purification to be a hassle, while 76.67% of the respondents were satisfied with the quality of drinking water after purification.

Regarding the incidence of water-related diseases, 3.33% of the households experienced hepatitis, 30.51% were attacked by typhoid/paratyphoid, 43.33% faced diarrhea, whereas 22.83% did not face any water-related diseases. None of the households reported incidence of cholera.

An average household experienced 10.17 total sick days, and lost 18.53 patient's work hours, 3.1 patient's school days, 10.93 patient's leisure hours, and 5.43 caregiver's leisure hours due to incidence of water-related diseases yearly.

Upon asking about the kind of measures can be undertaken at the household level to prevent such diseases, 10% of the respondents talked about improving sanitation, 46.67% referred to improving treatment of drinking water, 16.67% mentioned improving hygiene and another 10% suggested other measures, whereas 16.67% of the respondents did not come up with any responses. When asked about the kind of preventive measures the government can take to reduce incidence of water-related diseases, 73.33% of the respondents suggested provision of clean water, 3.33% emphasized on provision of sanitation, 10% highlighted educating the public about prevention methods, and 3.33% stressed on the importance of providing free vaccination. Therefore, the majority of the respondents had awareness about the importance of clean water in order to prevent water-related diseases.

The mean willingness to pay per liter of improved quality of drinking water was found to be BDT 14.87. Among the respondents interviewed, 30% did not want to pay for the hypothetical scenario. Of this 30%, 22.22% said that they were satisfied with the current quality of drinking water, while another 22.22% demanded that the government should provide safe drinking water at nominal rates. Around 44% did not trust that the government can arrange such a service, and 11.11% gave other reasons for not subscribing to the hypothetical scenario.

5. Estimation of Econometric Model

5.1 Summary Statistics of Dependent Variable & Covariates

Table 3 produces the summary statistics of the dependent variable and covariates. On an average, households were willing to pay BDT 4066.04 for availing improved quality drinking water. Pertaining to data over the past one year, each month the average household in the sample faced time costs due to illness amounting to BDT 1358.849, and spent BDT 246.611 and BDT 719.0412 for mitigating and defensive activities respectively. Thus, we find that the aggregate of the mean monthly defensive/coping costs and the cost of illness form the lower bound of the mean monthly WTP as asserted in the conceptual model. The mean age of the respondent was 29.3 years and approximately 83% of the respondents were female. Approximately 23% of the respondents were satisfied with the quality of drinking water after purification while they considered purification a hassle. The mean consumption of drinking water per household was 10.42 liters per day. One-fifth of the respondents expressed that they would consider purchasing bottled water for total drinking consumption requirements.

5.2 Results of Econometric Estimation

Table 4 provides the results of the econometric estimation of the model. A Tobit model has been used for the purpose of estimation. The results have been elucidated below.

The dependent variable has been regressed on the covariates mentioned in Section 3.2. Overall, the model is significant than an empty model with no regressors, as evidenced by the likelihood ratio chi-square statistic value of 34.64 which is significant at the 1% level of significance.

In Table 4, the first column lists the covariates used in the censored regression. The second column lists the corresponding estimated Tobit coefficients, that is, the marginal effects of a change in the covariates on the unobservable latent variable. The third and fourth columns produce the standard errors and 95% confidence intervals respectively for the corresponding covariates. The fifth column refers to the marginal effects of the covariates on the censored outcome, or in other words, the unconditional expected value of the dependent variable. The sixth column shows the marginal effects of the covariates on the observed values of the dependent variable, that is, on the values of the dependent variable that are conditional on being uncensored. The final column represents the marginal effects of the covariates on the probability of the dependent variable being observed (that is, having positive values). This can also be explained as the marginal effect of the covariates on the probability of the respondent's willingness to subscribe to the hypothetical scenario. All marginal effects are evaluated at the mean of the covariates that are continuous. In case of dummy variables, the marginal effects are evaluated for discrete changes from 0 to 1. The coefficients of the Tobit model for defensive expenditure, gender and consumption are statistically significant at the 1% level of significance, while that for radio and interaction are significant at the 10% level of significance. The explanation of the estimated model will focus on the marginal effects of the covariates on the observed values of the dependent variable and on the probability that the dependent variable is observed.

Empirical findings which have been consistent with the economic model as explained below. With an increase in the monthly opportunity cost, on an average the monthly WTP increases by BDT 0.18 while the probability of having positive WTP increases by 0.003%. Similarly, with a rise of BDT 1 in the monthly mitigating expenditures, the respondent's WTP would rise by BDT 0.81, and the probability of adopting the hypothetical scenario would increase by 0.001%. On an average, if monthly defensive expenditures increase by BDT 1, the monthly WTP for improved quality of drinking water would increase by BDT 1.97 while the probability of subscribing to such would increase by 0.03%.

As it has been demonstrated in previous studies that higher wealth implies higher willingness to pay for improved quality of drinking water, the current study finds that households with higher status of wealth are willing to pay BDT 58.14 more, while the probability of positive WTP increases by approximately 1%.

The econometric analysis shows that age of the respondent positively influences the WTP. Increase in age would lead to an increase in the monthly WTP of about BDT 29.58, while probability of positive willingness to pay will increase by 0.44%.

The existing literature suggested that female respondents were more willing to pay for improved quality of drinking water; but, the econometric analysis suggests that, compared to male respondents, on an average female respondents had monthly WTP lower by BDT 1631.64, and that female respondents had a 43% lower probability of demonstrating positive WTP. It may be noted that numerous observable and unobservable socio-economic and cultural factors contribute to gender characteristics and behavior patterns. Therefore, such factors may result in dissimilar findings about the effect of gender on WTP since the study area and sample of previous studies have different socio-economic and cultural backgrounds compared to that of the present study.

Although it was expected that education would have a positive effect on WTP, the results of econometric estimation suggests otherwise. With higher education, the monthly WTP would decrease by BDT 217.52 while the probability of positive WTP would decrease by 3%. However, the marginal effects on the observed variable and the probability are not significant at any common level of significance, and therefore, may not be considered representative of the population.

Households who read newspaper, listened to radio and watched TV exhibited a higher monthly WTP by BDT 726.76, BDT 2047.75 and BDT 778.26 respectively than those who did not, and the probability of positive WTP increased by 12%, 29% and 14 % respectively.

Households who consider purchasing bottled water to meet total drinking consumption needs are likely to increase their monthly WTP by BDT 2807.89, and have 27% higher probability of subscribing to the hypothetical scenario than households not considering bottled water for total consumption needs.

Likewise, households being satisfied with the quality of drinking water after purification but considering purification a hassle are, on an average, likely to have a higher monthly WTP by about BDT 3939.20, and are projected to exhibit a 35% higher probability of expressing positive willingness to pay for improved quality of drinking water.

As consumption of drinking water increases per liter, households would decrease their monthly WTP by BDT 652.14 while the probability of positive WTP would decrease by 10%.

Given that a household has access to regular and/or continuous water supply, the monthly WTP would decrease by BDT 3510.22 on an average, while the probability of demonstrating positive WTP would decrease by 27%.

6. Conclusion & Policy Recommendation

Poor quality drinking water brings about economic losses to households in Dhaka. The purpose of this study was to conduct an economic valuation of the social benefits of improving drinking water quality by estimating the monthly household willingness to pay using contingent valuation based on a hypothetical scenario. Revealed preferences method has been used to account for the averting and mitigating expenditures. To obtain relevant data, convenience sampling method has been used to interview 30 respondents representing households in Dhaka.

The mean monthly household WTP amounted to around 7.32%, while the mean monthly defensive expenditure, mitigating expenditure and opportunity cost of time lost due to water-related illnesses are 1.49%, 0.35% and 1.27% of monthly household income respectively. Hence, consistent with previous studies and theoretical assertions, this study emphasizes that coping cost and cost of illness are the lower bound for the willingness to pay for improved quality of drinking water.

The willingness to pay for improved drinking water service can be of significance for investment planning of utility companies and for taking decisions by regulators. An adequately high willingness to pay will act as an incentive for DWASA to make relevant investments to ensure regular supply of potable water to households. However, it must be addressed that the WTP value found in this study may not be representative of the population because, firstly, the sampling technique adopted does not account for the many diverse socio-economic backgrounds of households residing in Dhaka, and secondly, WTP from contingent valuation studies are critical upon the hypothetical scenario and, in many cases, the responses may be biased. In addition, another important question may be, how consistently does the respondent represent the household? For instance, will the WTP for safe drinking water of the household head, who has lost a profitable business opportunity due to suffering from typhoid, and the daughter from the same household, who has not been affected by water-related diseases in the past one year, be the same? How consistently will the daughter be able to provide a WTP response that would approximately reflect the utility gain of the household from consuming improved quality of drinking water?

Nevertheless, as suggested by Pattanayak et al. (2005), if the supply side costs of utility investment projects do not exceed the lower bound for the willingness to pay, then such projects can easily pass cost-benefit analysis tests, and therefore, the willingness to pay value presented in this paper may be of significance for utility planning for the income group surveyed.

However, the determinants of the WTP assessed in this paper can give direction to relevant policy makers to manage the situation in the short run. The study emphasizes that households that make greater expenditure to avert the risk of drinking water contamination are significantly more willing to pay for improved quality of drinking water. Respondents with greater exposure to media such as newspaper, TV, radio, are more aware of contamination of water and the incidence of serious water-related diseases, and thus, are likely to have a higher willingness to pay for safe water. On the other hand, factors such as gender of the respondent being female and regular/continuous water supply in the household have negative impact on the willingness to pay for safe drinking water. Hence, public campaigns may be launched using mass media, mainly targeting female audience, to inform people about water quality, purification methods, hygiene and safe storage of drinking water, and encourage them to share such information with other household members. Such policies may improve people's perception of drinking water quality and coping/defensive behavior. Therefore, the social costs of poor quality drinking water may be reduced by affecting household coping/defensive behavior.

This paper may be further improved by adopting a representative sampling technique and conducting sensitivity analysis to test for the internal and external validity of the results.

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List of Tables

Table 1: Socio Economic Profile of Surveyed Households

Variable	Observation	Mean	Std. Dev.	Min	Max
Household size	30	4.03	1.10	2	7
Household income	30	97900	132466.9	20000	655000
LCD/Plasma TV	30	0.3	0.47	0	1
Fridge	30	0.97	0.18	0	1
Computer	30	0.87	0.35	0	1
Air conditioner	30	0.37	0.49	0	1
Generator/IPS	30	0.67	0.48	0	1
Telephone	30	0.73	0.45	0	1
Car/Two-wheeler/Three-wheeler	30	0.53	0.51	0	1

Table 2: Expected Sign of Dependent and Independent Variables

Independent Variables	Expected Sign
Opportunity cost (*monthly time cost of losing leisure/work time due to water-related illness and due to coping activities, expressed in BDT*)	+
Mitigating expenditure (*monthly medical expenditure in BDT resulting from falling sick due to water-related diseases*)	+
Defensive expenditure (*monthly expenditure in BDT for coping with unsafe drinking water*)	+
Wealth (*does the household have monthly income greater than 50% of the surveyed households? 1=Yes, 0=No*)	+
Age (*age of the respondent in years*)	?
Gender (*gender of the respondent*)	+
Education (*educational level of the respondent*)	+
Newspaper (*does the respondent read the newspaper? 1=Yes, 0=No*)	+
Radio (*does the respondent listen to the radio? 1=Yes, 0=No*)	+
TV (*does the respondent watch TV? I=Yes, 0=No*)	+
Considering bottled water (*would the respondent be interested to buy bottled water for total household consumption needs? 1=Yes, 0=No*)	+
Interaction (*interaction term representing that the respondent is satisfied with the quality of drinking water after purification AND considers purification a hassle*)	+
Consumption (*household drinking water consumption in liters per day*)	-
Water supply (*does the household have irregular and/or continuous water supply? 1=Yes, 0=No*)	-

Table 3: Summary Statistics of the Dependent and Independent Variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
Covariates	30	4066.04	6978.459	0	36000
Opportunity cost	30	1358.849	2905.959	0	10044.12
Mitigating expenditure	30	246.611	769.078	0	4000
Defensive expenditure	30	719.0412	1711.787	0	7220
Wealth	30	0.5	0.508548	0	1
Age	30	29.3	10.1884	18	55
Gender	30	0.833333	0.379049	0	1
Education	30	12.36667	1.401559	9	14
Newspaper	30	0.9	0.305129	0	1
Radio	30	0.5	0.508548	0	1
TV	30	0.966667	0.182574	0	1
Considering bottled water	30	0.2	0.406838	0	1
Interaction	30	0.233333	0.430183	0	1
Consumption	30	10.41667	4.098114	4.5	20
Water supply	30	0.9	0.305129	0	1

Table 4: Tobit Model for Monthly WTP

					Marginal Effect at the Means		
Covariates	Coefficient	Std. Err.	95% Confidence Interval		Unconditional Expected Value	Conditional on being Uncensored	Probability Uncensored (%)
Opportunity cost	0.34	0.57	-0.87	1.55	0.25	0.18	0.003
Mitigating expenditure	1.56	1.84	-2.34	5.46	1.14	0.81	0.01
Defensive expenditure	3.80***	0.70	2.31	5.28	2.77***	1.97***	0.03***
Wealth	112.22	2203.90	-4559.84	4784.28	82.02	58.14	0.86
Age	57.11	115.97	-188.74	302.95	41.74	29.58	0.4366
Gender	-11722.91***	3149.67	-18399.92	-5045.90	-10332.00***	1631.64***	-43.33*
Education	-419.89	897.85	-2323.25	1483.47	-306.90	-217.52	-3.21
Newspaper	1514.24	3542.36	-5995.23	9023.72	1032.44	726.76	12.44
Radio	3934.29*	2136.28	-594.41	8463.00	2848.62*	2047.75*	29.44*
TV	1656.90	5361.70	-9709.41	13023.20	1106.42	778.26	13.85
Considering bottled water	4595.41	3319.85	-2442.37	11633.19	3740.77	2807.89*	27.24
Interaction	6253.77*	3048.91	-209.62	12717.16	5138.64**	3939.20***	34.85
Consumption	-1258.87***	325.31	-1948.50	-569.24	-920.10***	-652.14***	-9.62***
Water supply	-5318.82	3269.80	-12250.49	1612.85	-4528.97*	-3510.22**	-26.89
Constant	22901.54	12444.8	-3480.33	49283.41			

Number of obs. = 30
LR Chi square (14) = 34.64
Prob. > Chi square = 0.0017
Pseudo R^2 = 0.0760
Log likelihood = -210.44063

Obs. Summary:
9 left-censored observations at Monthly WTP <= 0
21 uncensored observations
0 right-censored observations

*** indicates significance level at 1 percent or lower,
** indicates significance level at 5 percent, and
* indicates significance level at 10 percent

List of Figures

Figure 1: Histograms of Monthly WTP, Defensive Expenditure, Mitigating Expenditure & Opportunity Cost of Time of Surveyed Households

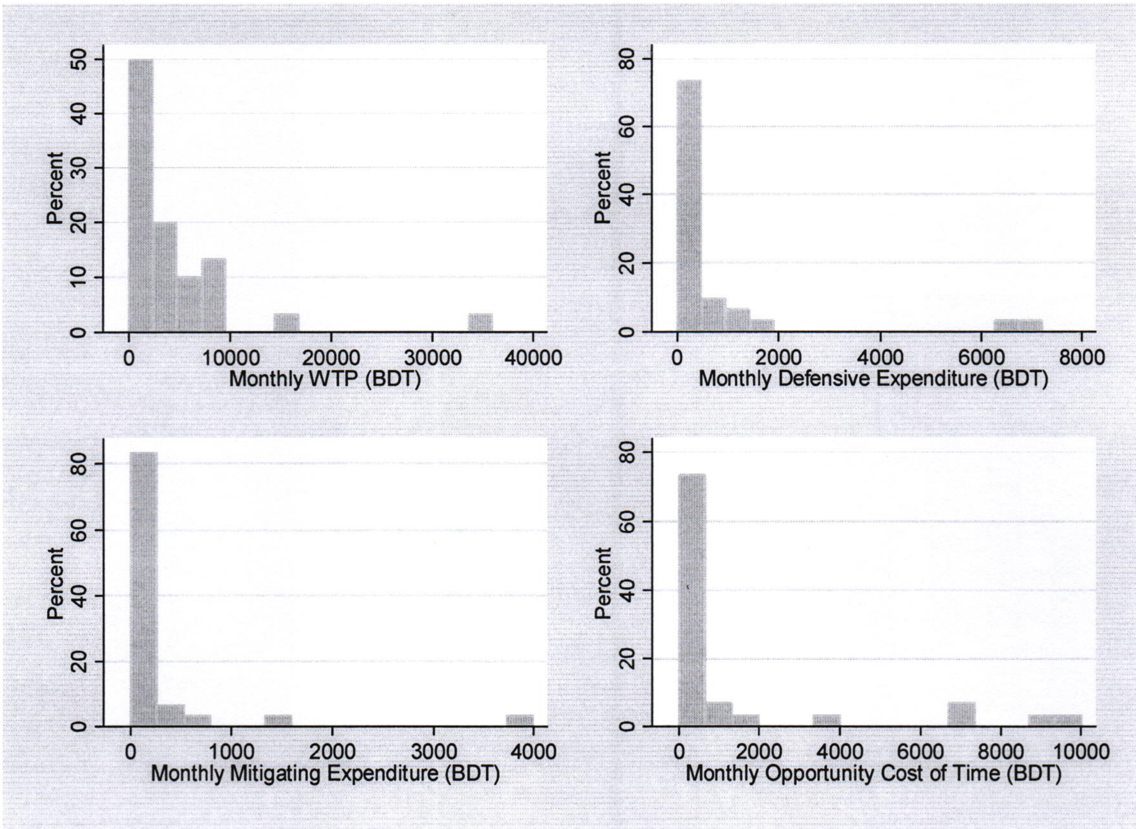
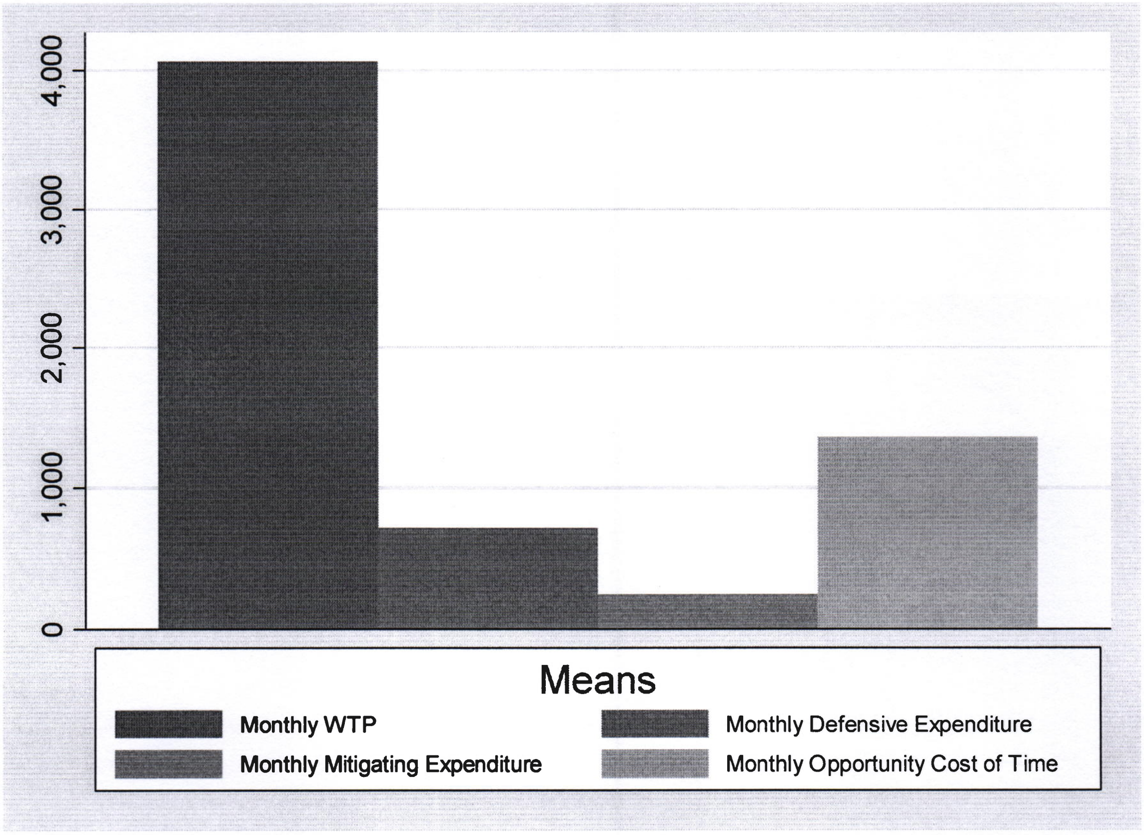
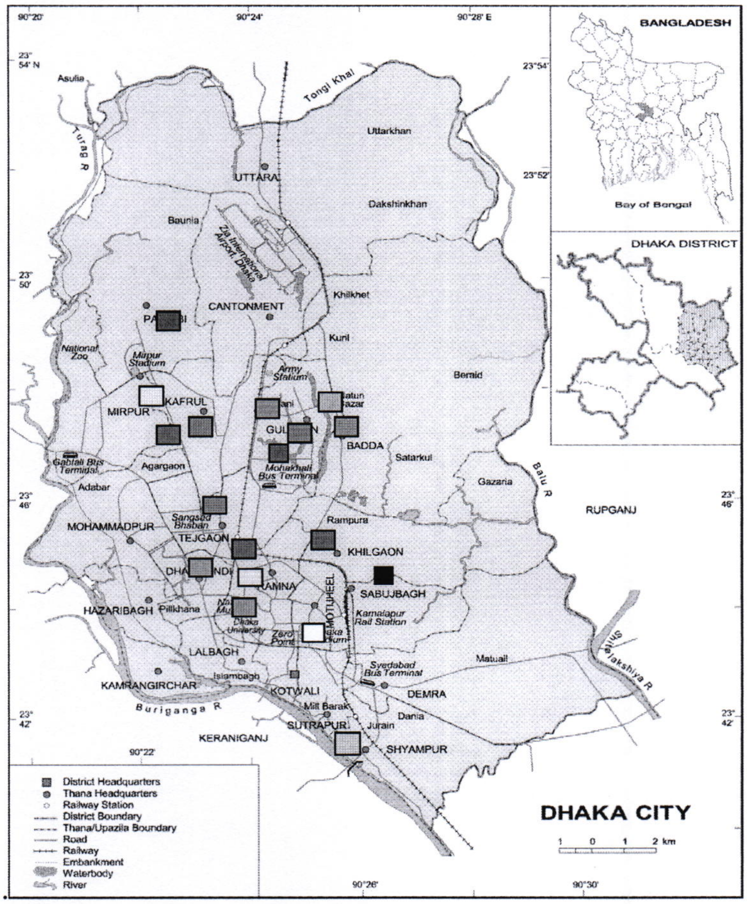


Figure 2: Bar Graph Showing Means of Monthly WTP, Defensive Expenditure, Mitigating Expenditure & Opportunity Cost of Time of Surveyed Households



Appendix 1: Study Area



Location Key:

- Badda
- Baily Road
- Banani
- Baridhara
- Basabo
- Dhaka University Area
- Dhanmondi
- Eskaton
- Gandaria
- Gulshan 1
- Kafrul
- Khilgaon
- Mirpur
- Mohakhali
- New Palton
- Pallabi
- Shewrapara
- Tejkunipara

Appendix 2: Survey Questionnaire

BRAC UNIVERSITY

Household WTP for Potable Water in Dhaka City: Comparison using Stated and Revealed Preferences

Department of Economics and Social Sciences
BRAC University

Location	Household #	

Greetings! We are conducting a survey on behalf of BRAC University on potable drinking water. We will be grateful if you agree to cooperate with us and allow us some of your time in responding to the questions. The information collected here will be confidential and available only to researchers. However, policy results will be shared with all relevant agencies.
Are you willing to participate in this survey? If YES, please fill in the details and proceed to questionnaire.

Enumerator's Information	Instructions:	Respondent's Information:
Name: ______________ Date: __________ Signature: ______________ Cross checked by: ______________ Date: __________	1. Read the questions carefully. 2. Write down the respondent's answers after viewing the appropriate codes. 3. For questions asking about awareness and perception, do not tell the options to the respondents first. Instead, match their replies with the options given, and then write down the appropriate codes. 4. Use a different font color such as red or blue when typing the respondent's answers.	Name: ______________ Member ID: ____ Road and House #: ______________ Phone #: __________ Housing Information a. Ownership (1=Owned, 2=Rented): ____ b. Type (1=Apartment, 2=Independent, 3=Duplex, 4=Tin) : ___

1. Household Profile (people who live together in a single home and eat their food from the same cooking pot)

							For earning members only			
Member ID (1=HH)	Name	Relation with HH	Sex (0=M 1=F)	Age	Highest Education (see code)	Profession (see code)	Hours worked per day	Days worked per month	How does ID receive salary? (1=Daily 2=Weekly 3=Monthly 4=Yearly)	Salary (BDT)
1.1	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**1.11**
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Relation to HH head (1.4):	**Age (1.5):**	**Education (1.6):**		**Profession (1.7):**
1=HH head 2=Wife/Husband 3=Son/Daughter 4=Son-in-law/Daughter-in-law 5=Parent 6=Parents-in-law 7=Brother/Sister 8=Sister-in-law/Brother-in-law 9=Other 10=Granddaughter/Grandson 11=Unrelated	0=Less than 6 months 1=6 months to 1 year Write full age for more than 1 year (rounded to whole number)	0= No schooling 1=First grade pass 2=Second grade pass 3=Third grade pass 4=Fourth grade pass equivalent 5=Fifth grade pass 6=Sixth grade pass 7=Seventh grade pass	8=Eighth grade pass 9=Ninth grade pass 10= S.S.C./ equivalent 11= H.S.C. / equivalent 12= Diploma/Vocation/Religious education 13= B.A./B.Comm./B.Sc./equivalent 14= M.A./M.Comm./M.Sc./equivalent 15= PhD.	1= Professional (Doctor/Engineer/Lawyer) 2=Govt./Non-govt./NGO officer 3= Govt./Non-govt./NGO worker 4=Businessperson 5=Teacher/Researcher 6=Retired 7=Disabled/ Unemployed/Not looking for work 9=Student 10=Housewife 11=Part-timer 12= Others (specify)

			Codes
1.12	Does your household have any other source of income?		1=Yes, 0=No
1.13	Specify.		
1.14	How much income do you receive from this source (BDT)?		

2. **Wealth characteristics of household**

	Do you own any of the following?	1=Yes, 0=No
2.1	LCD/Plasma TV	
2.2	Fridge	
2.3	Computer	
2.4	AC	
2.5	Generator	
2.6	Telephone	
2.8	Car	
2.9	Two-wheeler/Three-wheeler	

3. **Awareness & Hygiene**

				Codes
3.1	Do you read the newspaper?			1=Yes, 0=No
3.2	Do you listen to the radio?			1=Yes, 0=No
3.3	Do you watch TV?			1=Yes, 0=No
3.4	What kind of pollution do you learn from the media?	Newspaper		0=Did not learn about any pollution 1=Water pollution 2=Air pollution 3=Land pollution
		Radio		
		TV		
3.5	Which is the most serious environmental pollution according to you?			1=Water pollution 2=Air pollution 3=Land pollution
3.6	Name a disease caused by ingesting contaminated water.			1=Hepatitis 2=Typhoid/paratyphoid 3=Cholera 4=Diarrhea 5=Skin disease

			6=Other (Specify)	
3.7	Do you wash your hand…	Before cooking?		1=Yes, 0=No
		Before eating?		
		After defacation?		

4. **Drinking Water Profile**

			Codes
4.1	What is the source of water for your household?		1=Regular/continuous water supply 2=Irregular/discontinuous water supply
4.2	How do you store drinking water?		1=Uncovered container 2=Covered container
4.3	What is the cost of the storage containers? (BDT)		
4.4	How many years have you been using these containers?		
4.5	How many more years do you expect to use these containers?		
4.6	How often do you wash the container before storage of drinking water?		0=Don't wash 1=Once a month 2=Once every two weeks 3=Once a week 4=Once every few days 5=Once a day
4.7	How many liters of drinking water do you require in a day?		
4.8	Do you take any steps for purifying drinking water?		1=Yes, 0=No
4.9	If NO, specify reason.		1=Treatment is too costly 2=Water quality is good enough 3=Time consuming 4=Other
4.10	Do you purchase bottled water?		1=Yes, 0=No
4.11	How many liters of bottled water do you purchase per month?		
4.12	On an average, what is the price per liter of bottled water that you spend? (BDT)		

4.13	Would you consider buying bottled water for total drinking consumption needs?		1=Yes, 0=No
4.14	If NO, specify reason.		1=Expensive 2=Do not trust quality of bottled water 3=Other

Purification Methods Used by the Household

STRAINING			Codes
5.	Do you purify water by straining for drinking purpose?		1=Yes , 0=No
5.1	When do you strain water for drinking?		1=Just before drinking 2=Before boiling 3=Before filtering 4=Before & after boiling 5=At source, before boiling & after boiling prior to filtration
5.2	What is the cost of the strainer (**BDT**)?		
5.3	How many years have you used it?		
5.4	How many more years do you expect to use it?		

PURIFICATION TABLETS			Codes
6.	Do you purify water by purification tablets for drinking purpose?		1=Yes, 0=No
6.1	What is the cost for tablets incurred per month? (BDT)		

BOILING			**Codes**
7.	Do you purify water by boiling for drinking purpose?		1=Yes, 0=No
7.1	How many liters of water do you boil in a day?		
7.2	How many times do you boil water in a day?		
7.3	What is the cost of the boiling container? (BDT)		
7.4	How many years have you been using it?		
7.5	How many more years do you expect to use it?		
7.6	Do you publicly supplied gas or cylinder gas?		0= Publicly supplied gas 1= Cylinder gas

	FILTRATION		Codes
8.	Do you purify water by filtration for drinking purpose?		1=Yes, 0=No
8.1	What is the cost of installation of the filtering system (BDT)?		
8.2	How much maintenance cost do you face for the filter (BDT)?		
8.3	For how many years has the system been installed?		
8.4	For how many more years do you expect to use this filter?		
8.5	Is your filter run by electricity?		1=Yes, 0=No
8.6	For how many hours per day do you use electricity to power your filter?		

	PERCEPTION		Codes
9.	Do you consider purification a hassle?		1=Yes, 0=No
10.	If YES, specify why.		1=Time consuming 2=Other
11.	Are you satisfied with the quality of drinking water after purification?		1=Yes, 0=No
12.	If NO, specify why.		1=Unsatisfactory taste/odor/color 2=Perceived Contamination 3=Both 1 and 2
13.	Who engages in purification activity?		0=Domestic worker, 1=Household member
14.	If answer to previous question is 1, does this occupy member's leisure time?		1=Yes, 0=No
15.	How much leisure time (hours per day) is being lost for this?		

16.	HEALTH ISSUES			Codes
16.1	Has there been incidence of any of the following diseases in your household in the past one year?	Hepatitis		1=Yes, 0=No
		Typhoid/Paratyphoid		
		Cholera		
		Diarrhea		
		Other		

16.2	What action do you think you can take to prevent such diseases?		0=None 1=Improving sanitation 3=Improving treatment of drinking water 4=Hygiene 5=Other
16.3	What action can the government take to prevent diarrhea at the household level?		0=Don't Know 1=Provide Clean Water 2=Provide Sanitation 3=Educate the public about prevention methods 4=Other

17. Household information on water-related diseases

	Name & ID (Having diarrhea within last month)	What type of disease did the ID suffer in the last month? (see code)	How many days did the ID suffer in the last month?	How much did you spend for home treatment (total)? **(BDT)**	What was the total cost of medicine in the medical centre? **(BDT)**	How much did ID pay for transportation? **(total) (BDT)**	What was the total cost (without medicine) in the Medical centre? (with doctor's fee) **(BDT)**
	17.1	**17.2**	**17.3**	**17.4**	**17.5**	**17.6**	**17.7**
Child							
Adult							

Water-related disease (17.2):				
1=Hepatitis	2=Typhoid/Paratyphoid	3=Cholera	4=Diarrhea	5=Skin disease

18. Opportunity costs of water-related diseases in the past one year

ID	Name	How many working days did patient lose during and after diarrhea?	How many schooling days did patient miss during and after disease?	How many leisure hours did patient miss during and after disease?
18.1	**18.2**	**18.3**	**18.4**	**18.5**

ID	Name	How many working days did caregiver lose during and after disease?	How many schooling days did caregiver miss during and after disease?	How many leisure hours did caregiver miss during and after disease?
18.6	**18.7**	**18.8**	**18.9**	**18.10**

19. WTP Scenario

The water supplied to residential areas by DWASA does not meet drinking water standards. Consumption of contaminated water causes incidence of water-borne diseases such as diarrhea and cholera. Such diseases cause people to lose to miss work days, school days and leisure time. People also experience disutility from the state of being ill. Besides, unsafe water is characterized by inferior taste, color and/or odor. Hence, households deal with the problems of unsafe drinking water by boiling, filtering, etc. This might be time consuming and troublesome. One solution to the problem of unsafe water in Dhaka city can be to provide households with clean, piped drinking water supply. Households can use this piped water for drinking and/or cooking activities. You will no longer need to adopt water purification activities such as boiling/filtering. This service will also be more convenient than purchasing bottled water since you do not need to leave home for obtaining the water. This service can be provided by DWASA or any other relevant agency. Do you understand the scenario explained? Are you willing to pay for safe drinking water? If YES, please consider how much you value safe drinking water and how its consumption will improve your lifestyle with regards to better health, time management, work for home/office/school and leisure/entertainment activities. What is the price per liter of drinking water that you would be willing to pay to avail this service?				
Enter your bid here (BDT).		If NO, explain why.		1=Satisfied with current water quality 2=Government should provide safe water at nominal rates 3=Other (Specify)

That is the end of the questionnaire. Thank you for taking part in the survey.