THESIS

HOUSEHOLD'S WILLINGNESS-TO-PAY ESTIMATION FOR SAFE DRINKING WATER: A CASE STUDY IN VIETNAM

Submitted by

Quy Van Khuc

Department of Agricultural and Resource Economics

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Master's Committee:

Advisor: John B. Loomis

Christopher G. Goemans
Robert Kling

ABSTRACT

HOUSEHOLD’S WILLINGNESS-TO-PAY ESTIMATION FOR
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This thesis explores consumer behavior of households for drinking water by surveying and analyzing 235 households (HHs) in Hanoi and Hai Duong in the North of Vietnam, and Ho Chi Minh in South of Vietnam. Two classical methods have been employed, Contingent valuation method (CVM) and averting behavior method (ABM). Binary logit regression can help to identify internal and external factors influencing the decision of whether or not to pay for clean drinking water. In addition, the linear regression method allows to explore and to quantify the magnitude of relationship between the dependent variable and independent variables.

Generally, about half of the households surveyed are willing to pay for better drinking water. Most of them are HHs living in two major cities, Hanoi and Ho Chi Minh City. On average for all of the sampled households, the value of willingness-to-pay makes up small percentage of household income, just 0.247% of total household income. The decision to pay for water depends on both internal factors: the level of education and awareness, as well as external factors: living conditions and existing water source. For those households that are willing to pay to get clean water services, income, and current status of water resources are strong variables. In addition, those households that are actively looking for information and learning related to water often pay a fee for water use.

Different measures are practiced by HH’s to prevent diseases caused by possible polluted drinking water. Of the five averting activities, boiling water is HHs’ priority in rural areas due to low cost while buying bottled water is HH’s choice in the city because of the convenience.

Young people tend to use bottled water more than old people. Using a water filter increases amount of money they would be willing to pay for clean water, while income and habitat of using drinking water are also strong factors in determining willingness to pay a higher monthly water bill. This survey has compared two values: the value of WTP and the cost of averting expenditure (CAE). My results showed that WTP is not always greater than CAE. Empirical results have policy implications on drinking water price strategies and drinking water related projects investment in Vietnam. Policy-makers or planners should consider income, gender, level of education, existing water sources, lifestyles, and locale when making drinking water price strategies and water related investment.

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To end my acknowledgment I would like to quote lines of poetry "My gratitude of the life" which has just composed by me recently:

"I am grateful to life for it gives me a life
I owe the life since it loves me
I want to tell you by my honest heart
Thank the life much and it will live forever"

Fort Collins, October 9, 2012
Quy Van Khuc

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CHAPTER 1

Introduction

The 20th Century witnessed a population explosion in many countries around the world. The increase in population led to many negative consequences for society, especially environmental aspects. Population growth does mean that demand for food and social services increase as well. Through industrialization and urbanization, humans beings increasingly exploit natural resources and emit much more toxic pollution to the environment, which is the main cause leading to pollution of the natural environment. (World Water Council).

Water is one of the valuable resources, not only the people use daily, but also it is an indispensable material in the agricultural, industrial and economic activities. In particular, clean drinking water plays an important role in the protection of health and the reduction poverty in households. In fact, unexpectedly, water source is becoming over exhausted, pollution. Clean water is becoming scarce and expensive.

World Health Organization (WHO), in 2010, published a picture of water that 6 billion people on earth, there are nearly one sixth of the population without access to safe water, and most of them takes place in the developing countries. The report noted that nearly 2 billion people, mostly children under 5 years old in developing countries die from diseases dangerous diseases such as Diarrhea and Cholera caused directly by unsafe water source.

There is a widespread recognition that access to and use of safe drinking water is the basic need of human beings in the world. However, unexpectedly, it has problems. Recently studies of Mirajul Hag, 2007 have shown that there exists a positive relationship between income and percentage of the population have access to clean drinking water. A small percentage of investment in water-related households will bring great effect in preventing and reducing relevant diseases.

Vietnam is a low-income country and becoming a middle-income country in 2009. How the people have access to clean water and how effectively they use it is much attracting and appreciating by whole society. Until 2008, approximately 87% of the population lives in rural areas having access to safe drinking water. Regarding to available safe water system, Vietnam is being ranked 96 of 140 countries in the world (National Master Website).

Management and use of water resources in rational and effective way is a very challenging job. First of all, an understanding of water use at the micro level like household level is needed, having a great meaning. (Dale Whittington). Lack of information on household preferences in regard to potential improvements in water services is an important impediment to the implementation of public provision of safe and reliable drinking water supply systems. Better understanding of household preferences allows us to determine the preferred level of services and help designing appropriate policies for recovering maintenance costs and setting the project sustainable (William F. Vasquez, 2009). On the importance of valid estimates of willingness-to-pay (WTP) researchers agree with managers. Hence, it is imperative to get insight into the safe drinking water supply situation, households' perception about their willing to pay for safe drinking water. Considering valid estimates of willingness-to-pay is essential for developing an optimal pricing strategy in marketing. Such estimates can be used to forecast market response to price changes and for modeling demand functions (Balderjah, et al. 2010).

Therefore, to help the policy-makers and water service suppliers who have to set the reasonable price of water for residential consumption yearly, even monthly, the estimation of

WTP for safe drinking water is conducted. The study will estimate how the consumers who come from different status and characteristics response to the current drinking water sources. In particular, how they think about drinking water, how satisfied they are, what is their strategy they apply to use water effectively, what are the things that they need to meet their demand in terms of quantity and quality of drinking water. The study would also measure the averting expenditures bore by the households in the past and estimate WTP value for safe drinking water at present and in future. The metal-analysis and comparison between the different values of WTP and other costs would be made in sophisticated manner.

This study will estimate and analyze the magnitude of awareness, perception, practices and demand for safe drinking through using the classical method, averting cost or avoid cost and contingent valuation method (CVM). The Willingness-to-pay (WTP) for improved water quality will be conducted in three site surveys. Data is collected from 235 households (HHs). 49 HHs in Hanoi city, 97 HHs in Hai Duong province in the North of Vietnam, and 89 HHs in Ho Chi Minh city in the South of Vietnam. The binary and multinomial logit techniques are used in order to measure the effect of these variables on different purification methods and WTP separately in a manner. This study's main objectives focus on is:

(1) To describe the current drinking water sources used by HHs, and measure the magnitude of the perception of the people through their response to such the water;
(2) To measure households' ability and WTP for improved drinking water quality;
(3) To highlight and analyzed issues and factors influencing WTP in different survey sites; and
(4) To propose empirical policy implications.

The rest of the paper is organized in five chapters in detail as follow: Chapter 2 contains a review of relevant literatures on and methods used in the study: Contingent valuation method (CVM), adverting behavior method (ABM). In chapter 3 the main characteristics of the respondents and households and the responses to drinking water sources in terms of water quality and the valuation are described. Chapter 4 presents empirical results on WTP with in-depth analysis and WTP estimation using averting method (AM). As an important part in the study, the two WTP estimations mentioned above would be discussed. Chapter 5 ends by conclusions, and empirical suggestions on policy implication.

CHAPTER 2

Literature review and analytical framework

2.1. WILLINGNESS-TO-PAY AND ESTIMATION

Willingness to pay is what the concept of economic value is based on. The concept is if good is worth having, then it is the maximum amount that an person state they are willing to pay for a good (DFID, 1997). This principle is conceptually-simple and intuitive, even if not always easy to undertake, and its theoretical foundations can be located in conventional economic theory. As WTP values benefits in monetary terms, outcomes are comparable across all principles and are directly commensurate with costs. By way of precedent, environmental economists have already found the approach helpful in quantifying gains and losses in circumstances where, for whatever reason, market prices cannot be assigned to economic activities (Emma J. Frew, et al. 2005). The concept extends to environmental resources like water quality and natural resources like trees. The key assumption is that environmental values are anthropogenic. Whatever people evaluate the environment is worth is what it is worth. Economic methods can be used to attach estimates of willingness to pay to changes in the level of environmental quality and natural resource use. The use of the willingness-to-pay (WTP) technique as a means of evaluating health care technologies and environment has been increasing. WTP is now used in interdisciplinary studies for multi-purposes.

The WTP for better water quality has usually been drawn from the so-called averting expenditure model (ABM). The concept underlying the ABM is that individual’s valuation of an environmental “bad” can be measured through the money spends to defend herself against this bad (Beaumais, 2010). For example, HHs may find the way to avoid getting the health risks associated with exposure to unsafe drinking water through purchasing water filters or bottled water. Of course, boiling water is the cheapest way widely used by most of them. ABM, in fact, is measured by both revealed and stated preference approaches. The first refers to the actual costs that the households had to pay, while the later refer to the potential costs that they state how much their expenditure would be under hypothetical scenarios of environmental degradation. However, ABM in response to an environmental “bad” represent a lower bound for WTP for reductions in environmental degradation, which itself provides decision-makers with a minimum criterion for cost-benefit comparisons (Beaumais, et al. 2010).

It would appear that there have been numerous articles, papers, scientific documents written on WTP so far. According to Oliver Beaumais, 2010, two main study groups working on different sub-fields are identified. The first group of the studies has worked on how much the people to pay for reducing the concentration of bacteria or contaminating industrial pollutants to the public standard for drinking water quality. The second group of studies has analyzed water pollution by agricultural chemical residues.

Recently, reviews of drinking water quality studies in Less Developed Countries (LDC) reveals estimation of WTP value of HHs for safe drinking water have been published. Firstly, In 2009, the study uses a referendum-format contingent valuation (CV) survey to elicit household willingness to pay responses for safe and reliable drinking water in Parral, Mexico conducted by William F. Vasquez. The main results of the study show that the households currently adopt many averting and private investment choices like bottled water consumption, home-based water treatment, and water storage facilities to adapt to the existing water supply system. The behaviors imply the latent demand for safer and more reliable water services. The author demonstrates that the households are willing to pay from 1.8% to 7.55% of reported household income above their current water bill depending upon the assumptions about response uncertainty.

Mirajul Haq’s work, in 2007, represents the willingness-to-pay of the household level for safe drinking water, conducted in Abbottabad district, Pakistan. The author finds that the existing system of drinking water in the case study is not reliable in both services and quality to meet the requirements of the HHs and the reliability of both water services and quality is of value to them. Moreover, the location in urban areas is an important factor affecting the WTP for improved water services. For averting behavior strategies, the study show that education factor has statistically significant effects on the water purification behavior of the HHs. And finally the water quality and awareness have an effective role in influencing the general public perception towards the opportunity cost for using unsafe water.

Similarly, M. Genius, E. Hatzaki, 2008, studied on evaluation consumer’s willingness to pay for improved potable water quality and quantity. The study is conducted in Municipality of Rethymno, Greece. By using CVM methodology, the author found that female respondents, households with high income, with children, and households that do not use tap water for drinking, are on average willing to pay more.

A reliable study that provides a systematic overview of experimental evidence on WTP for safe drinking water in less developed countries is come from Clair Null, 2012. The author illustrates that in recent years there has been a major push to expand access to safe water by promoting water quality improvements, particularly point-of-use water treatment technologies such as filtration and chlorination. WTP for water quality improvements is less than the cost of the technology since it is difficult for households to observe the private benefits in terms of improved health.

WTP estimation

Several authors proposed different hierarchical classification frameworks to organize existing methods to WTP estimation (Breidert, et al 2006). Nagle and Holden (2002) classify method for measuring price sensitivity at the highest level into uncontrolled and experimentally controlled measurement of the variables. In the latter, a competitive context is present. Balderjahn (2003) quantify estimation methods on the highest level, whether they elicit price information at the individual level or at the aggregate level. Furthermore, Alison Wedgwood, 2003 declares that there are three ways to estimate WTP.

(1) Observing the prices that people pay for goods in various markets;

(2) Observing individual expenditures of money, time, labor, etc. to obtain goods or to avoid their loss; and

(3) Asking people directly what they are willing to pay for goods or services in future.

Obviously, even though several methods could be applied for measuring willingness-to-pay, the advantages and drawbacks of the methods are not discussed here but the discussion of the different methods clearly indicates that the simple method that should be used does not exist. Rather it depends on the objective of the policy-makers or researchers. If costly methods can be applied and quick results are not of main interest, different pricing strategies can be examined with field experiments in real market settings. If estimations of willingness-to-pay are needed frequently, it can be more efficient to apply less time consuming and less costly surveying techniques.

In this paper, basically, direct approach is used in this study for making reliable estimates of households' WTP for improvement in service and quality of water. Contingent valuation method (CVM), the approach uses stated preference simply directly ask individual how much he or she would be willing to pay for the better water services.

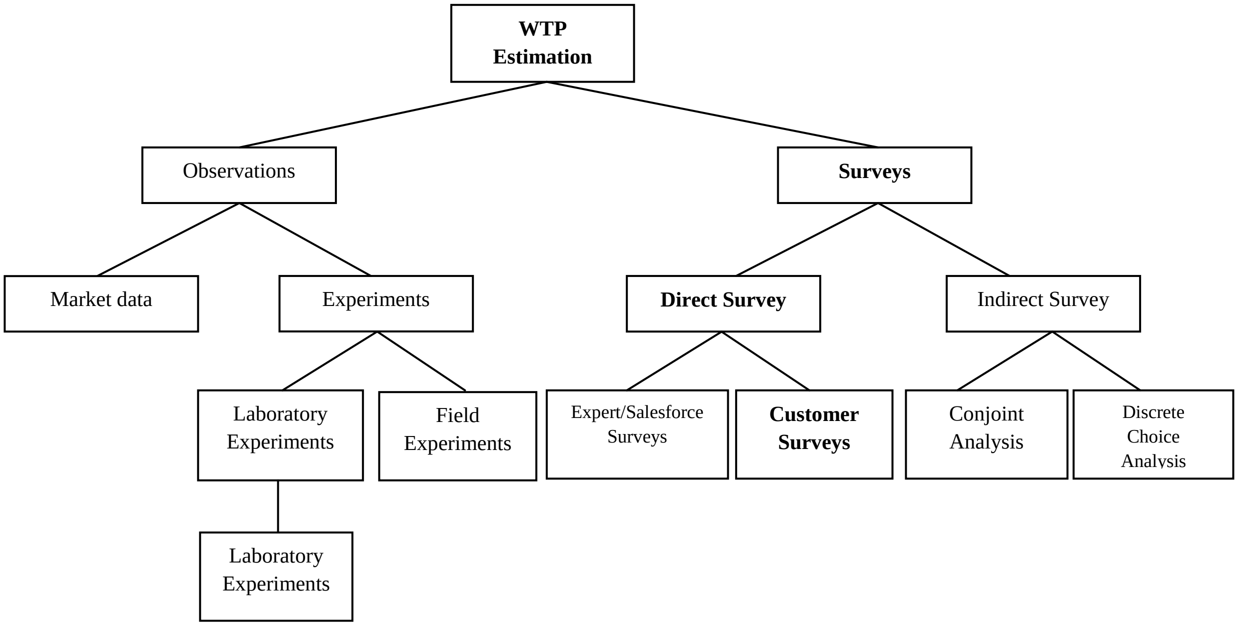


Figure 2.1 Classification of methods for estimation of willingness-to-pay (Christoph Breidert1, et al 2006)

2.2. CONTINGENT VALUATION METHOD (CVM)

The contingent valuation method (CVM) is a simple, flexible nonmarket valuation method that widely used in cost-benefit analysis and environmental impact assessment (L.Venkatachalam, 2004). CVM surveys should carefully describe both quality levels and ask for respondent willingness-to-pay for the change in quality (Mirajul Hag, et al. 2007). Its application in environmental economics consists of estimation of nonmarket use value and non-use values or both of environmental resources (L.Venkatachalam, 2004). The basic assumption underlying in this method is to represent or valuing the objective quality improvement that the survey asks them to value. In recent time CVM has been extensively applied in both DCs and LDCs to the valuation of a large range of environmental goods and services. CVM has been successfully used to a variety of water related issues including sanitation, water supply (Mirajul Hag, et al. 2007)

CVM model

Depending on property rights and institutions, water may be a non-market good, so non-market valuation method would be required to estimate the WTP.

Given the utility function U (q, t), where q is water quality and t is composite of all market goods. The utility function shows the individual's preferences over goods in both market and non-market goods. Consumers, in general, want to maximize her utility from quantity and quality of goods and services with budget constraint.

Given the expenditure function e (p, q, u), which measures the minimum amount of money the consumer must spend to achieve the given level of utility. Expenditure function is increasing function of 'P' and 'U' and decreasing function of 'q'. Now the consumer needs to minimize their cost while keeping constant the utility. Min (t + Pt) subject to U = (q, t) where price of composite good are equal to 1 (pt = 1). Using Lagrange's Multiplier, we could solve this problem above to obtain Hicksian demand for the corresponding goods.

Given Hicksian demand function, $h_i = h_i(p_{q,}\ u^*)$. Minimum expenditure function can be calculated by substituting the values of corresponding Hickisian demand in the minimum expenditure function:

$e^* = e\ (p, q, u^*)$

Where e is minimum expenditure required to achieve fixed level of utility $u^*$and using the water quality q, and is the function of price of other goods, the fixed level of utility and the quality of water itself.

The derivative of expenditure function with respect to price gives corresponding Hicks Compensated demand function for good.

$\partial e/\partial p_i = h_i\ (p_q, u^*)$

WTP for the change in water services is the integration of marginal WTP to achieve water quality from q to q^*

$$WTP = -\int_{q}^{q*} \partial e\ (q, u*)/\ \partial q\ \ dq$$

WTP is the maximum amount of money consumer would give up in order enjoy an improvement in quality. The willingness to pay for the improvement in quality is:

$WTP = e\ (p, q, u) - e\ (p, q^*, u)$

Where, q is a degraded level of quality and q^* is an improved level of quality. The difference in expenditure is either compensating surplus or equivalent surplus, if the reference level of utility is initial utility it is compensating and if the reference level of utility is final then it is equivalent surplus. WTP depends on income, wealth, household education level, distance from existing sources etc (Mirajul Hag, et al. 2007).

2.3. AVERTING BEHAVIOR METHOD (ABM)

Averting behavior model (ABM) suggests that WTP depends on any variable that affect the marginal product of pollution, mitigating activities or avoidance cost (Freeman, 1993). The economic effect of unsafe drinking water include change in the expenditures and well being in terms of medical costs, earning lost, lost production in the home, lost leisure time, and mitigating expenditures. Averting behavior (AB) begins with the assumption that people make choices in order to maximize their level of well-being when faced with exposure to unsafe drinking water Cropper and Oates,1991. The study adopted the previous model used by Smith 1991, Cropper and Freeman 1991, Freeman 1993, Bresahan, Dickie, and Gerking 1997, Whitehead 1998, etc.

The inadequate and unreliable water supply has made consumer to move towards more reliable alternatives. Therefore consumers engage in various averting behavior to cope with unreliable water quality. Suppose consumers engage in variety of averting behavior (Boiling water, installation of water filter, etc) with unreliable water quality. The averting behavior good provides utility indirectly through health production, or indirectly in the utility function (e.g. in case of boiling water, filtered water). In other words, individuals gain utility directly through the consumption of water and indirectly through the production of health is assumed. In the typical ABM, such as that developed by Courant and Porter, averting behavior activities enter the utility function only through the production of health (Mirajul Haq, et al. 2007).

ABM model

According to Mirajul Haq, 2007 ABM would begin with the utility function:

$$U(X, H, A, Q) \qquad (1)$$

Where X is composite market good; H is health production function; A is averting behavior (boiling water, installation of filter, and so on; Q is drinking water quality. U_A >0 and U_Q <0 Healthy time is produced through the heal production function:

$$H = H\ (A, Q; M, K, D) \qquad (2)$$

Where M is mitigating behavior (doctor visits, medicine); K is health capital; D is human capital. Substitution of health production function (2) into the utility function (1) yields the utility function expressed in composite commodity, leisure, averting behavior, and pollution

$$U = [X, H\ (A, Q), A, Q] \qquad (3)$$

In addition, the income function and cost function have its formula:

$$Y = w\ (T\text{-}H) = wT - wH = wT - wH\ (A, Q) \qquad (4)$$

$$C = X + P_A A \qquad (5)$$

Where w is the wage, T is total time available, $P_X = 1$, and P_A is the market price of averting strategy.

Equating the income function (4) and cost function (5) creates the full income budget constraint.

$$wT - wH\ (A, Q) = C = X + P_A A \quad \text{or} \quad wT = wH\ (A, Q) + X + P_A A \qquad (6)$$

The problem that the consumers have to face is:

Max U = U (.) subject to the constraint function (6)

Lagrange function (L) is expressed:

$$L = U[X, H\ (A, Q), A, Q] \quad + \lambda\ [wT - wH\ (A, Q) - X - P_A A\ ] \qquad (7)$$

First-order conditions for utility maximization need to be satisfied, in which

$$L_A = 0 \text{ or } U_H H_A + U_A - \lambda\ (P_A + wH_A) = 0 \qquad (8)$$

We can rewrite the equation (8) as follow:

$$U_H H_A + U_A - \lambda\ (P_A + wH_A) = 0$$

$<=> (U_H H_A + U_A)/\lambda = (P_A + wH_A)$

$<=> (U_H H_A + U_A)/\lambda - wH_A = P_A$

$<=> (U_H H_A + U_A)/\lambda - wH_A = P_A + wt_A$ (9)

$<=> (U_H + U_A)/\lambda – w = P_A/H_A$ (10)

Since $P_A = P_A + wt_A$ where P_A is the market price and t_A is the time the consumers conduct the behavior.

The function (9) indicate that the marginal benefit of averting behavior (marginal value of healthy time, the marginal value of adverting behavior, the opportunity cost of healthy time) on the left hand side (LHS) equals the marginal cost of averting behavior (the market cost, time cost) on the right hand side (RHS). Individuals or consumers will pursue averting behavior until the value of LHS equals RHS.

Similarly, $L_Q = 0$

$<=> U_H H_Q + U_Q – \lambda w H_Q = 0$ (11)

$<=> U_H H_Q + U_Q = \lambda w H_Q$

$<=> (U_H H_Q + U_Q)/\lambda = wH_Q$

$<=> (U_H H_Q + U_Q)/\lambda - wH_Q = 0$ (12)

The function (12) shows that the individuals or the consumers would avoid pollution until the total of the marginal value of healthy time, the marginal value of quality and the opportunity cost of healthy time on the LHS equals zero.

The indirect utility function is formed by substituting the optimal values of averting behaviors, mitigating behavior and leisure into utility function.

$V = V (P_A, PM, W, Q)$ (13)

Totally differenciating the indirect utility function (13) yields:

$$dV = V_{PA} dP_A + V_w d_w + V_Q d_Q \qquad (14)$$

So total derivative of quality yields:

$$dV/dQ = V_w (dw/dQ) + V_Q \qquad (15)$$

Therefore, $WTP_Q = dw/dQ = -v_{Q/\lambda}$ (16)

Besides, the marginal utility of pollution could be expressed below:

$$V_Q = (U_H - \lambda w)H_Q + U_Q = 0 \qquad (17)$$

And we can rewrite equation (8):

$$U_H H_A + U_A - \lambda (P_A + wH_A) = 0$$

$$\Leftrightarrow U_H - \lambda w = (\lambda P_A - U_A)/H_A \qquad (18)$$

Plugging equation (17) into (18) yields:

$$V_Q/\lambda = P_A (H_Q/H_A) - (U_A/\lambda)(H_Q/H_A) + U_Q/\lambda \qquad (19)$$

The function (19) implies that marginal value of quality could no longer be estimated with the understanding of production function and market prices with joint production and marginal utility of quality. Averting behavior would increase when joint production increase pollution.

Now putting the optimal values of A*(.) into health production function and totally differentiating yields:

$$dH = H_Q dQ + H_A dA^* \qquad (20)$$

Dividing both sides in function (19) by dQ yields:

$$dH/dQ = H_Q + H_A (dA^*/dQ) \qquad (21)$$

The function (21) indicates that the total effect on LHS is the sum of a direct effect (the marginal product of pollution on healthy) and indirect effect (the marginal product of averting behavior on healthy time and the marginal effect of pollution on averting behavior) on the RHS.

Multiplying both sides in function (21) with w yields:

$$w(dH/dQ) = w[H_Q + H_A(dA^*/dQ)] \qquad (22)$$

Multiplying both sides in function (22) with function (10) yields:

$$[dH/dQ - H_A(dA^*/dQ)][(U_H + U_A)/\lambda - w] = P_A(H_Q/H_A) \quad (23)$$

And since $P_A = H_A[dA^*/dQ)][(U_H + U_A)/\lambda - w]$

Therefore, $WTPQ = -P_A(H_Q/H_A)$

$$= -(dH/dQ)(U_H + U_A)/\lambda + w(dH/dQ) + P_A(dA^*/dQ) \qquad (24)$$

The function (24) indicates that marginal willingness to pay for quality on LHS broken into four components:

(1) The sum of the non-market value of the disutility of non-healthy time

(2) The aesthetic value of quality

(3) The opportunity cost of illness

(4) Averting expenditures after the optimal adjustment to the quality shown on the RHS of equation (24).

Obviously, these are consistent with the willingness to pay for small decrease in pollution can be divided into for components:

(i) The disutility associated with symptoms or lost leisure

(ii) Incurred medical expenses due to health effect from exposure to pollution

(iii) Lost wages due to health effect from exposure to pollution

(iv) Expenditure on averting actions taken to avoid health effects

Therefore, the willingness-to-pay for a reduction in pollution levels includes the individual value of savings on all four of these components (Leslie A Richardson, 2011). In this study, we would present the cost of averting expenditure associated with exposure to the potential contaminated drinking water used at home.

CHAPTER 3
Methodology of research and description of data

3.1. SAMPLING STRATEGY AND QUESTIONNAIRES

We combine the 2009 population census and the questionnaires namely “health during the station fire, tell us what you think” done by Loomis, 2010 as the sampling frame and survey instrument, respectively, for collecting data. 235 HHs are interviewed to find the information on the topic. Since we assume that the WTP for safe drinking water depend on many factors, so first, households in different areas had different water use status and demographics are interviewed. More specific, the survey site is designed in three different areas, Ha noi city, Hai Duong province, and Ho Chi Minh city. Ha Noi is the capital of Vietnam, while Hai Duong is the province where most people live now on agricultural production. Both Ha Noi city and Hai Duong province are in the North of Vietnam. In contrast, Ho Chi Minh city is the South of Vietnam, which is the biggest and dynamic city in terms of economic and entertainment side. The existence of some water sources like rain water or well water would be considered as good substitute for factory water or others when looking at economic aspect. In addition, the quality of water source and the cost that the households bear are important variables affecting the households’ decision on WTP. Such information would also be the indicators reflecting the level of satisfactory of the respondents. Information group regarding to the households’ response to water are an important part of data for this thesis. Questions are asked on whether the respondent is active to find the knowledge of water use, management or if they ever complain the water quality on water service suppliers.. These would show the perception or awareness of the respondent of the household on water. Obviously, each respondent come from different socio-economic conditions would respond differently, so it may affect WTP value. Furthermore existing treatment method like boiling, using water filter are used by the household would contribute to their decision on WTP, so it is also gathered. Finally, of course, the information on individual and household like sex, age, job or the level of education and income are always assumed as important variable in the regression model.

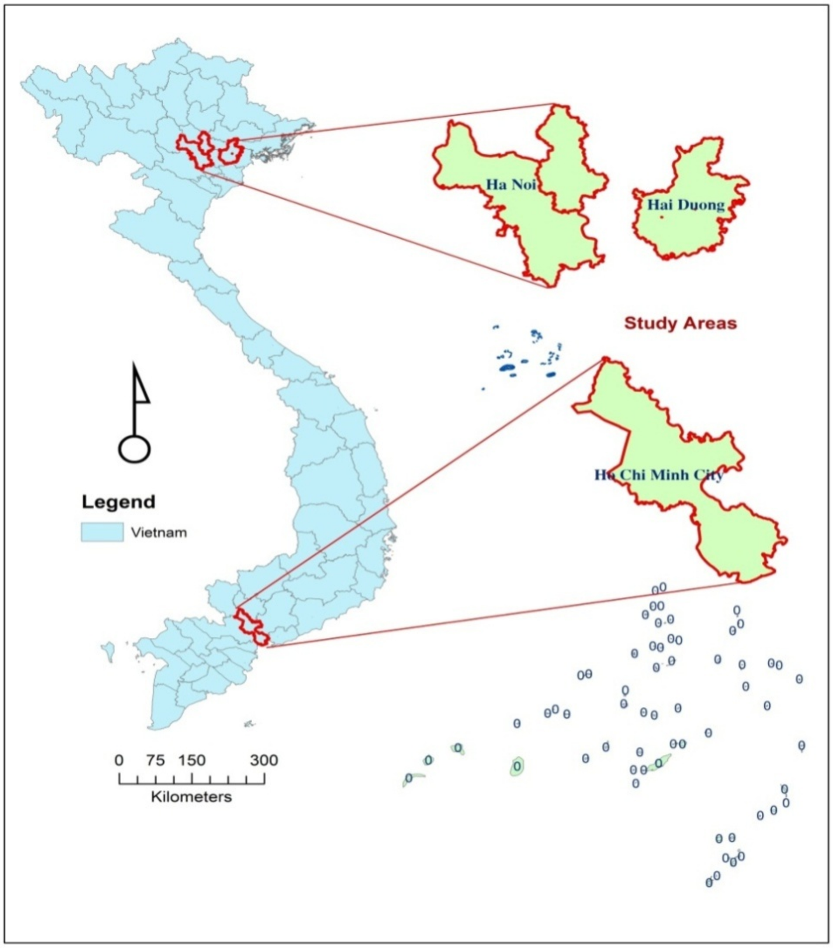


FIGURE 3.1 Study Areas in Vietnam

TABLE 3.1

Description of Variables

Variables		Description	Unit
Household related	REGI	Administration area where living (Hai Duong province: 1, Ha Noi city: 1, Ho Chi Minh: 0)	-
	LOCA	Local where living (city: 1, rural: 0)	-
	FAM_SIZE	People per household	-
Individual related	GEND	Gender (male: 1, female: 0)	-
	AGE	Age	Year
	JOB	Job (regular worker: 1, official staff: 3, manager: 4, over 60 years old and has no salary: 5, unemployment: 6)	-
	INCO	Monthly respondent income	MVND [1]
	HEA_HOU	Head of family (yes: 1, no: 0)	-
	EDUC	The level of education (Uneducated 0, elementary school: 1, secondary school: 2, high school: 3, university, collegue, vocational school: 4, graduate level: 5)	-
Water source related	FAC_WAT	Using factory water daily (yes: 1, no: 0)	-
	PUM_WAT	Using pump water daily (yes: 1, no: 0)	-
	WEL_WAT	Using well water daily (yes: 1, no: 0)	-
	BOT_WAT	Using bottled water daily (yes: 1, no: 0)	-
	RAI_WAT	Using rain water daily (yes: 1, no: 0)	-
Response-to-water related	ACT_KNO	Self-active to know about water (Yes: 1, no: 0)	-
	COM_SER	Have ever complain or talk to water supplier about quality of the water (yes: 1, no: 0)	-
	TAL_SAV	Sharing opinions on how to save water for others (yes: 1, no: 0)	-
Relevant cost and averting treatment related	WAT_FIL	Using water filter daily (yes: 1, no: 0)	-
	WATFIL_COS	Water filter cost	MVND
	BOI_WAT	Boilling water before drinking daily (yes: 1, no: 0)	-
	TMC	Monthly factory and bottled water bill	MVND

[1] MVND = Million Vietnam Dong = Million VND, in which 1 MVND is around 50 USD or 1 USD is equal to 20,000VND (according to 2012)

The survey is conducted in Ho Chi Minh city first, and then Hai Duong province, and finally Ha Noi city. In-person direct method is applied. All interviews are face-to-face for each household (the sampling unit). Heads of households or person who knows about water used at his or her house is chosen to interview to ensure the validity of the information about their households' water use behavior. Importantly, the respondents are randomly selected in all three survey sites. The contingent valuation method (CVM) and averting behavior method (ABM) are used to collecting data. The household questionnaires are designed and developed. 6 collaborators are trained and used to support the author to collect data, in which 3 people in Ho Chi Minh city, 1 person in Ha Noi and 2 people in Hai Duong province. The questionnaire is broken into four main parts. Part 1 asks about relevant water- sources used, the quality and the monthly water bill. Part 2 asks about how much the household and individual willingness to pay for safe drinking water; Part 3 asks about personal information covering gender, job, and income, etc. The last part asks more about the perception or the awareness of the respondents in terms of water use and management. Although all the respondents are randomly selected, they all are informed in advanced by the head of village or local. This makes sure that the available respondents who have enough knowledge and information to response to the question.

3.2. ECONOMETRICS FUNCTION AND ANALYSIS

It would appear to be an existence of the relationship among variables but we do not know how many independent variables which affect dependent variable or some questions like whether or not income variable can effect significantly on the households' decision to pay for safe drinking water and so on.

Model I: Binary Logit Regression

Model I, binary logit regression is used in this study to to estimate the effects of different explanatory variables on the decisions the HHs make to pay for improved drinking water and on the adoption of water treatment by them at home. One binary dependent variable and set of explanatory ones are used to run the model on SPSS software. The binary dependent variable takes the value equal to 1 if a HHs or individuals are willing to pay for improved drinking water, or they uses some water treatment method and zero if they do not.

Hence, to capture various determinants of whether a household would pay anything WTP, the below binary logit regression is constructed.

General model of Binary Logit Regression:

$$\text{Ln}\frac{P(Y=1)}{P(Y=0)} = \beta o + \beta_1 {*} X_1 + \beta_2 {*} X_2 + \beta_3 {*} X_3 + \ldots + \beta_n {*} X_n \qquad (3.1)$$

In which,

$P(Y = 1) = Po$: Probability of the HHs who are willing to pay

$P(Y = 0) = 1- Po$: Probability of the HHs who are willing to pay

$$\text{Ln}\ \frac{Po}{1-Po} = \text{Ln}\ \frac{P(pay)}{P(no\ pay)} = \beta o + \beta_1 {*} X_1 + \beta_2 {*} X_2 + \beta_3 {*} X_3 + \ldots + \beta_n {*} X_n$$

In this study, model I, the model is simply illustrated by below formula:

$$Y = \beta_0 + \beta_i {*} X_i + u_i$$

Where:

Y: dependent variable take 1 if the answer "yes" and take 0 if the answer "no"

X_i is the independent variable

β_0 is intercept of the regression;

u_i is error term

Model II: Multiple regression

Finding how the independent variables affect the dependent variable (WTP) in terms of quantitative and magnitude are an important component of this study, so model II or multivariate regression is constructed. Through the regression, the marginal effect of independent variables on WTP variable is found. Below is the general formula of model II:

$$WTP = \beta_0 + \sum_{i=1}^{n} \beta i * xi + u_i \quad (3.2)$$

Where:

WTP: dependent variable takes value that is greater than zero; X_i is the independent var ; β_i is intercept of the regression, and u_i is error term.

After the multivariate regression is constructed, we will test the model to check on whether or not it is enough reliable to use. VIF and Durbin-Watson is used to test the multicollinearity and the autocorrelation respectively. Park test is also calculated to check if the model's the error variance is non-constant or if the model has heteroscedascticity. In addition, for the binary Logit regression, Omnibus Tests is applied to check on the reliability of the model. Of course, the value of R-squared adjusted is an important part in the process of knowing the accuracy of the model.

Model III. Predicting changeable probability of dependent variable

Given binary Logit model, using the results of coefficient (β) and Exp (β) = e^ β, we form the scenario of changeable probability of dependent variable when changing the original probability.

Set P_0: Original probability;

P_1: Changeable Probability.

P_1 is calculated by below formula: $P_1 = \frac{Po*e^\wedge\beta}{1-Po*(1-e^{\beta})}$ (3.3)

<u>Other equations</u>

Expected value of WTP and expected cost of averting expenditure

Expected value of WTP (EWTP) is calculated by taking value of WTP times the probability of the respondent who are willing to pay for better drinking water. That is

EWTP = WTP*P(Y=1) (3.4)

Similarly, expected cost of averting expenditure (ECAE) is calculated by taking cost of averting expenditure (CAE) times the probability of the respondent who use averting actions P (Averting action) for safety. That is:

ECAE = CAE*P(AE=1) (3.5)

Confidence Interval for Mean and Median

The data is not normally distributed in lieu of normal distribution, so using one of three methods including Either Krinsky and Robb procedures, Delta, and Bootstrap to calculate the mean and median of WTP is much better than using traditional way. However, sample size of the survey to estimate WTP is large enough, below common formula is used in lieu of other methods to find the confidence intervals for mean and median WTP is still reasonable and acceptable.

That is, 95% C.I for value of WTP is applied the formula:

$$WTP - t_{0.025} * \left(\frac{S.E(WTP)}{n(HHs)}\right); WTP + t_{0.025} * \left(\frac{S.E(WTP)}{n(HHs)}\right) \quad (3.6)$$

3.3. DATA DESCRIPTION

The information on sample respondent and household is shown in table 3.2. It does appear that no very big difference in sex among respondents in Vietnam. That is because 55.3%, 44.7% of the people interviewed are male and female respectively.

Specifically, the rate of the respondent is female in the North (Hai Noi: 44.9%, Hai Duong: 48.5%) higher than that in the South (Ho Chi Minh: 40.4%). The average of the respondent age is around 47.17 years old, in which the respondents who come from Hai Duong and Ho Chi Minh have same age, around 45 years old, while those who are in Ha Noi is older, approximately 51 year olds.

In terms of education level of the respondent, the table 3.2 also illustrates that the people who are not the same in study areas. In general, the level of education of the respondents who are in two big city, Hanoi and Ho Chi Minh is considerably higher than the respondents who are in rural area, Hai Duong province. That is, in Hanoi and Ho Chi Minh, no uneducated respondents are recorded, while there is up to 4.1% of respondents appearing in Hai Duong. In addition, the percentage of respondents who got high school level in Hanoi, Ho Chi Minh is 38.8% and 32,6% respectively, which is higher than that is in Hai Duong 27.8%. Moreover, the percentage of respondent who study graduate school is only seen in Hanoi, 6.1% and in Ho Chi Minh, 7.9%.

Interestingly, the percentage of the respondent who graduated from college, university, or vocational school in Ho Chi Minh is highest, 38.2%, which is followed by Hai Duong, 24.7%, and Hanoi, just around 16.3%. This number is explained that although higher percentage of the respondent which is seen in Hai Duong, there is high percentage of the respondent who got vocational school as well. As a result, a number of respondents graduated from the college or university in Hanoi still higher those is in Hai Duong as usual.

TABLE 3.2

Sampled Respondents and Households

Description	Vietnam	Hanoi	Hai Duong	Ho Chi Minh
Original Respondent rate[2] (N=302)	277/332 (83.4%)	91/103 (88.3%)	98/108 (90.7%)	113/121 (93.3)
Adjusted respondent rate[3] (N=235)	235/332 (70.7%)	49/103 (47.5%)	97/108 (89.8)	89/121 73.5%)
Percentage of female respondents (%)	***97.9/100**[4]* **44.7**	***97.5/100**[5]* **44.9**	***96.1/100**[6]* **48.5**	***91.1/100**[7]* **40.4**
Age of respondent (year olds)	47.17 (13.398)	51.86 (11.859)	45.84 (12.062)	45.91 (14.970)
The percentage of respondent who are uneducated (%)	1.7	0	4.1	0
The percentage of respondent who got elementary school (%)	8.5	10.2	9.3	6.7
The percentage of respondent who got secondary school level (%)	25.5	28.6	34	14.6
The percentage of respondent who got high school level (%)	31.9	38.8	27.8	32.6
The percentage of respondent who graduated from college, university, or vocational school (%)	28.1	16.3	24.7	38.2
The percentage of respondent who study graduate school (%)	4.3	6.1	0	7.9
Percentage of households who are married (%)	92.3	95.9	97.9	84.3
Percentage of respondents who own the housing unit (%)	84.3	77.6	92.8	78.7
Number of people in the household	4.64 (2.243)	4.14 (1.399)	3.82 (1.506)	5.67 (2.750)
Number of people having income in the household	2.81 (1.384)	2.41 (0.972)	2.58 (1.00)	3.33 (1.792)
Monthly respondent's income (Million VND)	***1.387**[8]* **4.75** **(5.220)**	***2.013**[9]* **3.37** **(3.309)**	***1.306**[10]* **3.01** **(1.498)**	***2.737**[11]* **7.39** **(7.251)**
Monthly household's income (Million VND)	11.77 (9.819)	8.34 (4.414)	7.37 (6.282)	18.37 (11.437)
The percentage of respondent who are retired (%)	14.9	20.4	9.3	18
The percentage of respondent who are regular worker (%)	56.2	49.0	73.2	41.6
The percentage of respondent who are official worker (%)	19.6	10.2	15.5	29.2
The percentage of respondent who are manager (%)	3.0	0	2.1	5.6
The percentage of respondent who are over 60 years old, no salary retired (%)	5.5	16.3	0	5.6
The percentage of respondent who are unemployment (%)	0.9	4.1	0	0
Percentage of respondent who got medical check every year (%)	53.7	71.4	27.8	71.9

[2] Original respondent rate is the rate of all respondent (including student) interviewed

3 Adjusted respondent rate is the rate of only households interviewed

4 Sex ration of population in Vietnam, unit: males per 100 female (Source: Statistical Publishing House, 2011)

5 Sex ration of population in Hanoi, unit: males per 100 female (Source: Statistical Publishing House, 2011)

6 Sex ration of population in Hai Duong, unit: males per 100 female (Source: Statistical Publishing House, 2011)

7 Sex ration of population in Ho Chi Minh, unit: males per 100 female (Source: Statistical Publishing House, 2011)

8 Montly average income per capita in 2010 at current prices by income source and by province in Vietnam (Source: Statistical Publishing House, 2011)

9 Montly average income per capita in 2010 at current prices by income source and by province in Hanoi (Source: Statistical Publishing House, 2011)

10 Montly average income per capita in 2010 at current prices by income source and by province in Hai Duong (Source: Statistical Publishing House, 2011)

11 Montly average income per capita in 2010 at current prices by income source and by province in Ho Chi Minh (Source: Statistical Publishing House, 2011)

Regarding to family status, around 84% of the HHs who live in Ho Chi Minh asked to say “married” while this number found in Hai Duong and Hanoi are approximately 98% and 95.9% respectively. Besides, the percentage of the respondent, who is head of family, is 92.8%, 78.7%, and 77.6% in Hai Duong, Ho Chi Minh, and Hanoi respectively. Different family size appears in study areas, in which the average number of people per HHs in Ho Chi Minh is largest, 5.67. It is followed by Hanoi, 4.14 people per HHs, and Hai Duong, 3.82 HHs per HHs. Income is always of important criteria to reflect the standard of living of the household.

In terms of income of household, the number of people who have income in each family found in Ho Chi Minh city is 3.33 while this number found in Hai Duong is 2.58 and in Hanoi is 2.41. Monthly income average in general is 4.75 MVND but it is higher in the South (Ho Chi Minh city: 7.39 MVND) and lower in the North (Hanoi: 3.37 MVND and Hai Duong: 3.01 MVND). As expected, the labor distribution among study areas showing the difference in the geographic, socio-economic conditions. The percentage of the respondents who are regular work in Hai Duong is highest, 73.2%. The last row in the table show that the percentage of the respondents who got medical live in Ha Noi, Hai Duong, and Ho Chi Minh city is 71.4%, 27.8%, and 71.9%. Overall, in this study we capture different information which comes from different aspects like gender, education, income, job, etc. A brief description indicate that the respondents, who are in big city, Hanoi, Ho Chi Minh, have more better condition of living than those who are in rural area, Hai Duong. Such difference in geographic, socio-economic conditions among study areas is assumed important factors which may directly and indirectly affect their willingness-to-pay for better drinking water mentioned later in the next chapter.

TABLE 3.3.a

Water Quality Responses

Description	In Vietnam				
	Factory water	Pump water	Well water	Bottled water	Rain water
The percentage of respondents who say that they see color and smell from water (%)		18.8	4.3		2.1
The response to the quality of water					
The percentage of respondents who say that the quality of water is very good (%)	24.2	1.3		3.1	0.9
The percentage of respondents who say that the quality of water is good (%)	39.8	4.7	1.3	18.8	8.5
The percentage of respondents who say that the quality of water is normal (%)	29	20.3	4.7	3.8	8.5
The percentage of respondents who say that the quality of water is not good (%)	1.3	4.7	3.0	1.7	2.1
The percentage of respondents who say that water is dangerous (%)			0.9		
The percentage of respondents who do not know (%)	2.2	0.4	1.7	3.0	
The percentage of respondents who have no information (%)	3.5	68.5	88.4	69.4	79.9
Total	100	100	100		100
The response to the level of satisfactory of water					
The percentage of respondents who are very satisfied (%)	14.9	1.4		1.5	1.7
The percentage of respondents who are satisfied (%)	42.3	2.8	1.3	10.4	7.3
The percentage of respondents who are normal (%)	36.3	16.6	7.7	7.9	8.6
The percentage of respondents who are unsatisfied (%)	1.8	5.5	3.0	1.5	2.2
The percentage of respondents who are very unsatisfied (%)		0.5			
The percentage of respondents who have no information (%)	4.8	73.3	88	78.7	80.2
Total	100	100	100	100	100

TABLE 3.3.b

Water Quality Responses

Description	In Hanoi				
	Factory water	Pump water	Well water	Bottled water	Rain water
The percentage of respondents who say that they see color and smell from water (%)	87.8	22.9			
The response to the quality of water					
The percentage of respondents who say that the quality of water is very good (%)	30.6	4.1		2.0	
The percentage of respondents who say that the quality of water is good (%)	36.7	8.2		4.1	
The percentage of respondents who say that the quality of water is normal (%)	32.7	49	2.0		
The percentage of respondents who say that the quality of water is not good (%)					
The percentage of respondents who say that water is dangerous (%)					
The percentage of respondents who do not know (%)					
The percentage of respondents who have no information (%)		38.8	98.0	93.9	100
Total	100	100	100	100	100
The response to the level of satisfactory of water					
The percentage of respondents who are very satisfied (%)	19.1	4.3			
The percentage of respondents who are satisfied (%)	40.4	8.5		4.2	
The percentage of respondents who are normal (%)	40.4	44.7	2.0		
The percentage of respondents who are unsatisfied (%)		2.1			
The percentage of respondents who are very unsatisfied (%)					
The percentage of respondents who have no information (%)		40.4	98.0	95.8	100
Total	100	100	100	100	100

TABLE 3.3.c

Water Quality Responses

Description	In Hai Duong				
	Factory water	Pump water	Well water	Bottled water	Rain water
The percentage of respondents who say that they see color and smell from water (%)	25.3	15.2	10.8		4.2
The response to the quality of water					
The percentage of respondents who say that the quality of water is very good (%)	38.1	1.0		6.2	2.1
The percentage of respondents who say that the quality of water is good (%)	30.9	7.3	3.1	6.2	20.8
The percentage of respondents who say that the quality of water is normal (%)	25.8	15.6	10.4	1.0	20.8
The percentage of respondents who say that the quality of water is not good (%)		3.1	7.3	2.1	4.2
The percentage of respondents who say that water is dangerous (%)			2.1		
The percentage of respondents who do not know (%)		1.0	4.2	2.1	
The percentage of respondents who have no information (%)	5.2	71.9	72.9	82.5	52.1
Total	100	100	100	100	100
The response to the level of satisfactory of water					
The percentage of respondents who are very satisfied (%)	19.2	1.1		3.2	4.2
The percentage of respondents who are satisfied (%)	44.9	2.3	3.1	7.4	17.9
The percentage of respondents who are normal (%)	29.5	12.5	17.7	3.2	21.1
The percentage of respondents who are unsatisfied (%)		4.5	7.3	2.1	5.3
The percentage of respondents who are very unsatisfied (%)		1.1			
The percentage of respondents who have no information (%)	6.4	78.4	71.9	84.2	51.6
Total	100	100	100	100	100

TABLE 3.3.d

Water Quality Responses

Description	In Ho Chi Minh				
	Factory water	Pump water	Well water	Bottled water	Rain water
The percentage of respondents who say that they see color and smell from water (%)	51.2	20.2			1.1
The response to the quality of water					
The percentage of respondents who say that the quality of water is very good (%)	4.7				
The percentage of respondents who say that the quality of water is good (%)	51.8			42.2	
The percentage of respondents who say that the quality of water is normal (%)	30.6	9.2		9.6	
The percentage of respondents who say that the quality of water is not good (%)	3.5	9.2		2.4	1.1
The percentage of respondents who say that water is dangerous (%)					
The percentage of respondents who do not know (%)	5.9			6.0	
The percentage of respondents who have no information (%)	3.5	81.6	100	39.8	98.9
Total	100	100	100	100	100
The response to the level of satisfactory of water					
The percentage of respondents who are very satisfied (%)	2.3				
The percentage of respondents who are satisfied (%)	39.5			20.3	
The percentage of respondents who are normal (%)	44.2	4.9		22	
The percentage of respondents who are unsatisfied (%)	7.0	8.5		1.7	
The percentage of respondents who are very unsatisfied (%)					
The percentage of respondents who have no information (%)	7.0	86.6	100	55.9	100
Total	100	100	100	100	100

The table 3.3.a, 3.3.b, 3.3.c and 3.3.d represents the water quality responses of the respondents who live in Hanoi city, Hai Duong, and Ho Chi Minh. Clearly, 5 main water sources are now used by HHs. They are factory water, pump water, well water, bottled water, and rain water. Basically, bottled water is mainly used for cooking and drinking while pump water and well water is preferred to use for washing, cleaning, and bathing. Interestingly, factory water and rainwater is used for multi-purpose. Some use mainly factory water for cooking, drinking, the others like using factory for cleaning, washing or bathing. Very few households used water source mentioned above for business. This results indicate that the households live in rural have relied on the natural water source more than the people live in city do. The response to the quality of water used at home is shown in the table 3.3.a. 44% of the respondent says that they have ever see the factory water has a color or smell, while that is seen for the pump water, well water, and rain water is 18.8%, 4.3%, and 2.1%. Excluding the bottled water, the people evaluate the quality of factory is much better than the others. Near two thirds of the respondents said that the factory water quality is good and very good while just less than 10% of them say again for pump water and rain water, even only 1.3% of the respondent says well water is good. 0.7% of the respondent, reports that well water may be dangerous and harmful to the health. Specifically, up to 87.8% of the household living in Ha Noi said that they see the unusual color and smell from factory water, while this number is found in Hai Duong and Ho Chi Minh is 25.3% and 51.2% respectively.

Table 3.3.a, 3.3.b, 3.3.c and 3.3.d also show the response to the level of satisfactory of water used by HHs. In Vietnam, generally, HHs feel happy with factory water the most, next is bottled water, then rain water, pump water and well water. Specifically, for factory water, few percentage of HHs, only 1.8%, who are unhappy with current water sources while more one

thirds of respondents who feel normal, and near a half of them who are happy and satisfied. Only pump water which got 0.5% of the respondents who are very unsatisfied while only in well water that there is no HHs who say “very satisfied”. In the North of Vietnam, there is no difference in the rate of the respondent who are very satisfied with factory water, which are 19.1% and 19.2% found in Hanoi and Hai Duong respectively, while only 2.3% of HHs who live in Ho Chi Minh feel like that. In contrast, 20.3% of the respondents who live in Ho Chi Minh say “satisfied” with bottled water, while just only 7.4% and 4.2% of HHs who have the same feeling in each sampled study areas, Hai Duong and Hanoi respectively.

Overall, table 3.3.a, 3.3.b, 3.3.c and 3.3.d provide a picture of water quality responses of all water resources used by HHs. There is high rate of respondent who highly appreciate the quality of factory water and bottled water. Especially, the bottled water is preferred more by the Southern people while the Northern people feel happier with factory water. Pump water bring “very unhappy feeling” to HHs, while well water has never make them very satisfied.

CHAPTER 4
Empirical results and discussion

4.1. THE HOUSEHOLD'S RESPONSES TO WILLINGNESS-TO-PAY

The empirical results of 235 HH's response across Hanoi, Hai Duong and Ho Chi Minh of whether or not they are willing to pay for better drinking water are shown in Figure 4.1 and Table 4.1. On average, roughly 51% of the total number of respondents agrees to pay for improved water quality while around 49% of them say no. However, the level of households' WTP appears in three study areas differently. Approximately 71% and 56% of the total households interviewed in Hanoi and Ho Chi Minh say "yes" versus 29% and 44% respectively of them says "no" to pay for safe drinking water. By contrast, in Hai Duong, only 35% of the total household asked say "agree" and 65% of them say "do not agree" to pay for improved water quality. This indicates that the people live in big city would be willing to pay more than those who live in rural area. Again, the difference in WTP responses to safe drinking water among study areas raises an empirical question. What is determinant of WTP of the households? In other words, if geographic characteristics, income and perception become main factors affecting the decision on WTP for improved drinking water. These concerns would be answered in the part 4.2 in this paper. At present, we temporarily leave these questions behind to go on how much exactly the households are willing to pay for safe drinking water.

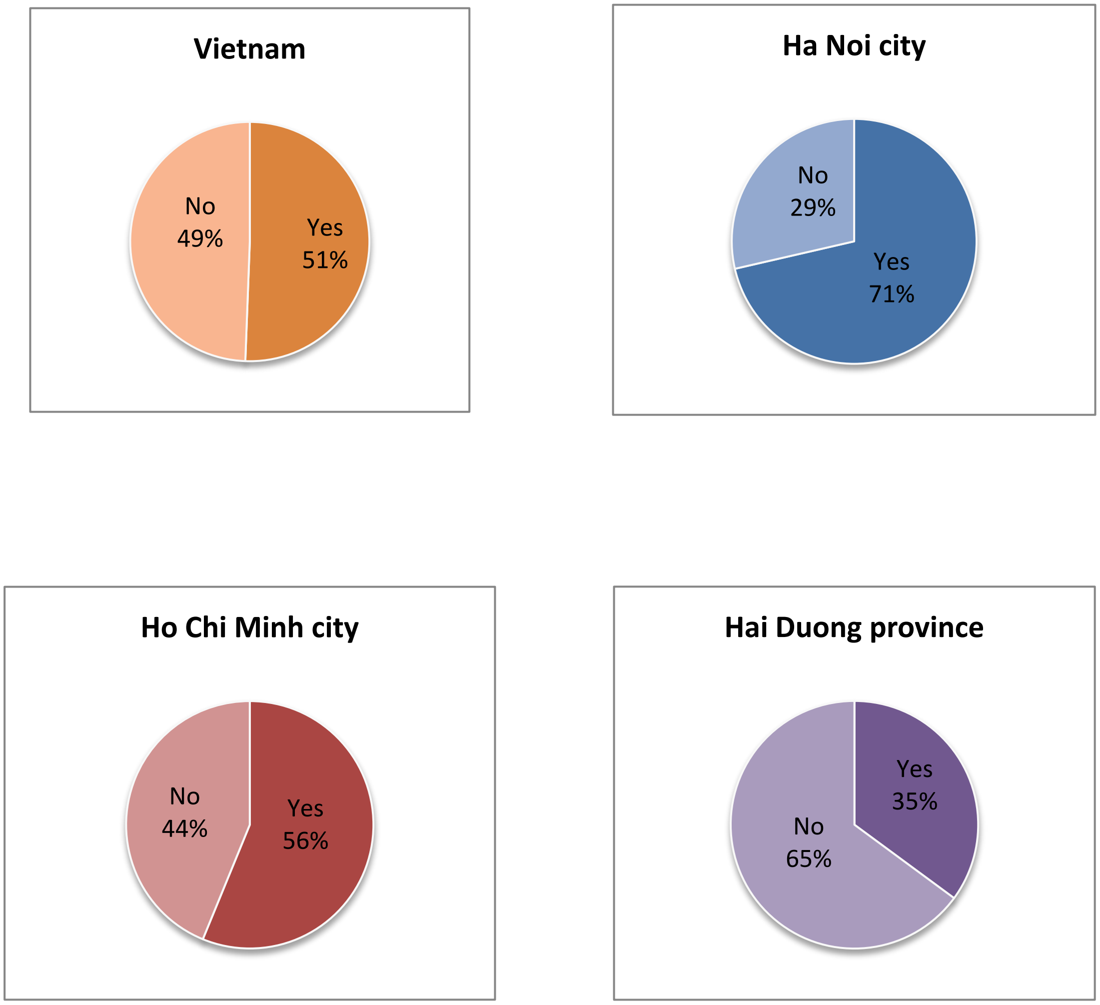


FIGURE 4.1 Acceptance for Willingness-to-pay by Study Area

TABLE 4.1

Summary of Probability of being Willingness-to-pay by Study Areas

Survey areas		Vietnam	Hanoi	Hai Duong	Ho Chi Minh
Number Households pay	(HHs)	119	35	34	50
Percentage of WTP	**(%)**	**51**	**71**	**35**	**56**
Minimum WTP	(MVND)	0.000	0.005	0.000	0.008
Maximum WTP	(MVND)	0.500	0.150	0.150	0.500
Std. Deviation	(MVND)	0.069	0.025	0.037	0.092
Average WTP	(MVND)	0.061	0.041	0.038	0.09
CI (95%) of Mean of WTP [12]	(MVND)	[0.057-0.081]	[0.033-0.049]	[0.025-0.051]	[0.064-0.116]
Expected Value of WTP	(MVND)	0.031	0.029	0.013	0.051

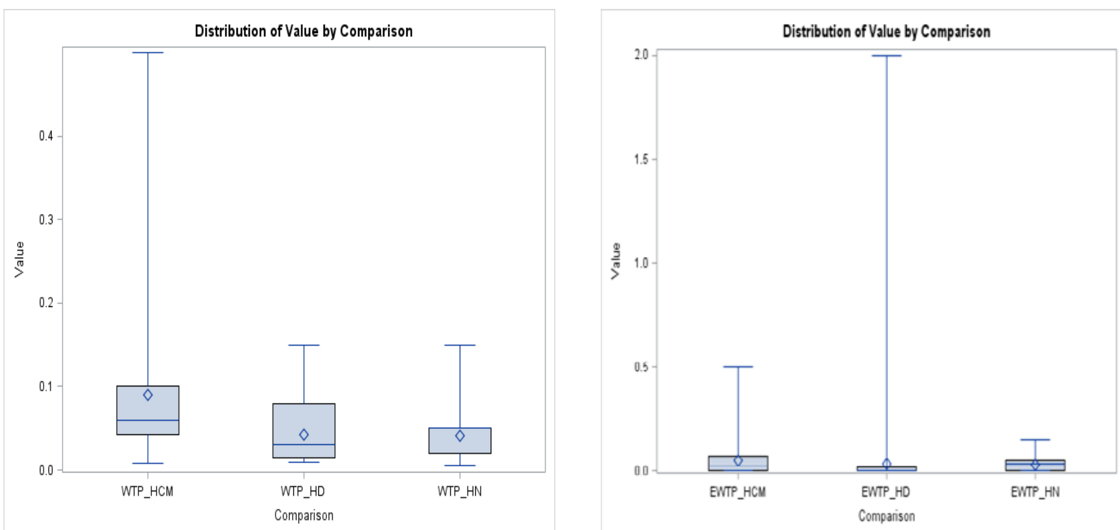


FIGURE 4.2 WTP vs EWTP by Study Area

[12] C.I 95% of WTP Mean is calculated by equation (3.6)

By employing equation (3.4) for calculating Expected Value of WTP (EWTP) and (3.6) for calculating Confidence Interval (C.I) of Mean of WTP, Table 4.1 is constructed. This table represents the specific amount of money that the households who are willing to pay for improved drinking water in all survey sites. Obviously, those respondents in Ho Chi Minh city pay with largest absolute amount of money, 0.09MVND per respondent per month. It is followed by the respondents in Ha Noi and Hai Duong province with 0.041MVND and 0.038MVND respectively. On average, overall of the three survey sites, each respondent who agree to pay for improve water quality with 0.061MVND per month. However, the relationship of WTP and EWTP among Hanoi, Hai Duong, and Ho Chi Minh shown in Figure 4.2 are not statistically different respectively. These empirical results indicates that no matter the people live, in the North or in the South, in big city or in small city, statistical difference of WTP and EWTP are not seen. The different geographic is not strong variable affecting the HHs willing to pay for better drinking water.

4.2. DETERMINANTS OF WILLINGNESS-TO-PAY

Table 4.2 represents the empirical results of factors contributing to WTP across all study areas. The Binary Logit regression is constructed, where dependent variable is the decision if the households are or are not willing to pay for safe drinking water while independent variables are listed in the first column.

Obviously, region, education level, job, existence of pump water, perception and boiling water are determinants that has significantly effect on the households’ decision to WTP for safe drinking water. More detailed, EDUC are the most significant statistic variables with 99% confidence level. These empirical results are also found in By Ifabiy, I.P, (2011). The positive coefficient, 0.880 indicates that the respondent who earn higher education level tend to pay for safe drinking more than the others. With 95% confidence level, the independent variable PUM_WAT is shown with its positive value of 1.786. This would indicate that the HHs who use current pump water daily tends more to pay for improved water than others do. Next, a similar positive coefficient, 1.063 would appear in variables of ACK_KNO at 90% of level of the confidence. This implies that those respondents who are active to learn water related knowledge tend to pay for better drinking water. Expectedly, variable of JOB and LOCA the coefficient is found in the table 4.2 is negative, -0.506 and -1.705 respectively. This indicates that the respondents who are aged over 60 years old and unemployment, and the respondent who live in rural area are not willing to pay for safe drinking water.

TABLE 4.2

Factors of Willingness-to-pay Using MODEL I, Binary Logit Regression

Independent variables	Vietnam	Ha noi		Hai duong		Ho chi Minh	
	Full[13] Model	Full Model	Reduced[14] model	Full Model	Reduced model	Full Model	Reduced model
GEND	-0.190[15] (0.503[16])	-89.676 (22945.521)	Reduced	-1.984 (1.935)	**-4.279**** **(2.018)**	32.385 (33284.449)	**1.234*** **(0.662)**
REGI	-0.846 (0.937)	Reduced by computer[17]	Reduced	Reduced by computer	reduced	Reduced by computer	Reduced
LOCA	**-1.705*** **(0.928)**	Reduced by computer	Reduced	20.244 (17178.356)	**-4.058** **(2.621)**	-15.323 (29901.539)	**-1.680*** **(0.988)**
AGE	-0.008 (0.021)	2.037 (503.269)	0.022 (0.038)	-0.109 (0.075)	-0.031 (0.048)	0.501 (821.936)	0.029 (0.028)
EDUC	**0.880***** **(0.319)**	59.781 (7425.955)	**1.379***** **(0.507)**	1.453 (1.053)	1.253 (0.800)	33.832 (33211.031)	**0.952**** **(0.446)**
JOB	**-0.506*** **(0.265)**	-138.132 (13105.000)	-0.379 (0.245)	-0.808 (1.311)	-0.569 (0.827)	-81.396 (80306.836)	-0.282 (0.333)
HEA_HOU	-0.105 (0.641)	-77.518 (242483.673)	Reduced	6.116 (5.669)	reduced	36.539 (13501.220)	Reduced
INCO	-0.012 (0.056)	41.952 (5362.757)	0.067 (0.139)	0.972 (0.685)	0.519 (0.432)	0.044 (996.532)	-0.005 (0.038)
WAT_FIL	0.235 (0.844)	604.195 (302886.693)	Reduced	**-5.720*** **(3.467)**	-3.090 (2.253)	-31.604 (133236.305)	-1.015 (0.771)
WATFIL_COS	-0.120 (0.318)	-130.264 (63463.608)	Reduced	-0.058 (1.272)	1.884 (1.559)	2.876 (413858.910)	1.432 (1.168)
PUM_WAT	**1.786**** **(0.642)**	18.912 (10475.583)	0.094 (0.807)	1.731 (2.304)	**3.415**** **(1.486)**	-16.519 (99441.291)	-0.473 (0.789)
WEL_WAT	-0.872 (0.912)	398.105 (248302.396)	Reduced	-1.271 (1.847)	**-2.248** **(1.593)**	Reduced by computer	Reduced
BOT_WAT	0.204 (0.760)	-4.0009 (40365.409)	Reduced	3.571 (4.127)	reduced	-14.487 (70141.980)	-0.104 (0.640)
RAI_WAT	-0.266 (0.864)	Reduced by computer	Reduced	20.970 (17178.356)	reduced	-12.981 (39522.267)	Reduced
ACT_KNO	**1.063*** **(0.610)**	-64.666 (61335.772)	Reduced	0.816 (1.149)	0.836 (0.892)	62.449 (54964.038)	**1.806**** **(0.820)**
COM_SER	0.454 (0.754)	-35.091 (20656.389)	Reduced	2.231 (1.912)	**2.706*** **(1.578)**	50.566 (738906.893)	0.260 (0.868)
BOI_WAT	1.583 (1.131)	Reduced by computer	Reduced	46.076 (43710.027)	reduced	43.945 (52844.408)	Reduced
TAL_SAV	0.423 (1.055)	6.136 (41277.123)	Reduced	-23.325 (40192.963)	reduced	-16.155 (35056.071)	Reduced
TMC	4.833 (3.688)	124.315 (43399.664)	Reduced	-32.015 (27.241)	-5.276 (10.112)	-49.396 (132420.116)	Reduced
Constant	-2.434 (1.979)	79.807 (279798.223)	-2.407 (2.931)	-46.735 (66417.775)	0.628 (3.097)	42.613 (175037.271)	-2.886 (2.190)
N	235	49	49	97	97	89	89
Log Likelihood	121.153	0.000	43.856	29.263	44.871	0.000	74.986
LR chi2	31.012	44.316	14.774	33.109	26.303	39.892	32.323
Prob>chi2	0.040	0.000	0.011	0.016	0.015	0.001	0.001

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$

[13] **Full model** is full regression including all possible independent variables collected in survey sites

[14] **Reduced model** is regression excluding some unnecessary independent variables, which are rejected by computer automatically or by hand

[15] For instance, **coefficient** of the Gender variable in model

[16] **Standard error of Coefficient**

[17] **Reduced by computer** is in full model since data contains high multicollinearity or some other problems. This independent variable is excluded automatically from this full model by computer

Similar results are found in Simiret Wendimu (2011), Clair Null (2012), education level of the respondent, reliability on existing water supply, respondent perception are significant that can explain the decision on WTP. Specifically, looking at empirical results of different study areas, while only variable of EDUC has significant statistic in Ha Noi, GEND, LOCA, PUM_WAT, WEL_WAT, COM_SER are the determinants making the difference in the households' decision in Hai Duong. In Ho Chi Minh city GEND, LOCA, EDUC, and ACK_KNO are seen again. Interestingly, the study found that the respondents who are female tend to pay for WTP less, while, as usually, the city-people would pay for WTP more. Making use of water sources like natural source would make the household reduce the probability to pay for improved drinking water. In Hai Duong province, for example, where the household use well water and rain water. Besides, education level would appear to be an important factor in Ha Noi and Ho Chi Minh with 99%, and 95% confidence level respectively while gender has 99% and 95% of level of confidence in Hai Duong and Ho Chi Minh city. Furthermore, the active behavior to learn about relevant water becomes big factor with 99% confidence level.

In summary, several independent variables appear explaining the WTP variable. Overall, those people who live in better condition like big city, who has higher level of education tends to pay more for safe drinking water while the respondents who are female and higher tend to do so in Hai Duong and Ho Chi Minh respectively.

4.3. PREDICTING HOUSEHOLD’S DEMAND FOR SAFE DRINKING WATER

Those HHs who are willing to pay for better drinking water are included in model II. Dependent variable is continuous variable, the positive value of WTP, which is maximum amount of money HHs is willing to pay for better water service as they expect while independent variables are listed on the first column in table 4.3.

Clearly, in Vietnam case, a total of 20 independent variables are considered in econometric analysis, but out of which just only 4 variables appears to be significantly influence the households’ WTP for cleaner drinking water. The parameter estimate for income variable is significant (P-value <0.01) and positive number, 0.006 does mean that the richer households are willing to pay more. The marginal effect result presented in Table 4.3 shows that if the income of the households increase by 1MVND, the marginal effect of WTP would increase by 0.006MVND as well.

Next, the variable of RAI_WAT is found to have significant (P-value <0.05) and positive effect 0.002. This suggests that willingness to pay for improved drinking water increase as the households do use rain water. This might be due to the HHs doubt the quality of rain water that they have ever used rain water for a long time. Unlike two big city, Hanoi and Ho Chi Minh city, in rural area, Hai Duong province, there is high number of HHs using rain water daily. However, recently, through mess media, they more know that rain water is not always safe water source for their health. Therefore, they actually want to protect their health by using better drinking water if they have chance.

The two last independent variables that appear to be significant are BOI_WAT and TMC. Positive parameter estimate, 0.0039, indicates that those households that are boiling water before drinking would also be willing to pay for safe drinking water, while TMC appears to be very strong variable with its coefficient of 0.322 showing the positive relationship between consumption for water monthly with WTP. The positive correlation among WTP and LOCA, TMC suggests that better area to live, higher amount of money the household would pay for.

TABLE 4.3

Marginal Effect of Willingness-to-pay using MODEL II, multiple regression

Independent Variables	Vietnam		Hanoi		Hai Duong		Ho Chi Minh	
	Full Model	Reduced model	Full Model	Reduced model	Full Model	Reduced model	Full Model	Reduced model
GEND	-0.015 (0.010)	-0.001 (0.009)	-0.021 (0.015)	-0.020 (0.012)	-0.022 (0.048)	-0.015 (0.11)	0.099 (0.000)	0.015 (0.031)
REGI	0.012 (0.019)	-0.007 (0.012)	Reduced by computer	Reduced	Reduced by computer	Reduced	Reduced by computer	Reduced
LOCA	-0.018 (0.018)	-0.011 (0.012)	Reduced by computer	Reduced	-0.053 (0.137)	Reduced	0.064 (0.000)	0.041 (0.036)
AGE	0.000 (0.000)	reduced	0.000 (0.001)	-0.001 (0.000)	0.003 (0.005)	Reduced	0.002 (0.000)	-0.001 (0.001)
EDUC	0.001 (0.006)	0.008* (0.004)	0.009 (0.009)	Reduced	0.018 (0.050)	Reduced	-0.056 (0.000)	-0.033 (0.018)
JOB	-0.009 (0.005)	-0.005 (0.004)	0.010 (0.010)	Reduced	-0.026 (0.045)	0.000 (0.009)	0.075 (0.000)	-0.005 (0.011)
HEA_HOU	-0.010 (0.014)	-0.001 (0.011)	0.010 (0.015)	0.010 (0.012)	-0.158 (0.235)	0.021 (0.019)	-0.212 (0.000)	Reduced
INCO	0.006*** (0.001)	0.002*** (0.001)	0.005 (0.006)	Reduced	0.013 (0.038)	-0.002 (0.007)	0.010 (0.000)	0.006*** (0.002)
WAT_FIL	0.008 (0.018)	-0.002 (0.012)	-0.042 (0.050)	Reduced	0.043 (0.084)	0.045 (0.025)	0.045 (0.000)	0.009 (0.030)
WATFIL_COS	-0.001 (0.007)	0.001 (0.005)	0.008 (0.013)	Reduced	0.009 (0.030)	-0.014** (0.006)	-0.015 (0.000)	0.004 (0.023)
FAC_WAT	Reduced by computer	Reduced	Reduced by computer	Reduced	Reduced by computer	Reduced	Reduced by computer	-0.079 (0.077)
PUM_WAT	-0.005 (0.012)	0.010 (0.009)	-0.027 (0.017)	-0.012 (0.015)	0.025 (0.065)	Reduced	0.025 (0.000)	0.010 (0.028)
WEL_WAT	-0.027 (0.019)	-0.014 (0.016)	-0.051 (0.053)	-0.025 (0.040)	0.045 (0.076)	-0.005 (0.015)	Reduced by computer	Reduced
BOT_WAT	0.015 (0.015)	-0.005 (0.011)	-0.005 (0.026)	-0.009 (0.025)	-0.130 (0.139)	0.004 (0.019)	-0.049 (0.000)	-0.013 (0.028)
RAI_WAT	0.002** (0.019)	Reduced	Reduced by computer	reduced	0.046 (0.123)	Reduced	-0.142 (0.000)	Reduced
ACT_KNO	0.012 (0.013)	0.011 (0.009)	-0.013 (0.048)	-0.016 (0.032)	0.025 (0.038)	0.021* (0.012)	-0.019 (0.000)	0.018 (0.032)
COM_SER	-0.003 (0.015)	0.007 (0.010)	-0.017 (0.021)	0.006 (0.018)	-0.027 (0.049)	reduced	Reduced by computer	0.005 (0.033)
BOI_WAT	0.039* (0.023)	Reduced	Reduced by computer	0.033 (0.028)	Reduced by computer	reduced	-0.008 (0.000)	Reduced
TAL_SAV	0.026 (0.023)	Reduced	0.035 (0.033)	reduced	0.166 (0.201)	reduced	Reduced by computer	Reduced
TMC	0.322*** (0.067)	0.191*** (0.050)	0.145 (0.090)	0.195** (0.068)	0.704 (0.665)	0.257* (0.120)	0.762 (0.000)	0.466*** (0.137)
Constant	-0.044 (0.042)	-0.009 (0.020)	-0.040 (0.095)	0.048 (0.048)	-0.219 (0.279)	-0.011 (0.033)	-0.108 (0.000)	0.145 (0.109)
N	119	119	35	35	34	34	50	50
R squared	0.496	0.230	0.789	0.630	0.895	0.690	1	0.549
Adjusted R squared	0.390	0.157	0.394	0.365	-0.893	0.433	n/a	0.314
Durbin-Watson	2.120	1.942	2.154	2.337	2.266	2.571	2.00	1.659
Regression Sig.	0.000	0.000	0.163	0.067	0.824	0.055	n/a	0.028
VIF of all var.	(1.20-3.50)		(1.00-2.20)			(1.10-4.30)		(1.00-4.00)

*: p < 0.10, **: p < 0.05, ***: p < 0.01

Leaving the overall Vietnam case behind, we are looking to different study areas. Firstly, Hanoi city, Table 4.3 shows that 2 out 10 variables in total are significant in econometric regression results. The variable that measure gender have negative parameter estimate, suggesting that female who are willing to pay less than male. The marginal effect result shows that if respondent is female, the amount of money they are willing to pay for safe drinking water would decrease by 0.020MVND. The next strong variable that has significant effect on WTP is TMC. Positive parameter estimate, 0.195, indicates that total monthly cost for water is directly proportional to the amount of money they pay for better drinking water. In detailed, if the households pay 1MVND for using water monthly, they are willing to pay 0.195MVND more for safe drinking water.

The next study area, Hai Duong province appears with 4 out of 8 independent variables is significant in econometric regression result. Similarly in Hanoi case, gender again appears to be strong variable explaining the value of WTP. In original model, the negative parameter estimate is -0.022, suggesting that the household would be pay an additional amount of 0.022MVND for using improved drinking water if the respondent is female. This empirical estimate indicates that the female in rural would be willing to pay more than male. In addition, WATFIL_COST, ACK_KNO, and TMC appears to be three

The cultural and lifestyle characteristics are assumed reason of such result. Finally, Ho Chi Minh city, the empirical results of econometric regression is shown in the last column. Interestingly, INCOM and TMC appear again to be significant variables. The parameter estimate of income variable is positive 0.006 indicate that the household would pay additional amount of 0.006MVND as their income increases by 1MVND. Next, the coefficient for TMC variable has positive 0.466 suggesting that the household’s WTP increase by 0.466MVND if the total monthly cost increases by 1MVND.

In summary, marginal effect of the independent variable on WTP depends on lots of determinants across different study areas. As expected, the richer people and the household who has higher perception of what would be willing to pay more for safe drinking water. Besides, available choices of using water resources, higher demand for water are also be strong variables significantly influence on marginal effect of WTP. Of course, cultural and geographic characteristics are also significant factors.

TABLE 4.4

Changing Probability of the Willingness-to-pay, MODEL III

Variales	B	e^B	Modeling the probability of changing the Willingness-to-pay When independent variable changes by 1 unit and original probability equal (%)				
			0.1	0.2	0.3	0.4	0.5
GEND	-0.190	0.827	0.08	0.17	0.26	0.36	0.45
REGI	-0.846	0.429	0.05	0.10	0.16	0.22	0.30
LOCA	-1.705	0.182	0.02	0.04	0.07	0.11	0.15
AGE	-0.008	0.993	0.10	0.20	0.30	0.40	0.50
EDUC	0.880	2.41	0.21	0.38	0.51	0.62	0.71
JOB	-0.506	0.603	0.06	0.13	0.21	0.29	0.38
OWN_HOU	-0.105	0.9	0.09	0.18	0.28	0.38	0.47
INCO	-0.012	0.988	0.10	0.20	0.30	0.40	0.50
WAT_FIL	0.235	1.265	0.12	0.24	0.35	0.46	0.56
WATFIL_COS	-0.120	0.887	0.09	0.18	0.28	0.37	0.47
PUM_WAT	1.786	5.967	0.40	0.60	0.72	0.80	0.86
WEL_WAT	-0.872	0.418	0.04	0.09	0.15	0.22	0.29
BOT_WAT	0.204	1.226	0.12	0.23	0.34	0.45	0.55
RAI_WAT	-0.266	0.766	0.08	0.16	0.25	0.34	0.43
ACT_KNO	1.063	2.896	0.24	0.42	0.55	0.66	0.74
COM_SER	0.454	1.575	0.15	0.28	0.40	0.51	0.61
BOI_WAT	1.583	4.869	0.35	0.55	0.68	0.76	0.83
TAL_SAV	0.423	1.527	0.15	0.28	0.40	0.50	0.60
TMC	4.833	125.623	0.93	0.97	0.98	0.99	0.99

In Table 4.4, using the results of coefficient (B) and value of (Exp(B)= e^B) yields a scenario, in which original probability changes from 0.1 to 0.5 or (from 10% to 50%). Out of a total 20 variables is calculated, 9 variables take positive coefficient (B) yielding the probability of the households who are willing to pay for safe drinking water higher than original probability of dependent variable, WTP. Those variables are EDUCE, WATFIL_COS, PUM_WAT, WEL_WAT, BOT_WAT, ACT_KNO, COM_SER, BOI_WAT, TAL_SAV and TMC. However, as indicated in Table 4.2, 4 out of them are significant variables. They are EDUC, RAI_WAT, ACT_KNO, BOI_WAT, COM_SER and TMC variable. Looking at the first one, EDUC, Table 4.4 shows that when changing the original probability of WTP from 0.1, 0.2, 0.3, 0.4, 0.5 if the respondent get higher educational level, the probability of the household who are willing to pay for better water quality will increase ranging from 0.21, 0.38, 0.51, 0.62, 0.71 respectively. Clearly, this indicates that the changeable probability is higher than original ones. Similar scenarios appear again for RAI_WAT, BOI_WAT and TMC variable. In contrast, negative coefficient appears to be WEL-WAT variable, for instances. If original probability of the respondent who use WEL_WAT ranges from 0.1, 0.2, 0.3, 0.4 and 0,5 then the probability of willing-to-pay for cleaner drinking water is 0.04, 0.09, 0.15, 0.22 and 0.29 respectively. This indicates that the changeable probability is much less than original ones. Like WEL_WAT, similar scenario is seen at INCO, WATFIL_COS, RAI_WAT variable. These empirical results suggest that the probability of the household's decision on agreeing to pay for safe drinking water much depend on 5 independent variables and its magnitude, in which awareness and perception of water, economic condition, existing water resources are much more important than others. This is very consistent to the results found in Table 4.3.

TABLE 4.5

Summary of the Potential Demand for Water

Description	Vietnam	Hanoi	Hai Duong	Ho Chi Minh
The percentage of respondent who are willing to pay (%)	50.60	71.40	35.10	56.20
The mean number of certainty level of the respondents' answer to be willing to pay (out of 10)	8.31	8.05	7.26	8.50
The percentage of respondent who say the demand for factory water increases (%)	54.20	75.00	56.00	38.40
The percentage of respondent who say the demand for factory water remain stay (%)	39.60	25.00	35.20	54.80
The percentage of respondent who say the demand for factory water decreases (%)	2.40	0.00	3.30	2.70
No answer (%)	3.80	0.00	5.50	4.10
The percentage of respondent who say the demand for bottled water increases (%)	11.80	4.10	3.20	16.70
The percentage of respondent who say the demand for bottled water remain stay (%)	19.40	2.00	10.60	38.90
The percentage of respondent who say the demand for bottled water decreases (%)	0.70	0.00	1.10	0.00
No answer (%)	0.00	93.90	85.20	44.44

One of the underlying purposes of this study is get insight into the potential demand for water in general and safe drinking water in specific. Table 4.5 provides a picture of the potential demand for water and safe drinking water. That is, more a half of the respondents interviewed in Ho Chi Minh city say “yes” to pay for safe drinking water, while more two thirds of those people who live in Hanoi city agree to take “money out their pocket” for improved water and around one thirds of the households asked in Hai Duong do that. In addition, on average, the respondent who is willing to pay at least 83% of certainty level. Specifically, for the demand for factory water and bottled water, table 4.5 illustrates that over 50% and 11% of the household have increase their demand for factory water and bottled water while the percentage of the respondents keeping constant their demand for both kind of such water is near 40% and around 20% respectively. Only small percentage of the household, 2.4% and 0.7%, says that their demand for factory water and bottled water decreases respectively. Looking across at study areas, Hanoi appears to be the highest percentage of the respondent who says the demand for factory water increases, 75%. It is followed by Hai Duong, and Ho Chi Minh with 56% and 38.4% respectively. In contrast, for bottled water, near 17% of the respondent who live in the South of Vietnam confirm that their demand increase while this number appears in Hanoi and Hai Duong is just only 4.1% and 3.2% respectively.

In summary, there is a considerable number of HHs who is willing to pay for better drinking water services. Most of them come from the big city. For the water supplier’s eyes, the market of bottled water in South of Vietnam is larger and more open than that in the North of Vietnam. In contrast, the market of factory water in North of Vietnam is bigger and more potential than that in the South of Vietnam higher.

4.4. AVERTING EXPENDITURE COST

By employing equation (3.5), the expected value of averting cost (ECAE) is calculated. In Table 4.6, three main treatments are used consisting of using water filter, boiling water and drinking bottled water. That is, more 40% of the respondents living in Ho Chi Minh city using water filter while just under 13% and 8% of households who live in Ha Noi city and Hai Duong province do the same treatment. However, boiling water seem much more common to the household living in the North (Hai Duong province above 95% and Ha Noi city 97%) than those people who live in the South (Ho Chi Minh city 80%). For bottled water, around 60% of the households in Ho Chi Minh is using daily while this number found in Hanoi and Hai Duong is just approximately 6% and 17% respectively. Besides, the HHs also use different facilities for storing rain water, but its cost is not calculated in this study.

Table 4.6.a and 4.6.b illustrates the averting expenditure cost incurred by the households to reduce the risk of getting diseases or damages associated with polluted water. The predicted cost of averting expenditure (CAE) is calculated by applying the equation (3.5). Expected value of adverting expenditure the household bear monthly is 0.023, 0.002, 0.010, and 0.048 found in Vietnam, Hanoi, Hai Duong, and Ho Chi Minh respectively. In fact, this value would be higher than this above value since including the cost of boiling water, or purchasing facilities for storage, and other methods. Since the quality of factory water is not good enough, using factory water is not considered as averting action. Besides, the mean absolute of CAE and ECAE of using bottled water incurred by household bear for over one month is found in Vietnam, Hanoi, Hai Duong, and Ho Chi Minh is 0.073 and 0.023, 0.036 and 0.002, 0.062 and 0.010, and 0.078 and 0.048 respectively. Unlike absolute value of CAE and ECAE is presented, Figure 4.3 illustrates relationship of the cost of averting expenditure (CAE) and expected cost of averting

expenditure (ECAE) among Hanoi, Hai Duong, and Ho Chi Minh. Although absolute value of the mean of CAE and ECAE among three above cases is different, statistical difference of CAE and ECAE among them is not found respectively. In other words, this result indicates that the households living in southern region would not have higher payment of getting bottled water than those who live in northern region, but the households living in rural pay less for getting bottled water than those who live in big city.

TABLE 4.6.a

Averting Expenditure Cost: Purchasing bottled water

Survey site	% of HHs do	Average Expenditure each month			Expected expenditure each month		
		Mean	C.I 95%		Mean	C.I 95%	
Vietnam	31.5	0.073	0.058	0.088	0.023	0.016	0.029
Hanoi	6.1	0.036	0.007	0.065	0.002	0.000	0.005
Hai Duong	17.5	0.062	0.033	0.091	0.010	0.004	0.016
Ho Chi Minh	60.7	0.078	0.059	0.097	0.048	0.034	0.062

TABLE 4.6.b

Averting Expenditure Cost: Purchasing water filter water

Survey site	% of HHs do	Average Expenditure >30 days			Expected expenditure >30 days		
		Mean	C.I 95%		Mean	C.I 95%	
Vietnam	22.1	0.959	0.555	1.364	0.212	0.111	0.314
Hanoi	12.2	3.083	1.102	5.065	0.378	0.032	0.724
Hai Duong	7.20	1.881	0.000	3.820	0.136	0.000	0.283
Ho Chi Minh	43.8	0.467	0.248	0.686	0.205	0.099	0.311

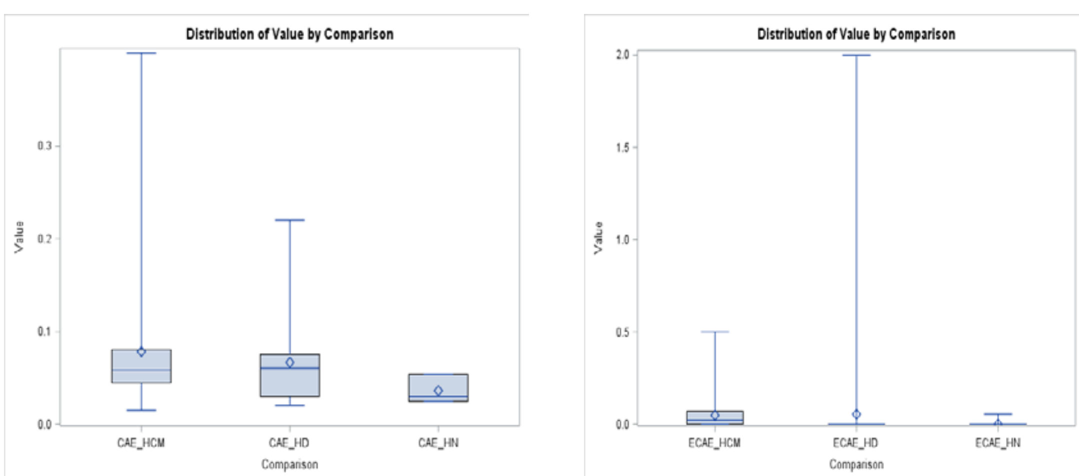


FIGURE 4.3 CAE and ECAE by Study Area

One possible explanation that would be reasonable and logic is that the household living in rural have more natural water resource like well water resource or rain water resource, but they have to save their limited income. Traditional treatment of water like boiling water is the best for them. For the household live in big city, they might have less choices of using water sources but they have more opportunity to earn money. To deal with the problem of limited time or to maximize their utility, they choose to use different services. Therefore, It is not hard to explain that paying for safe drinking water is always their priority at home of urban residents.

In summary, empirical results on averting behavior appear that different treatment-water methods are used in which the reliance on natural condition for the household living in rural is higher than those living in city. With limited income resource, to save money, the local people tend to make use of any natural sources as much as possible. Although boiling water may take time compare to other water treatment, it is traditional way to help them save money the most. The results also indicate that the difference in geographic characteristics (the North versus the South) which is consistent with lifestyle or culture does not result in difference in averting behavior and averting expenditure.

TABLE 4.7

Determinants of Averting Actions Using MODEL I-Binary Logit Regression

Variables	Depvariable .var (yes/no) Using bottled water daily	Dependent .var (yes/no) Using waterfilter daily		Dependent var (yes/no) Boilling water daily	
	Full Model	Full Model	Reduced model	Full Model	Reduced model
GEND	1.147 (0.942)	-69.528 (27975.081)	-0.035 (0.764)	-47.297 (3227.966)	**-3.268*** **(1.938)**
REGI	**-4.339***** **(1.663)**	-21.508 (6808.508)	**-4.638***** **(1.448)**	100.067 (33704.744)	**3.305*** **(1.921)**
LOCA	-1.732 (1.319)	133.172 (19517.233)	**3.598**** **(1.570)**	-41.745 (5389.973)	-0.190 (1.292)
AGE	**-0.085**** **(0.040)**	4.721 (470.917)	0.010 (0.036)	0.335 (231.968)	1.662 (3.929)
EDUC	0.400 (0.661)	-2.969 (1146.980)	0.246 (0.441)	-26.789 (3516.496)	0.146 (0.872)
JOB	-0.278 (0.463)	11.320 (28197.357)	0.501 (0.383)	11.117 (2080.544)	Reduced
HEA_HOU	-0.807 (1.151)	61.350 (5380.158)	0.964 (1.010)	-66.472 (5488.150)	Reduced
INCO	0.015 (0.061)	3.840 (702.742)	**-0.370*** **(0.190)**	3.707 (350.139)	0.010 (0.096)
WAT_FIL	0.939 (1.155)	Reduced by computer	Reduced	-0.845 (7508.008)	Reduced
WATFIL_COS	-0.163 (1.020)	755.861 (37580.008)	Reduced	232.436 (14603.222)	Reduced
PUM_WAT	**2.744**** **(1.372)**	-74.139 (32048.658)	-0.048 (0.971)	13.159 (6113.273)	-1.203 (1.752)
WEL_WAT	**3.087**** **(1.433)**	36.059 (8268.850)	0.478 (1.813)	-177.762 (11592.667)	Reduced
BOT_WAT	Reduced by computer	137.369 (37677.097)	1.762 (1.291)	-3.282 (2418.767)	-0.452 (1.376)
RAI_WAT	-1.012 (1.341)	73.322 (29710.296)	1.852 (1.767)	58.360 (15512.910)	Reduced
ACT_KNO	0.504 (1.132)	-26.056 (24799.353)	0.448 (0.966)	73.039 (33391.293)	Reduced
COM_SER	1.357 (1.480)	-44.721 (12229.580)	-0.248 (1.045)	29.729 (32591.406)	Reduced
BOI_WAT	-0.134 (1.233)	-64.350 (27026.703)	-1.247 (1.459)	Reduced by computer	Reduced
TAL_SAV	-0.950 (1.552)	-22.735 (10733.395)	1.499 (1.659)	95.856 (4988.804)	**3.958*** **(2.101)**
TMC	**8.609**** **(4.103)**	-718.634 (48829.646)	**-18.146**** **(8.017)**	-34.034 (54754.945)	-6.045 (6.151)
Constant	3.160 (2.859)	-305.142 (81517.531)	-1.923 (3.166)	27.827 (12087.387)	1.662 (3.929)
N	235	235	235	235	235
Log Likelihood	52.928	0.000	68.233	0.000	28.155
LR chi2	64.984	101.240	33.007	46.571	21.206
Prob>chi2	0.000	0.000	0.017	0.000	0.020

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$

Again, by using the Logit regression, Table 4.7 presents the determinants of averting expenditure-cost, in which dependent variable are whether or not the HHs use bottled water, water filter, and boiling water daily while independent variables are listed in the first column. Specifically, for constructing models, some variable like FAC_WAT, BOT_WAT, WAT_FIL, etc is excluded by computer automatically, while some is are rejected by both computer and by hand to make sure that the model is significant enough to explain the relationship of relevant variables.

For first model where dependent variable is whether they are using bottled water, REGI and AGE are two significant statistic variables with negative coefficient -4.339 and -0.085 respectively. These such coefficients indicate that the HHs living in Northern area would drink bottled water less while young people would have higher demand for bottled water.

For the next model, the dependent variable is whether they are using water filter, 4 out of 13 is strong variables having significant effect of if the household use water filter at home. The P-value <0.05 and positive parameter estimate of LOCA variable suggests that the respondents who live in city would be willing to pay more for safe drinking water. Similarly, the P-value <0.10 and negative parameter estimate of INCO indicates that if the higher income people who tend not to use water filter. Again, the negative coefficient of REGI variable is found. Furthermore, TMC variable contribute its effect on the household' decision on using water filter as averting action. Negative coefficient, -18.146, shows that higher consumption of bottled water and factory water results in using water filter less, and inverse.

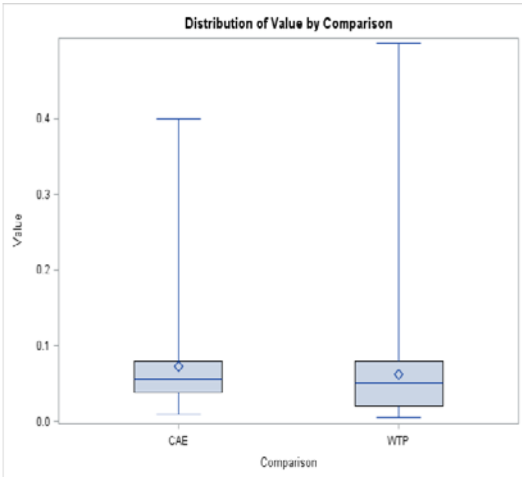
The last model regression appears of if they are using method of boiling water. The variable of GEND has significant effect of the model with its negative parameter estimate is -3.268. This indicates that the female boil water more frequently than the male. However, positive parameter of 3.305 and 3.958 in REGI and TAL_SAV variables suggest that the northern people and the economic people tend to boil water than those come from Southern region and uneconomic people respectively.

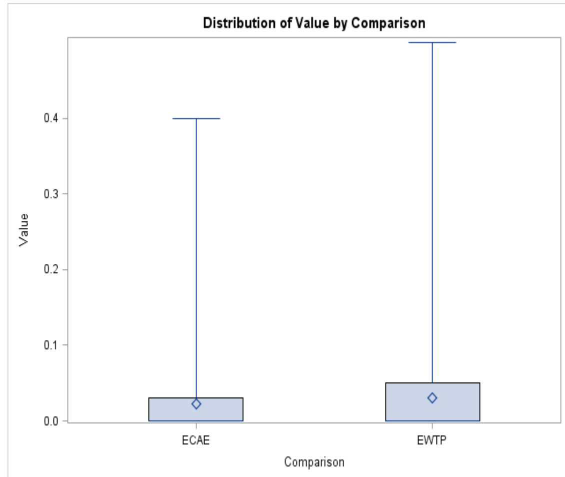
In summary, sex, income, level of consumption and awareness has important role in influencing on the household's choice of using water treatment methods. Besides, the difference of geographic conditions and existing water resources are also important variables as well.

4.5. AVERTING EXPENDITURE COST VERSUS WILLINGNESS-TO-PAY

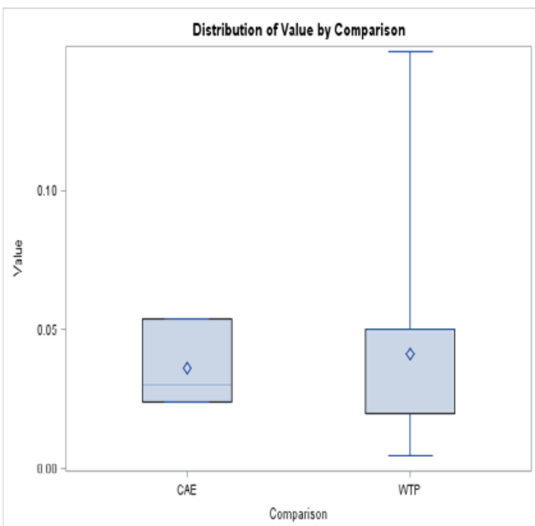
The relationship between the cost of averting expenditure and WTP is indicated on several studies. Most paper shows that WTP is estimated by averting costs which is underestimated since some hidden costs are not taken into consideration. WTP is a sum of cost of illness, expenditures on averting action, and disutility associated with symptom or lost leisure/recreation (Leslie A. Richardson, et al. 2011) and can be estimated using CVM or defensive behavior method. However, averting expenditure are not in general a good measure of willingness to pay and averting expenditure are not always even a lower bound on willingness to pay (Richard C. Porter, 1981). In this study, two values of averting expenditure and WTP is calculated again. Figure 4.4 presents both of them in terms of value that derived from only those households who are willing to pay for safe drinking water in study areas and expected value that is calculated for whole population. Clearly, looking at data under statistics', all 8 graphs below show that no statistical differences of value of WTP and CAE are found even though the mean value of them are not the same.

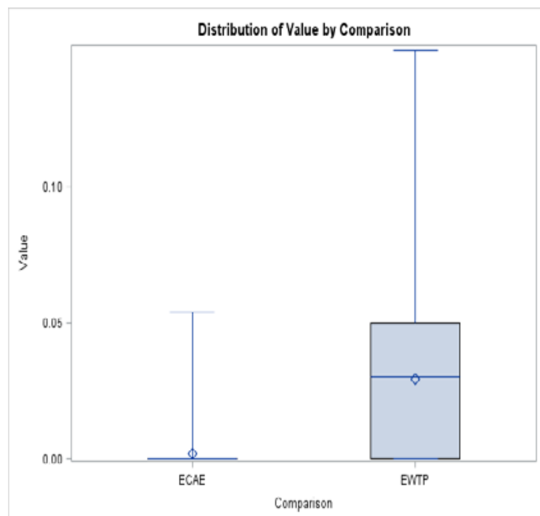
Vietnam Vietnam



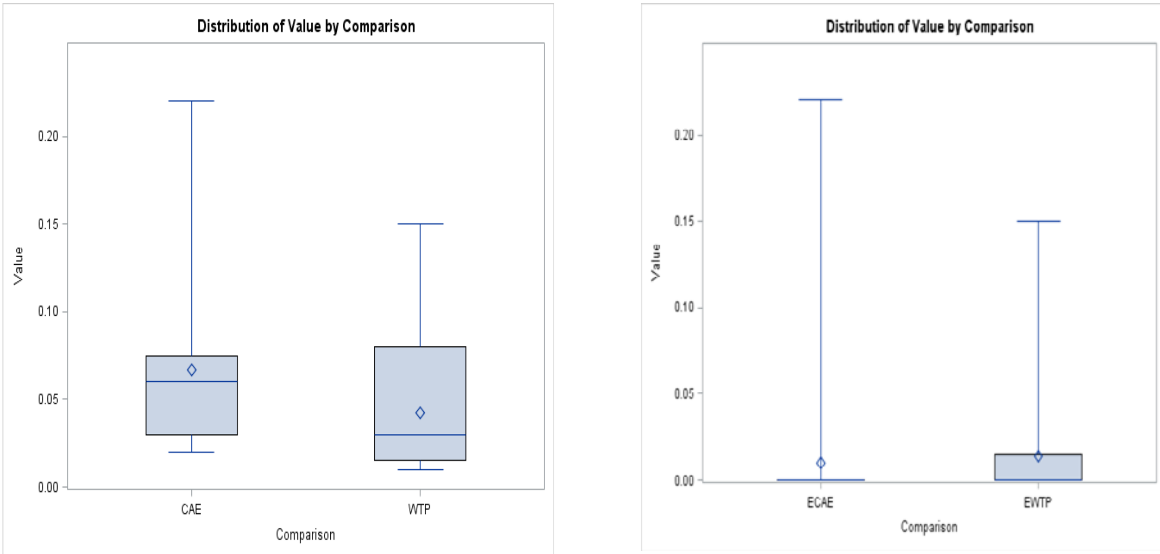


Hanoi Hanoi





Hai Duong Hai Duong



Ho Chi Minh Ho Chi Minh

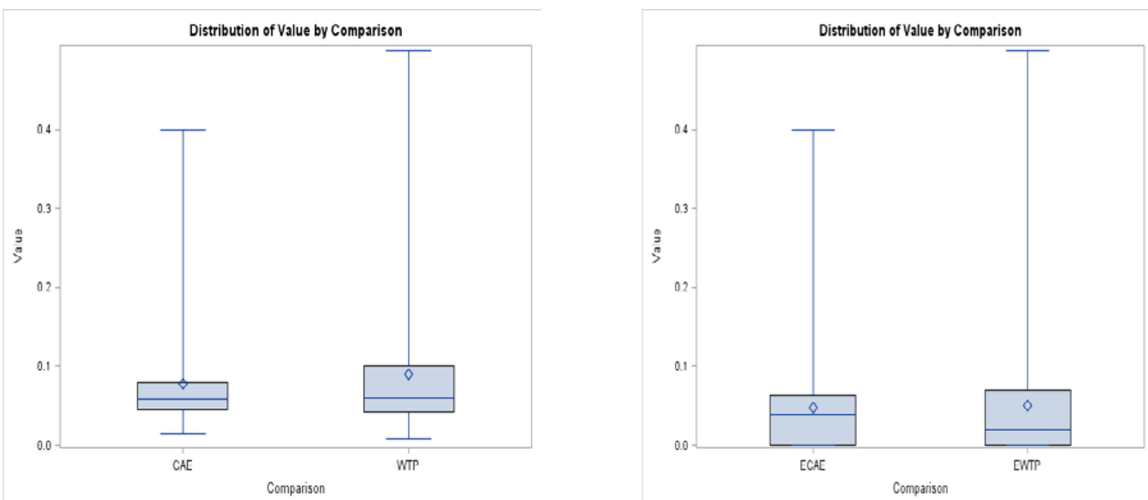


FIGURE 4.4 Comparison between the Cost of Averting Expenditure and Willingness-to pay

TABLE 4.8

Comparison of the Percentage of Family income and Money the Household Would Pay for Improved Drinking Water Quality

Itiems	N	Mean	C.I 95%	
EWTP (18) vs family income				
Vietnam	235	0.247%	0.193	0.302
Hanoi	49	0.406%	0.265	0.547
Hai duong	97	0.138%	0.070	0.207
Ho Chi Minh	89	0.277%	0.186	0.368
ECAE (19) vs family income				
Vietnam	235	0.173%	0.115	0.231
Hanoi	49	0.027%	0.000	0.060
Hai duong	97	0.115%	0.044	0.185
Ho Chi Minh	89	0.331%	0.199	0.462
EFAC (20) vs family income				
Vietnam	235	1.149%	1.030	1.2677
Hanoi	49	1.492%	1.168	1.816
Hai duong	97	1.211%	1.042	1.379
Ho Chi Minh	89	0.856%	0.688	1.024
Potential total cost (21) vs family income (22)				
Vietnam	235	1.569%	1.403	1.735
Hanoi	49	1.925%	1.459	2.391
Hai duong	97	1.462%	1.228	1.700
Ho Chi Minh	89	1.464%	1.219	1.710

18 **EWTP** is expected value of WTP for full data monthly

19 **ECAE** is expected value of averting expenditure for full data monthly

20 **EFAC** is expected value of fee for using factory water for full data monthly

21 **Potential total cost** is sum of EWTP, ECAE, and EFAC for full data monthly

22 **Family income** is sum of income from all member in family for full data monthly

Table 4.8 represents very more detailed the relationship between the expected cost of averting expenditure and the expected value of willingness-to-pay through comparing both of them with the whole family income. That is, the relationship between EWTP and ECAE compared to the family income is 0.246% versus 0.027, 0.406% versus 0.115 and 0.277% versus 0.331 in Vietnam, Hanoi, Hai Duong, and Ho Chi Minh respectively. In addition, the potential cost including the monthly fee for using factory water and bottled water and the value of willingness-to-pay appear in Hanoi, Hai Duong and Ho Chi Minh is 1.925%, 1.464%, and 1.464% respectively. Although, again, no statistically different valid estimation of EWTP and ECAE is found, these results bring two important empirical implications. The first is that the cost incurred by using water at HHs account for very small number comparing to the household's income. In other words, it does not matter to HHs' budget if they pay for better drinking water to get better potential heath. Policy adjustment for market of improved drinking water would be effective and attainable if fee for better drinking water, at least, is not over 1.925%, 1.464%, and 1.464% of whole household's income in Ha noi, Hai Duong, and Ho Chi Minh respectively. The second is that WTP is not always greater than CAE, which is indicated in Richard C. Porter (1981). The empirical result suggests that valid estimation of WTP might be derived from applying CAE, but it is not always true in all cases.

CHAPTER 5
Conclusion and policy suggestion

5.1. CONCLUSION

This study has employed CVM to get insight into value of WTP that household are willing to pay in return for receiving better drinking water. In-person interviews are conducted based on the open-end WTP questions and semi-structure questionnaires. A total 235 households across Vietnam are interviewed in which 49 respondents are in Hanoi, 97 respondents are in Hai Duong and 89 respondents are in Ho Chi Minh. Besides strictly considering requirement of enough sample size for analysis, all possible factors, which may affect the decision of willing-to-pay, are also covered. These include gender, level of education, age, income, existing water resources, and so on. To deeply understand the WTP and its relationship with other factors, econometric model is adopted in which binary logit regression model and multivariate regression model is employed.

Empirical results from the study imply that even though the cultural and geographic characteristics are considered important determinants of the probability of the household’s decision on if the household are willing to pay for safe drinking water, it does not bring the statistical difference in WTP, EWTP, CAE, and ECAE across Hanoi, Hai Duong, and Ho Chi Minh respectively. The respondents who gain higher level of education and higher perception of water in general would be willing to pay for safe drinking water. In Hai Duong and Ho Chi Minh, gender is strong variable that could influence WTP as well.

A picture of potential demand for water and improved drinking water is drawn. Although given the same WTP and EWTP, higher population, higher percentage with higher level of certainty that HHs are willing to pay for better drinking water suggest that the market in the two big cities is much larger than rural area. Hence, potential demand for water in Hanoi and Ho Chi Minh city is higher than that in rural area. Specifically, out of 5 available water resources, factory water resource becomes largest ones used at home.

Several treatment method of water is applied in household across the country. The people who live in the North like using boiling water, those who live in the South prefer using bottled water and water filter to others. In rural (Hai Duong), the people tend to take advantage of natural resource better than those who are in two big cities. This results in decrease in demand for water and low rate of the population willing to pay for safe drinking water. The dependent correlation of existing water sources and its substitute water resources has significant effect of the household's choice of using water treatment methods. Again, the difference of geographic conditions, the scale of family, or the costs of using water are also important variables as well. The cost of averting expenditure (CAE) and WTP as well as ECAE and EWTP are compared respectively in the study areas. My results suggest that WTP is not always greater than CAE. This is consistent to the argument of Porter (1981).

5.2. SUGGESTION, POLICY IMPLICATION, LIMITATION

The empirical results of the study partly reflect the households' perception, assessment of water resource and their willingness to pay for better drinking water. These results might bring the following policy implications.

First, constructing policy on the price of safe drinking water is based on many factors such as cost-benefit analysis, living standard of people, WTP and EWTP per family income, potential demand for safe drinking water, other socio-political-economic factors, etc. By understanding such information, better policy will be enacted on the price of clean drinking water. Theoretically and practically, market failure results from asymmetric knowledge which is when the HHs and water service suppliers do not have the same information about a market of water or clean drinking water. Therefore, although there is not statistical difference of WTP and EWTP across Vietnam, market failure of water will be resolved if the macro-level policy on water resource, in general, and drinking water in specific should be flexible and applicable to each region, specific localities across the country. That is, water pricing policies applied to urban areas is different from that applied to rural areas. Given the income level of the population found in this study, the price is allowed no more than around 1.9% of family income for urban and roughly 1.4% for rural areas.

Second, the water related investment and management should seriously consider the current consumption of each kind of water in each region across the country. That is, bottled water company should be established more in the South of Vietnam while maximizing the usage of cheap and safe equipment should be preferable in rural area. Constructing new water factory, new company to producing higher and safer water quality to meet higher demand in Vietnam, especially in the South is very imperative. In addition, the evidence that up to roughly two fifth of the HHs who do not highly evaluate the quality of current water and there is the same percentage of HHs who are not satisfied current water source is found, indicating that opportunity for improvement in water services for water planner and business. Furthermore, high demand for factory and bottled water across the whole Vietnam, especially in two big cities with high certainty of payment of the HHs is shown also bring more potential chance for investment in water service, which will open the prospective of high quality water business and production in the near future.

Third, the government should more actively support safe drinking water related businesses, companies in rural areas, where low-income households with their limited ability to pay for water and better drinking water. More water related studies should be carried out in rural areas where people use water from different sources, to ensure the health of the people, to determine whether or not current water quality meets safety standards and health of the people and to understand rational and efficient water management in rural area.

Fourth, education and income are two key factors affecting the demand for clean water. The government and enterprises need to focus on the expansion of production, creating jobs, raising incomes for people, along with adequate investment in education. As a result, quality of life of the people will increase, at the same time, the higher demand for consumption would lead to business development.

The last but not least, "prevention is better than cure" motto has existed for a long time but has great practical significance. Having access and better use of water will contribute to achieving the above objectives. Therefore, along with the efforts of the government in promulgating specific policies, propaganda, advertising of clean water is also considered effective way to bring real benefits to the people, the state and the enterprises as a whole.

Limitation and suggestive further study in future

This survey has employed CVM which is widely used in nonmarket valuation, yet this method is still suspected by some real scientists in terms of validity side. In addition, valid estimation of C.I of WTP should have employed one of three methods: Kinsky and Robb procedures, Delta, and Boostrap rather than using normal calculation of equation (3.6) since data of WTP is not normally distributed. Furthermore, CAE comprises many sub-values and calculating its value is complicated, in which finding exact number of boiling water cost is not easy. In this thesis, to simply the calculation of CAE, only bottled water is consider resulting in omitting considerable value of CAE. The last but not least is that although the sample size cover three sites, with more 200 households/respondents, it is still not perfect representative data of Vietnam as well as sub-regions since it is still small. Those limitations above suggest that further study should consider carefully for higher quality research.

REFERENCES

1. Antoci, S. Barghesi and P. Russu. 2005. Environmental Defensive Expenditure, *Expectations and Growth, Population and Environment*, Vol. 27, No. 2 (Nov., 2005), pp. 227-244.
2. Beaumais O. 2010. What are households willingness to pay for better tap water quality? A cross-country valuation study. *Working papers*.
3. Champ P. 2003. Collecting survey data for nonmarket valuation. A primer on non-market valuation. *Kluwer Academic Publishing*.
4. Charles W. Abdalla, Brian A. Roach and Donald J. Epp.1992. Valuing environmental quality changes Using averting expenditure: An application to groundwater contamination. *Land economics*, Vol 68, No.2 (May, 1992), pp. 163-169.
5. Courant P. 1981. Averting expenditure and the cost of pollution. *Journal of environmental economics and management* 8, 321-329 (1981).
6. Dickie M. 2003. Defensive behavior and damage cost methods. A primer on nonmarket valuation 395-444, *Kluwer Academic Publishing*.
7. Genius M. 2008. Evaluating consumers’ willingness to pay for improved potable water quality and quantity. *Water resource manage* (2008) 22: 1825-1834.
8. Gujarati D and Dawn C. Porter 2009. Basic econometrics.
9. Hoang Trong. 2008. Data analysis with SPSS. Ho Chi Minh university of economics. Vol 1, Vol 2, *Hong Duc publishing.*
10. Ifabiyi, I.P, 2011. Willingness to pay for water at household level in Ilorin, Kwara State, Nigeria. *Global journal of human social science,* Vol 11 issue 2 version 1.0 March 2011.
11. Iftikhar Ahmad, Miraj ul Hag, and Abdul Sattar. 2010. Factors determining public demand for safe drinking water (A Case Study of District Peshawar). PIDE *Working paper* 2010:58.
12. Jeanty W. 2007. Constructing Krinsky and Robb confidence intervals for mean and median willingness to pay (WTP) using stata. The Ohio State University, 6th *North American Stata User’s group meeting*, Boston, MA.
13. Jordan J and Abdelmoneim, 1993. Willingness to pay for improvements in drinking water quality. *Water resources research*, vol. 29, no. 2, pages 237-245, February 1993.
14. Jordan J and Abdelmoneim. 1993. Willingness to pay for improvements in drinking water quality. *Water resources research*, vol.29, no.2, pages 237-245.

15. Jun Xu and J. Scott Long. 2005. Using the delta method to construct confidence intervals for predicted probabilities, rates, and discrete changes. *The Stata Journal*.
16. Kenneth D. Bailey. 1994. Methods of social research. The free press.
17. Loomis J. 2010. Your health during the station fire, tell us what you think. Department of Agricultural and Eesources Economics, *Colorado State University*.
18. Mi-Jung Um, Seung-Jun Kwak and Tai-Yoo Kim. 2002. Estimating willingness to pay for improved drinking water using averting behavior method with perception measure. *Environmental and resource economics* 21: 287-302, 2002.
19. Mirajul Haq, Usman Mustafa, and Iftikhar Ahmad. 2007. Household's willingness to pay for safe drinking water: A case study of Abbottabad district. *The paskistan Development Review* 46: 4 Part II (winter 2007) pp. 1137-1153.
20. Null C. 2012. Willingness to pay for cleaner water in less developed countries: systematic review of experimental evidence. *International Initiative for impact evaluation systematic review* 006.
21. Pham Khanh Nam and Tran Vo Hung Son, 2005. Household demand for improved water services in Ho Chi Minh city: A comparison of contingent valuation and choice modeling estimates. *Economy and Environment program for Southeast Asia*, Research report, No. 2005-RR3.
22. Richardson L. 2011. Quantifying the economic health cost of exposure to wildfire smoke: Four essays in non-market valuation, methodological comparisons, and econometric methods to address endogeneity. *Dissertation*, Colorado State University.
23. Rosado M. 1998. Willingness to pay for Drinking Water in Urban Areas of Developing Countries. *AAEA Annual Meeting* August 2-5, 1998 Salt Lake, Utah.
24. Simiret Wendimu and Wagayhu Bekele. 2011. Determinants of individual willingness to pay for quality water supply: The case of Wonji Shoa Sugar Estate, Ethiopia. *Journal of Ecology and the Natural Environment* Vol. 3(15), pp. 474-480.
25. Vasquez .W, Pallab Mozumder, Jesus Hernandez-Arce, Robert P. Berens. 2009. Willingness to pay for safe drinking water: evidence from Parral, Mexico. *Journal of Environmental management* 90 (2009) 3391-3400.
26. Whittington D, John Briscore, Xinming mu and William Barron.1990. Estimating the Willingness to pay for Water services in Developing Countries: A Case study of the Use of

Contingent Valuation Surveys in Southern Haiti. *Economic development and Cultural Change*, Vol.38, no.2 (1990), pp.293-311.

27. Yoo-Yong Hyun. 2006. Using multinomial logistic regression analysis to understand anglers willingness to substitute other fishing locations. *Proceedings* of the 2006 Northeastern Recreation Research Symposium.

APPENDIX

Colorado State University (CSU)

Department of Agricultural and Resource Economics

Questions used for survey (in Hà Nội, Tp. HCM, và Hải Dương)

Tell us what you think about
"Drinking water and your health"

Part	Part title	Number of page
A	Water consumption at the household	7
B	Personal health history	5
C	Please tell us about yourself	12
D	Extra questions	11
Total		35

Student: Khúc Văn Quý

Advisor: John B. Loomis

School: Colorado State University

The data collected to use for completing the Master thesis

Hồ Chí Minh, revised 08/04/ 2012

Note: Please to read the questions carefully and answer according to the instructions. Thank you!

Part A: The current consumption of water at the Household

In this part A, we would like to learn and know how do the households use the water and how does they evaluate the quality of water in order to recognize the demand for the safe drinking water.

Your answers are confidential. Please answer with your best understanding!

Which kind of water does your family use for the last (mark on the blank)

□ Factory water, if Yes → move to part A1
□ Pump water, if Yes → move to part A2
□ Water (from the well that made buy hand), if Yes → move to part A3
□ Bottled water, if Yes → move to part A4
□ Rain water (from rain), if Yes → move to part A5
□ Other (describe in detail)____

(**Hint:** You mark any kind of water that your family uses for. You can chose two or more answer (options)

Part A1. Question about factory water

---

1. What your purpose of using factory water?
   - □ For cooking, drinking
   - □ For washing, cleaning stuff, and so on
   - □ For running business
   - □ Other
2. In your own opinion, what is about the quality of that water

- Very good, safe
- Quite good, safe
- Fair
- Not good, safe
- Not very good, safe, harmful to health
- Do not know

3. Could you smell the bad smells and see the unusual colors following?
   (Check one box)
   □ yes □ no
   If no, move to question number **6**
4. How oftern do you see?

- Very much
- Sometimes
- Rare
- do not remember

5. How many days did you notice the smell and color

- More one week
- 3-7 day
- 1-3 day
- 0.5-1 day
- Few hours
- Do not remember

6. How much do you pay for your factory water shown in the receipt in the last month
   ________________VND

7. What is the trend in payment in water during last three month?

   □ Increase
   □ Constant
   □ Decrease

8. How satisfied do you feel about factory water?
- Very satisfied
- Satisfied
- Normal
- Unsatisfied
- Very unsatisfied

9. Are you willing to pay an additional amount of money to receive better factory water (which makes you very satisfied)?

   □ Yes □ No

   If yes, please answer the question number 10,12 or 11,12

10. Please tell us how much **extra money** are you willing to pay for receiving safe drinking water per month? __________________VND

11. Please tell us how much **extra money** are you willing to pay for receiving 01 cubic meter of safe drinking water per month? __________VND/01 cubic meter

12. Please tell us how certain you are that you would actually answer

1	2	3	4	5	6	7	8	9	10
Not very certain									Very certain

Part A2. Questions on pump water

---

1. What your purpose of using pump water?
   - □ For cooking, drinking
   - □ For washing, cleaning stuff, and so on
   - □ For running business
   - □ Other
2. In your own opinion, what is about the quality of that water

- Very good, safe
- Quite good, safe
- Fair
- Not good, safe
- Not very good, safe, harmful to health
- Do not know

3. Could you smell the bad smells and see the unusual colors following?
   (Check one box)
   □ yes □ no

   If no, move to question number **6**
4. How often do you see?

- Very much
- Sometimes
- Rare
- do not remember

5. How many days did you notice the smell and color

- More one week
- 3-7 day
- 1-3 day
- 0.5-1 day
- Few hours
- Do not remember

6. How satisfied do you feel about **pump water**?

- Very satisfied
- Satisfied
- Fair
- Unsatisfied
- Very unsatisfied

Part A3. Questions on well water

1. What your purpose of using pump water?
    - □ For cooking, drinking
    - □ For washing, cleaning stuff, and so on
    - □ For running business
    - □ Other
2. In your own opinion, what is about the quality of that water

- Very good, safe
- Quite good, safe
- Fair
- Not good, safe
- Not very good, safe, harmful to health
- Do not know

3. Could you smell the bad smells and see the unusual colors following?
   (Check one box)

   □ yes □ no

   If no, move to question number **6**
4. How often do you see?

- Very much
- Sometimes
- Rare
- do not remember

5. How many days did you notice the smell and color

- More one week
- 3-7 day
- 1-3 day
- 0.5-1 day
- Few hours
- Do not remember

6. How satisfied do you feel about **pump water**?

- Very satisfied
- Satisfied
- Fair
- Unsatisfied
- Very unsatisfied

Part A4. Questions on bottled water

1. What your purpose of using factory water?
   - □ For cooking, drinking
   - □ For washing, cleaning stuff, and so on
   - □ For running business
   - □ Other
2. In your own opinion, what is about the quality of that water

- Very good, safe
- Quite good, safe
- Fair
- Not good, safe
- Not very good, safe, harmful to health
- Do not know

3. How many bottled water bottle does your family use per month?

4. How much does it cost you per bottled water?

5. What is the trend in payment in water during last three month?
   - □ Increase
   - □ Constant
   - □ Decrease
6. What is the name of water bottle do you drink?
7. How do you know?
8. Have you ever used different kind of water bottle?
   If yes, tell us the reason why?
9. Have you ever told to, complained, sued with the supplier of water bottle?
10. How satisfied do you feel about factory water?

- Very satisfied
- Satisfied
- Fair
- Unsatisfied
- Very unsatisfied

11. Are you willing to pay an additional amount of money to receive better **bottled water** (which makes you very satisfied)?
    □ Yes □ No

- If yes, please answer the question number 12,14 or 13,14

12. Please tell us how much **extra money** are you willing to pay for receiving better drinking water per month? __________________VND

13. Please tell us how much **extra money** are you willing to pay for receiving 01 bottle of safe drinking water per month? _______________VND/01 bottle

14. Please tell us how certain you are that you would actually answer

1	2	3	4	5	6	7	8	9	10

Not very certain Very certain

Part A5. Questions on rain water

1. What your purpose of using pump water?
   - □ For cooking, drinking
   - □ For washing, cleaning stuff, and so on
   - □ For running business
   - □ Other
2. In your own opinion, what is about the quality of that water

- Very good, safe
- Quite good, safe
- Fair
- Not good, safe
- Not very good, safe, harmful to health
- Do not know

3. Could you smell the bad smells and see the unusual colors following? *(Check one box)*

   □ Yes □ No

4. How satisfied do you feel about **rain water**?

- Very satisfied
- Satisfied
- Fair
- Unsatisfied
- Very unsatisfied

Part A6. Questions on equipment for filtering, cleaning water

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1. Does your family have water filter? □ Yes □ No

- If yes → Move to the question number 2
- If no→ Move to the question number 5

2. When did you buy?

3. How much does it cost you? ------------VND

4. How well does it work?

- Very effective
- Quite effective
- Normal
- Ineffective
- Do not know

5. Have you ever seen, hear, read new papers or mess media on some things related in polluted water or water factory which produce bottle water under quality standard?

   □ Yes □ No

   - If no, move to → **part B**
   - If yes, move to → **question number 6**

6. Do you change your habit after having such information?

   □ Yes □ No

Section B: Your Health History

In this section, we ask about your general health. As with the rest of the information in this survey, all responses are completely confidential.

1. Have you smoked more than a 100 cigarettes in your entire life? *(Check one box)*

□ Yes □ Are you currently a smoker?
(Check one box) □ Yes □ No
□ No

2. On average, how many alcoholic drinks do you have per week? *(Check one box)*

□ None

□ 1-7

□ 8-14

□ More than 14

3. How would you rate your overall health? *(Check one box)*

□ Excellent

□ Good

□ Fair

□ Poor

4. Do you visit a physician once every year or two for general check-ups? *(Check one box)*

□ Yes

□ No

5. Has a doctor ever diagnosed you with a serious stomach problems (ulcer) or intestinal problems? *(Check one box)*

□ Yes □ Was it still present in the last 12 months?*(Check one box)*
□ Yes □ No
□ No

Section C: Please Tell Us About Yourself

In this section we ask about your background. As with the rest of the information in this survey, all responses are completely confidential.

1. Are you *(Check one box)*

□ Male

□ Female

2. Are you married? *(Check one box)*

□ Yes

□ No

3. In what year were you born? *(Fill in the blank)* 19__________

4. Did you live here during most of the last month? Yes No

5. How long have you lived in this place? *(Fill in the blank)* __________ years __________ months

6. What is your highest level of education? *(Check one box)*

□ Elementary school (class 1-5)
□ Secondary School (class 6-9)
□ High School (class 10-12)
□ College or Technical School, unversity
□ Advanced Degree (M.S., M.A., Ph.D., etc.)

7. How many total members are in your household? *(Fill in the blanks)*

__________ number of people in your household under 18 years of age

__________ number of people in your household 18 to 60 years of age

__________ number of people in your household over 60 years of age

8. Which of the following best describes your current employment situation? *(Check one box)*

□ Employed full-time

□ Employed part-time

□ Not employed ☐ Please go to Question #12

□ Retired ☐ Please go to Question #12

9. Are you paid hourly or are you on salary? *(Check one box)*

□ Hourly ☐ What is your hourly wage (before taxes)? VDN__________

How many hours per month do you typically work? __________ hours

□ Salary ☐ What is your current monthly salary (before taxes)? VDN__________

10. How many members of your household contribute to paying the household expenses?
(Fill in the blank)

__________ number of household members who help pay household expenses

11. **Please tell us about your income, what is the income per person on average in your family? (Unit: million VND)**

<2	2-3	3-4
4-5	5-6	6-7
7-8	8-9	9-10
10-11	11-12	12-13
13-14	14-15	15-16
16-20	20-30	>30

12. **Please tell me know:**

Name: ____

Address: ____

Phone number:____

Part D: Extra questions

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1. In your own opinion, what is safe drinking water?

2. In general, how do you feel and evaluate the current water?
- Very Satisfied
- Satisfied
- Normal
- Unsatisfied
- Very unsatisfied

3. How do you think by yourself about your own knowledge of water, water use and management in general?
- Very well understanding
- Well
- Basic
- Little
- Do not know

Please tell us how certain you are that you would actually answer

1 2 3 4 5 6 7 8 9 10

Not very certain Very certain

4. How important do you think about the water?
- Very important
- Important
- Normal
- Unimportant
- Do not know

5. Have you ever look for getting to know the current water? □ Yes □ No

If yes, tell us the way that you experiences below:

□ In the story with others
□ To look for information on the Internet
□ To ask for the relevant people
□ Other

6. Have you ever told, complained, sued to service companies about some water related problems?
   □ Yes □ No

7. Do you boil water before drinking water?
   □ Yes □ No

8. How much money does your family use for water compare to that use for other expense?
- Very large
- Large
- Normal
- Little
- Very little
- Do not know

Please tell us how certain you are that you would actually answer

1 2 3 4 5 6 7 8 9 10

Not very certain Very certain

9. Have you ever remind your family member of using water economically?
   □ yes □ no

10. How does your family use water
- Economic
- Normal
- Not economic
- Do know

Please tell us how certain you are that you would actually answer

1 2 3 4 5 6 7 8 9 10

Not very certain Very certain

11. How well do you take care of water and something relevant to water?
- Very much
- Much
- Normal
- Little
- No
- Do know

Please tell us how certain you are that you would actually answer

1	2	3	4	5	6	7	8	9	10
Not very certain									Very certain

Thank you very much for your answers on those questions!