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Water Tariff System Analysis, Economic Valuation and Water Demand Function of Sustainable Municipal Consumption: a Case Study of Najafabad City of Isfahan

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ABSTRACT

Nowadays, given that water is recognized as a socioeconomic commodity that plays a vital role in human life, management of its proper use, and emphasis on economic instruments, which is essential for balancing supply and demand. In this regard, the limitation of the water supply has led policymakers to focus on economic demand management tools such as pricing. Thus, the present study aimed to estimate the economic value, analyze the demand function, and water elasticity for domestic consumption, which can be the basis for an effective pricing policy in the water section. To this end, demand functions and elasticity are estimated by consumption levels by using regression analysis. Then, the maximum subscribers' willingness to pay is estimated and compared with the current tariffs, using the contingent valuation method. The data were collected by filling 385 questionnaires for urban households at Najaf Abad city in 2018. The results showed that according to the increasing block tariff (IBT), the relationships between the levels, price , and income elasticity were -0.27 and 0.32, respectively. Also, the weighted average of water economic value for urban households of this city varies from IRR 5664 to IRR 9379 per cubic meter between the consumer groups and the willingness to pay is lower in the high consumption group. Based on the findings, the economic value of water is higher than the current tariff in all consumption groups. Therefore, it is recommended that water tariffs be reviewed and increased incrementally over time due to its nonzero price elasticities.

1. Introduction

Water is a rare, vital and natural resource which human beings need continuously at any time and place. In addition, water is a valuable and

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irreplaceable commodity in the economic and social development of countries (X. Chen, Li, Li, Hu, & Hu, 2020). The demand for high quality water is increasing due to the growing population of cities, development of facilities and rising living standards. On the other hand, because of restrictions in water resources, one can not only rely on the creation and/or development of the resources, but it is necessary to reduce the need for water supply as much as possible (Ren et al., 2020). Hence, providing available and safe water is regarded as one of the most important challenges for governments (Niva, Cai, Taka, Kummu, & Varis, 2020). Therefore, adopting proper scientific and managerial approaches for optimal utilization of water supply is important. Balancing the supply and demand is considered as the main issue in the economic management of water resources in each region. In this regard, consumption of waste water, desalination of sea water and use of unusual waters regarding the supply, as well as the policies to reduce the consumption and use high water efficiency solutions regarding the demand should be highlighted (Ben Zaied, Kertous, Ben Cheikh, & Ben Lahouel, 2020; Lach, Ingram, & Rayner, 2005)

An analysis of Iran's upstream documents on the tariff system and urban water pricing shows that law is fair distribution of water, receipt of current costs and depreciation, with regard to the economic and social conditions of each region, which is consistent with economic principles. However, the receipt of water tariffs is based on the internal regulations of the Ministry of Energy instead of performing the above, leading to an ineffective pricing system, non-covered cost of the water companies and the critical condition of water resources. However, the long term water policy, adopted by the Cabinet in 2003, emphasized that "the determination of water rate for various consumptions should be such that the primary needs of drinking and sanitation are preferred in the framework of urban and rural consumption patterns, and the costs of operation and maintenance should be covered for expenditures beyond that in the first stage, with regard to financing and diversification of these resources (Hanemann, 2018). In the next step, recovery of capital costs should be provided". Also, based on the cross-sectional document of water resources management adopted by the Cabinet in 2005, water pricing should be in such a way that the average price is inclined to the final cost in line with the reform of the Iran's economic structure. Further, water allocation to other consumptions should be in the form of economic mechanisms and determination of appropriate pricing and tariff rules should be done regarding the type of product, climate conditions and consumption in order to determine the consumption pattern. Pricing, water

The question which arises in this regard is why water is priced less than the actual price, despite the emphasis of upstream documents. This question may be answered in light of the objectives of the tariff system and pricing. Analysis of the urban water tariff structure in Tehran province indicates that the water industry in Tehran was run by the Tehran Municipality and Water Organization before establishing the Ministry of Energy (1963). The pricing method was fixed at that time, due to the lack of scientific studies. After the establishment of Ministry of Energy, water rates were calculated based on the scientific principles. In fact, the two-part tariff system has been implemented in Tehran since 1976, and accordingly the progressive incremental rate system were considered in 1980-1984, linear progressive rate system was common 1985-1989, and the incremental rate system in broken lines[1] started in 1990-1993. It should be noted that the operating costs and depreciation are the basis for determining the tariff since the formation of Tehran Province Water and Wastewater Company in 1992. Similarly, the progressive incremental rate system was re-established in 1994-1995 and the incremental rate system in broken lines was executed in 1996. Then, Targeted Subsidies Law has been used since 2010, and the progressive incremental rate system (increasing block) was implemented and

1. In the incremental rate system in broken lines, different stages of consumption are considered and the amount of water consumed in each stage is subjected to a certain rate. As the rate increases through increasing consumption, and the price is rising rapidly from one step up with a very small increase in consumption.

continued until today. In the formulation of the tariffs, one coefficient was considered due to the requirement of the law to apply the variables of water quality, cost of utilization and geographical area of each city, according to the abovementioned issues. This coefficient is multiplied by the same rate for each level, so the water price is calculated for each consumption level in that city. However, non-household water rates continue to be implemented uniformly (Table 1).

Table 1. Computational formula and tariffs for household water sales in Iran

Computational Formula	**Consumption Levels (m^3)**
x 1.290	$0 < x \leq 5$
3.200 - x 1.930	$5 < x \leq 10$
9.600 - x 2.570	$10 < x \leq 15$
19.350 - x 3.220	$15 < x \leq 20$
44.950 - x 4.500	$20 < x \leq 25$
109.450 - x 7.080	$25 < x \leq 30$
186.550 - x 9.650	$30 < x \leq 35$
299.250 - x 12.870	$35 < x \leq 40$
814.050 - x 25.740	$40 < x \leq 50$
2.101.050 - x 50.480	$50 < x$

Reference: Tehran Province Water and Wastewater Company (2015)

The study of urban water tariff system evolutions indicated that the number of consumption levels failed to a special order, which varied from 4 to 12. Therefore, the question raised is how many consumption levels are optimal. Second, the method of price discrimination between the levels of different sections was linear progressive, progressive incremental and progressive in broken lines. In addition, the global experiences represent numerous tariff systems. Therefore, the present study aimed to see whether the type of tariff plan is suitable for discriminatory pricing.

According to the above-mentioned issues, the water pricing system in the household sector in Iran and most countries of the world is the increasing block pricing system. In this system, price elasticity of demand is different in all levels of consumption and higher consumption levels pay higher tariffs. But, since the demand side of water and the tendency and preferences of water subscribers were neglected in calculating tariffs for the levels, the defined tariffs are not economically optimal. In other words, the calculation of water tariffs will not be effective when the supply is merely under consideration. Therefore, the purpose of this study is to analyze the water demand function and to examine the preferences and willingness of water applicants to pay, through which proposals can be made to reform the existing tariff system that pays less attention to economic principles.

The background of the research is mentioned below. Then the methodology of estimating the willingness of subscribers to pay and then their demand function is examined. The method of data collection and model variables are described below. Finally, in the results section, while presenting the socio-economic characteristics of the sample, the results of estimating models for determining the economic value of water for different classes and the results of estimating discrete-continuous demand functions of water are presented and policy proposals are presented.

2. Literature Review

In this section, an analysis of the previous studies is provided first, and then the historical structure of the tariff system of Iran is examined and experiences are mentioned. Finally, some global experiences are pinpointed. Studies on the analysis of the tariff system and domestic water demand can be divided into three parts. The first group reviewed the estimation of drinking water demand function (Baerenklau, Schwabe, & Dinar, 2013; H. Chen & Yang, 2009; Fuente, 2019; Jessoe, 2013; Yang Liu & Mauter, 2020; Ying Liu, Yao, Bai, & Liu, 2016; Wichman, 2014; Zeneli, 2016). The second group examined the economic value and willingness to pay for drinking water (Burt et al., 2017; Chatterjee, Triplett, Johnson, & Ahmed, 2017; Entele & Lee, 2020; Jiang & Rohendi, 2018; Khan, Brouwer, & Yang, 2014; Kidane, Wei, & Sibhatu, 2019; Polyzou, Jones, Evangelinos, & Halvadakis, 2011; Van Houtven, Pattanayak, Usmani, & Yang, 2017). Finally, the third group focused the tariff system and pricing of drinking water (Garcia & Reynaud, 2004; Molinos-Senante, Villegas, & Maziotis, 2019; Neto & Camkin, 2020; Neverre & Dumas, 2015; Romano, Guerrini, & Senoner, 2020; Ruijs, Zimmermann, & van den Berg, 2008; Suárez-Varela, Martínez-Espiñeira, & González-Gómez, 2015; H. Wang, Xie, & Li, 2010).

Based on the results, there are many factors affecting household water consumption such as air temperature, income, characteristics, size, building characteristics, amount and pressure of available water, consumer goods price index, etc. In addition, in all of the studies conducted on the estimation of household water demand functions, the absolute value of price and income elasticity of water demand was calculated less than one, indicating the necessity of water as an economic commodity. In other words, the little vulnerability of domestic water demand to price and income changes is related to its necessity and low-cost. However, it is worth noting that non-zero price elasticity of water shows that tariff increases can be used as an effective way to reduce water consumption, especially when the water price approaches its actual price (Fuente, 2019; Zeneli, 2016).

Further, the examination of global experiences indicates that the water price should be based on the actual cost prices and reliance on consumers' affordability by considering the recommendations of the international water-related bodies. Over the past few decades, most of the developed and developing countries have adjusted the selling price. Fixed charge, fixed volume charge, increasing block and decreasing block are used more. Water tariffs in the Netherlands, Belgium and Germany are based on the volume charge, so that 90% of volume charge, 7% of fixed charge and 3% of increasing block charge were applied in the Netherlands (Fuente, 2019). Therefore, we tried to examine the consumers’ willingness to pay on the demand side in the present paper in order to improve the tariff system and increase its efficiency.

3. Methodology

For more than two decades, more attention has been paid to demand management rather than supply management for water resources management. To this end, experts have introduced integrated water resources management (IWRM) (Chang et al., 2020). The integrated management involves two general policies and a main purpose (K. Wang, Davies, & Liu, 2019). Based on the integrated management policies water should be treated as an economic, social and environmental commodity (Demetropoulou et al., 2019). In addition, the guiding policies and options in water management should be analyzed in an integrated framework. Further, the main purpose of the integrated management is to achieve sustainable development, efficiency and fair consumption of water resources (Pires et al., 2017). In this regard, demand management instruments can be divided into economic, legal-organizational, and cultural instruments (Salman & Mualla, 2008). Regarding economic instruments, economists believe that water is a private commodity and its price must be determined through a competitive market (Pires et al., 2017). The fact that water is regarded as an economic commodity is reported in the Dublin Conference (1992) on water and the environment. Economic instruments include concepts such as cost recovery, water pricing, tariff system and promotion of suitable water markets, and the like. Fundamentally, water pricing is an important part of water resources policy making, planning and water demand management. Pricing advocators believe that water pricing policy significantly improves the status of water management operations, basically covers the cost of water services in part or in general, allows for a rational use of water through its impact on consumers' behavior, and prepares the basis for investing in sustainable resources by providing the necessary capital (Hosseini, Parizi, Ataie-Ashtiani, & Simmons, 2019).

The set of objectives pursued by the policy maker in the water tariff system can be divided into economic objectives (cost recovery and efficiency of water companies, environmental costs, sustainable development, and welfare improvements of the next generation, etc.), and social objectives (reduction of social tensions, equality, improvement of income distribution, etc.). It seems that overemphasis on the social dimension of the water tariff system's objectives has led to less attention to the economic dimension, especially the pricing policy, and even to judge it even without detailed and experimental studies of its effectiveness. Therefore, it seems that the economic efficiency of the tariff system will be improved by modifying the pricing system and using the price discrimination approach while observing the social aspects.

3.1. Subscribers' Willingness to Pay for Water

Water is considered as an economic commodity when it is consumed in the urban section (household). Some of the methods used to measure the economic value of water as a final product are contingent valuation method, benefit transfer method and observation of water market transactions method (McDougall, Hanley, Quilliam, Needham, & Oliver, 2020). In the present study, contingent valuation method was used to calculate the urban households' willingness to pay at Najafabad city. To determine the measuring model of the willingness to pay, it is assumed that a person accepts the proposed amount for the value of drinking water on the basis of maximizing his desirability under the following conditions or rejecting in other cases (Hanemann, 2018):

$$U(1, Y - A; S) + \varepsilon_1 \geq U(0, Y; S) + \varepsilon_0 \quad (1)$$

In the equation 1, U represents the indirect desirability that one obtains. Y and A are the income of the individual and the proposed amount, respectively; and S indicates the socioeconomic characteristics influenced by individual taste. $\varepsilon_0, \varepsilon_1$ are random variables with an average of zero distributed equally and independently. The desirability difference of ΔU can be described as follows:

$$\Delta U = U(1, Y - A; S) - U(O, Y; S) + (\varepsilon_1 - \varepsilon_0) \tag{2}$$

The dual questionnaire format for evaluating contingent valuation has a dual choice dependent variable which requires a qualitative selection model. Logit and Probit Models are usually used for quality selection methods (Hanemann, 1984, 2018; Lee, 1997). Logit, Probit, or Tobit Model is used for a qualitative selection. The probability (P_i) that a person accepts one of the proposals (A) is as follows based on the Logit Model:

$$P_1 = F_\eta(\Delta U) = \frac{1}{1 + \exp(-\Delta U)} = \frac{1}{1 + \exp\{-(\alpha - \beta A + \gamma Y + \theta S)\}} \tag{3}$$

$F_\eta(\Delta U)$ is considered as a cumulative distribution function and includes socioeconomic variables. θ, γ, β are estimated coefficients which are expected as $\theta>0$, $\gamma>0$, $\beta\leq 0$. The Logit Model parameters are estimated using the maximum likelihood method, which is the most common technique for estimating the Logit Model (Lehtonen, Kuuluvainen, Pouta, Rekola, & Li, 2003). Numerical integration in the range of zero to the highest proposition is computed as follows (Equation 4):

$$E(WTP) = \int_0^{\max A} F_\eta(\Delta U)dA = \int_0^{\max A} \left(\frac{1}{1 + \exp[-\alpha^* + \beta A]}\right)dA \tag{4}$$

where E(WTP) is regarded as the expected value of willingness to pay and α^* is the modified y-intercept, which is added by the socioeconomic parameters to the original y-intercept α. (Equation 5):

$$\alpha^* = (\alpha + \gamma Y + \theta S) \tag{5}$$

3.2. Water Consumption Demand Function

The price of water in the household consumption is calculated as blocked in the form of increasing blocks. In order to estimate the demand function of commodities with the same price structure, we face a nonlinear demand function. In other words, the price and the amount are both endogenous. Differentiating each block from another one with the common points means that the blocks are broken, and the choice of the consumption block is a discrete choice. On the other hand, by choosing a block, the price is determined in addition to determining the scope of consumption. After fixing the block, the amount of consumption within which each block should be determined that is considered continuously and is counted as a continuous choice. Therefore, the discrete-continuous choice model (DCC) is used to estimate the variation of consumption with nonlinear cost including discrete and continuous choice concurrent with determination of the two important variables of price and amount (Hanemann, 1984, 2018; Hewitt et al., 2016).. To solve the problems, some methods were proposed in the literature such as simultaneous equations and variable tool patterns, none of which are in line with the block prices (Olmstead, Hanemann, & Stavins, 2005). Finally, the best model to solve the mentioned problems in the economic literature is the discrete-continuous choice with two errors, estimated by the maximum likelihood method. Using this model to estimate water demand was first introduced by Hewitt in 1993 (Hewitt et al., 2016). The following equation 6 is used to analyze the water demand with the blocked prices in the form of a discrete-continuous choice model:

$$\ln w = \alpha z + \beta \ln p + \delta \ln y + \eta + \varepsilon \tag{6}$$

Where W represents the amount of household water consumption, z indicates the social information matrix of households such as household size, and number of the members, p is considered as the average price that the consumer pays for each unit of consumption, and y is regarded as household income. This pattern has two error components including η which is an error component which expresses the heterogeneity of household water consumption preferences not explained by the variables and household characteristics in the pattern. ε is regarded as optimization error and, despite this error, it is assumed that the actual consumption is not always equal to the optimal consumption. Further, ε is called perceived error because an econometric expert cannot apply all the factors affecting consumption in the pattern. In summary, ε is a household and econometric error.

Estimation of the demand function is a bit complicated despite increasing block prices. In the general form of the demand function, assuming k blocks, the consumption price of each unit in the k-fold block is shown by P_k. Despite k blocks, there is k-1 common points between the blocks that w_k shows the consumption in these points. In the discrete-continuous choice model, there are two conditional and non-conditional demands. In the conditional demand, the consumer consumes provided that the amount of his consumption should be placed in a special block and his demand function equals to the equation 7. In this equation, $\tilde{y}_k = y + d_k$ is the revenue of k-fold block, where d_k is determined based on the equation (7):

$$\begin{cases} d_k = 0 \quad \text{if} \quad k = 1 \\ d_k = \sum_{j=1}^{k-1} (p_{j+1} - p_j) w_k \quad \text{if} \quad k \succ 1 \end{cases} \tag{7}$$

To consume more than the first block, there is a difference between the final price and the average price, and the consumer benefits from the amount of d_k subsidies. This amount is resulting from the difference in the amount that the consumer should pay and the amount he paid now if all of the units are priced at that amount (only the surplus of the common point is to be paid at a higher block price). The total amount of the received subsidy is added to the consumer's income $\tilde{y}_k = y + d_k$ and $\tilde{y}_k$ falls within the consumer's budget limit as his total income. d_k variable is called a differential variable, introduced and used by Taylor and Nordin. As stated, there is a separate conditional demand function for each block of consumption. In return, there is an unconditional demand function for general choice of the consumer, where not only his consumption is determined by the fixed price condition, but also the consumption block is chosen in practice. In equation 8, the unconditional demand function is presented as a function of conditional demand and the common points of the blocks. In fact, the logarithm of likelihood function for k of more than one block is converted to equation 8:

$$
Lnw_i = \begin{cases} Lnw_1^*(z, p_1, \tilde{y}_1; \alpha, \beta, \delta) + \eta + \varepsilon \\ \text{if } \; -\infty \prec \eta \prec Lnw_1 - Lnw_1^*(z, p_1, \tilde{y}_1; \alpha, \beta, \delta) \\ Lnw_1 + \varepsilon \\ \text{if } \; Lnw_1 - Lnw_1^*(z, p_1, \tilde{y}_1; \alpha, \beta, \delta) \prec \eta \prec Lnw_1 - \ln w_2^*(z, p_2, \tilde{y}_2; \alpha, \beta, \delta) \\ Lnw_2^*(z, p_2, \tilde{y}_2; \alpha, \beta, \delta) + \eta + \varepsilon \\ \text{if } \; Lnw_1 - Lnw_2^*(z, p_2, \tilde{y}_2; \alpha, \beta, \delta) \prec \eta \prec Lnw_2 - \ln w_2^*(z, p_2, \tilde{y}_2; \alpha, \beta, \delta) \\ \vdots \\ Lnw_{k-1} + \varepsilon \\ \text{if } \; Lnw_{k-1} - Lnw_{k-1}^*(z, p_{k-1}, \tilde{y}_{k-1}; \alpha, \beta, \delta) \prec \eta \prec Lnw_{k-1} - \ln w_k^*(z, p_k, \tilde{y}_k; \alpha, \beta, \delta) \\ Lnw_k^*(z, p_k, \tilde{y}_k; \alpha, \beta, \delta) + \eta + \varepsilon \\ \text{if } \; Lnw_{k-1} - Lnw_k^*(z, p_k, \tilde{y}_k; \alpha, \beta, \delta) \prec \eta \prec \infty \end{cases} \tag{8}
$$

In this function, w indicates the amount of the observed consumption and w^*_k represents the optimal amount of consumption during the k-fold block. Φ is considered as normalized cumulative distribution function. In the following, equation 9 is used to convert the equation 8 to the equation that the coefficients of the demand function can be deduced from. The first section of equation 9 is related to the consumptions which are placed at k blocks and constitute the linear section of the budget constraint. The second part is related to the consumptions which are exactly placed at each k-1 threshold or common points. In fact, equation 9 is a relation maximized by nonlinear methods and the demand parameters are estimated based on this equation:

$$\ln L = \sum_{\text{uniform price}} \ln\left(\frac{1}{\sqrt{2\pi}} * \frac{\exp -(s_1)^2/2}{\sigma_v}\right) +$$

$$\sum_{\text{block price}} \ln \left[\begin{array}{l} \sum_{k=1}^{k} \left(\frac{1}{\sqrt{2\pi}} * \frac{\exp -(s_k)^2/2}{\sigma_v}\right) * (\phi(r_k) - \phi(n_k)) + \\ \sum_{k=1}^{k-1} \left(\frac{1}{\sqrt{2\pi}} * \frac{\exp -(u_k)^2/2}{\sigma_\varepsilon}\right) * (\phi(m_k) - \phi(t_k)) \end{array} \right] \quad (9)$$

$$v = \eta + \varepsilon \;;\rho = corr(v,\eta) \;;s_k = (\ln w_i - \ln w_k^*(0)) / \sigma_v$$

$$u_k = (\ln w_i - \ln w_k) / \sigma_\varepsilon \;;t_k = (\ln w_k - \ln w_k^*(0)) / \sigma_\eta$$

$$r_k = (t_k - \rho s_k) / \sqrt{1-\rho^2} \;;m_k = (\ln w_k - \ln w_{k+1}^*(0)) / \sigma_\eta$$

$$n_k = (m_{k-1} - \rho s_k) / \sqrt{1-\rho^2}$$

Maximization of this pattern can be done by nonlinear method or optimization method (BFGS)[1]. After solving this system, the coefficients of variables are estimated (Olmstead et al., 2005).The outputs of this model can be interpreted based on conditional and non-conditional elasticities. The conditional elasticities that can be deduced directly from the price and income coefficients of the model[2] show the household's vulnerability with the assumption that each consumer is retained in the observed block and the non-conditional elasticities that can be calculated on the basis of statistical simulations consider the effect of changing these variables on the probability of changing the consumer’s position in the block in addition to the effect of price and income changes and assessment of the households' vulnerability[3].

The variables used in the Logit Model for estimating the economic value of water as well as the demand function for different levels of consumption are given in the following table.

1. Broyden-Fletcher-Goldfard-Shanno Optimization Method

2. It is calculated based on $e_{p,cons} = \frac{\partial cons}{\partial p} \bullet \frac{p_{average}}{cons_{average}}$ and $e_{inc,cons} = \frac{\partial cons}{\partial inc} \bullet \frac{inc_{average}}{cons_{average}}$.

3. Non-conditional elasticity was not calculated due to the cross sectional nature of the data and irrationality of the assumption of relocation of subscribers between the levels in the data collection period.

Table 2. Variables used in household water value estimation

Variable	Manner of Entry to Model	Expected Sign
Water Quality Satisfaction (QLW)	Virtually, one for water quality satisfaction and zero otherwise	Negative
Water Quantity Satisfaction (QNW)	Virtually, one for water quantity satisfaction and zero otherwise	Negative
Average Monthly Income (INC)	Per thousand tomans	Positive
Water Consumption (CONS)	Per cubic meter	--
Number of Household Members (MEM)	Per capita	Positive
Proposed Variable (BID)	Per thousand tomans	Negative
Gender of the Head (HEAD)	Virtually, one for man and zero for woman	--
Age of the Head (AGE)	As a continuous variable	Negative
Education of the Head (D_i)	As a virtual variable with different levels[1]	Positive

3.3. Data collection and study area

A stratified random sampling method was used to collect data. Therefore, the studied population included all urban households in Najafabad, which are surveyed in the form of six urban areas (categories). Cochran formula (1977) was used to determine the sample size, using the simple random sampling method in each category. Based on the above explanations, 385 complete questionnaires were extracted and used from the total population of 72799 households in Najafabad. Given that it was not possible to categorize urban water subscribers in different blocks and complete the questionnaire, there was a limitation of data for estimating econometric patterns in each block. Therefore, based on the previous experiences, three new consumption levels were defined and the results were compared with the total households for

1. Cochran formula

better calculation and interpretation of water value. The first consumption level ranges zero to 15 cubic meters, the second level ranges 16 to 25 cubic meters, and the third level is more than 26 cubic meters within a month. There are 189, 138, and 58 households in the first, second, and third level, respectively.

4. Results and Discussion

4.1. Descriptive Analysis of Socioeconomic Characteristics of the Sample

In this section, some of the most important socioeconomic characteristics of households are evaluated within the scope of the study, based on the data collected from field studies. Data analysis showed that the average income of urban households in Najafabad is 1.8 million tomans monthly. Regarding the level of satisfaction with quantity and quality of water, as shown in Figure 1, 77% of the households are satisfied with the quality of domestic water and the rest are dissatisfied with the inadequate water treatment as the main cause. Further, 87% of the sample size is satisfied with the quantity of household water, and the reason for the rest 13% dissatisfaction is low water pressure in some places. The education level of the head of family indicates that 19.48% of the heads are illiterate in urban areas and 3.38% hold master's degree or higher. In analyzing the urban households' willingness to pay, as shown in Table 3, the percentage of primary amount acceptance in urban areas of Najafabad was 55% and the percentage of secondary amount acceptance was 63%. In fact, the difficult living conditions and inflation expectations have caused people not to pay more for better water quality.

Table 3. Household willingness to pay in urban areas in Najafabad city

Description		Acceptance of the proposed primary amount	Acceptance of the proposed secondary amount
Urban Households	Frequency	212	241
	Percentage	55	63

4.2. The Results of Estimating Water Pricing Models for Different Levels

Here, the data related to all of the households in the population were collected and the economic value of water is estimated in Table 4 as a pattern for all of the urban households in Najafabad.

Table 4. Results of the Logit model estimation for all levels in Najafabad urban areas

Variable	Variable Type (Unit)	Regression Coefficient	Standard Deviation	Statistic t	Final Effect
BID	Continuous (one thousand tomans)	-0.18	0.02	-8.02	-0.0443
AGE	Continuous (year)	-0.01	0.01	-0.79	-0.0022
CONS	Continuous (cubic meter)	0.00	0.01	-0.67	-0.0001
D1	Virtual variable of education level (illiterate)	-0.96	0.60	-1.58	-0.2293
D2	Virtual variable of education level (ability to read and write)	-0.71	0.55	-1.30	-0.1706
D3	Virtual variable of education level (High School Diploma)	-0.80	0.54	-1.49	-0.1925
D4	Virtual variable of education level (Associate Degree)	-0.76	0.62	-1.24	-0.1833
D5	Virtual variable of education level (Bachelor Degree)	-0.33	0.53	-0.61	-0.0785
HEAD	Virtual	-0.17	0.37	-0.45	-0.0403
INC	Continuous (one thousand tomans)	0.00	0.00	7.81	0.0003
MEM	Continuous (per capita)	-0.40	0.09	-4.63	-0.0958
QLW	Virtual	0.20	0.21	0.96	0.0474
QNW	Virtual	-0.06	0.26	-0.24	-0.0150
C	y-intercept	1.71	0.86	2.00	--
	Logarithm of likelihood function	-461.25			
	McFadden's Coefficient of Determination	0.12			
	Percentage of the correct prediction	67.53			

The percentage of correct prediction of the estimated model is 67.53%, which means that the estimated model can predict a high percentage of the dependent variable values with respect to the explanatory variables and approximately 67.53% of the respondents allocated the predicted YES or NO willingness to pay by providing perfect ratio of information. The McFadden's statistics indicates that the way the explanatory variables of the model explain the changes in the dependent variables. Since the dependent variable of the Logit models only has 0 and 1 value, observations will be made around these points and naturally, coefficient of determination of these models is low.

As shown, in addition to the proposed variable, the monthly income variable and the number of household members significantly affect the probability of accepting the proposed average and their sign is in line with the expectations. In other words, the probability of accepting the proposed price increases by increasing the income and/or decreasing the household size and proposed price variables. For example, the final effect coefficient of the BID variable indicates that, the probability of the proposed price acceptance reduces by 4% by increasing one unit in this variable (per thousand tomans). Instead, by increasing one unit in the INC variable (per thousand tomans), the probability of the proposed price acceptance increases by 0.03%. In other words, if 10 thousand tomans is added to the proposed price, the probability of its acceptance reduces by 40%. Further, the probability of the proposed price acceptance increases by 30% if one million tomans is added to the household income. Based on the methodology, the total economic value was calculated by integration of the surface under the logit probability distribution curve and then divided by the average household water consumption in a month (17.43 cubic meters) to get the value of each cubic meter of water. The results indicated that the economic value of each cubic meter of plumping water for households at Najafabad urban areas is IRR 7688. Based on the provided explanations in the methodology section, the results of Logit Model estimation and the subscribers' willingness to pay in urban areas are discussed in the following, based on the defined consumption levels:

Table 5. Results of Logit model estimation in the first level of consumption

Variable	Variable Type (Unit)	Regression Coefficient	Standard Deviation	Statistic t	Final Effect
BID	Continuous (one thousand tomans)	-0.19	0.03	-6.02	-0.047
AGE	Continuous (year)	0.00	0.02	0.15	0.001
CONS	Continuous (cubic meter)	-0.07	0.04	-1.80	-0.016
D1	Virtual variable of education level (illiterate)	-0.20	0.85	-0.24	-0.048
D2	Virtual variable of education level (ability to read and write)	0.01	0.74	0.01	0.002
D3	Virtual variable of education level (High School Diploma)	0.14	0.73	0.19	0.033
D4	Virtual variable of education level (Associate Degree)	0.07	0.82	0.09	0.018
D5	Virtual variable of education level (Bachelor Degree)	0.80	0.74	1.08	0.193
HEAD	Virtual	0.09	0.47	0.18	0.021
INC	Continuous (one thousand tomans)	0.00	0.00	5.88	0.0003
MEM	Continuous (per capita)	-0.34	0.14	-2.49	-0.081
QLW	Virtual	0.42	0.33	1.29	0.102
QNW	Virtual	-0.26	0.38	-0.68	-0.063
C	y-intercept	0.48	1.16	0.41	--
	Logarithm of likelihood function	-222			
	McFadden's Coefficient of Determination	0.13			
	Percentage of the correct prediction	68.25			

The percentage of correct prediction of the estimated model is 68.25%, which means that approximately 68.25% of the respondents have allotted the predicted YES or NO willingness to pay by providing perfect ratio of information. Based on the methodology, the total economic value was calculated by integration of the surface under the logit probability distribution curve and then divided by the average household water consumption in a month (10.39 cubic meters) to obtain the value of each cubic meter of water. The results indicated that the economic value of each cubic meter of plumping water for households at Najafabad urban areas is IRR 9379.

Table 6. Results of Logit model estimation in the second level of consumption

Variable	Variable Type (Unit)	Regression Coefficient	Standard Deviation	Statistic t	Final Effect
BID	Continuous (one thousand tomans)	-0.20	0.04	-4.98	-0.0485
AGE	Continuous (year)	-0.02	0.02	-1.10	-0.0052
CONS	Continuous (cubic meter)	0.09	0.05	1.75	0.0203
D1	Virtual variable of education level (illiterate)	-1.71	1.08	-1.59	-0.4054
D2	Virtual variable of education level (ability to read and write)	-1.60	0.95	-1.67	-0.3783
D3	Virtual variable of education level (High School Diploma)	-1.77	0.93	-1.91	-0.4195
D4	Virtual variable of education level (Associate Degree)	-1.73	1.14	-1.52	-0.4095
D5	Virtual variable of education level (Bachelor Degree)	-1.07	0.90	-1.19	-0.2528
HEAD	Virtual	-1.02	0.82	-1.23	-0.2409

Variable	Variable Type (Unit)	Regression Coefficient	Standard Deviation	Statistic t	Final Effect
INC	Continuous (one thousand tomans)	0.00	0.00	5.15	0.0004
MEM	Continuous (per capita)	-0.35	0.14	-2.57	-0.0837
QLW	Virtual	-0.09	0.33	-0.27	-0.0213
QNW	Virtual	0.02	0.50	0.48	0.0057
C	y-intercep	1.99	1.90	1.05	--
	Logarithm of likelihood function	-160.29			
	McFadden's Coefficient of Determination	0.14			
	Percentage of the correct prediction	69.20			

Further, in this level, the total economic value was calculated by integrating the surface under the logit probability distribution curve and divided by the average household water consumption in a month (20.36 cubic meters). The results indicated that the economic value of each cubic meter of plumping water for households at Najafabad urban areas is IRR 7948.

Table 7. Results of Logit model estimation in the third level of consumption

Variable	Variable Type (Unit)	Regression Coefficient	Standard Deviation	Statistic t	Final Effect
BID	Continuous (one thousand tomans)	-0.26	0.07	-3.76	-0.0612
AGE	Continuous (year)	-0.06	0.03	-1.72	-0.0136
CONS	Continuous (cubic meter)	-0.04	0.04	-1.01	-0.0088
D1	Virtual variable of education level (illiterate)	-2.34	2.38	-0.98	-0.5586
D2	Virtual variable of education level (ability to read and write)	-2.09	2.32	-0.90	-0.4981

Variable	Variable Type (Unit)	Regression Coefficient	Standard Deviation	Statistic t	Final Effect
D3	Virtual variable of education level (High School Diploma)	-3.08	2.32	-1.32	-0.7348
D4	Virtual variable of education level (Associate Degree)	-2.91	2.40	-1.21	-0.6955
D5	Virtual variable of education level (Bachelor Degree)	-3.49	2.27	-1.54	-0.8342
HEAD	Virtual	0.36	1.12	0.32	0.0855
INC	Continuous (one thousand tomans)	0.00	0.00	3.18	0.0004
MEM	Continuous (per capita)	-0.91	0.26	-3.49	-0.2170
QLW	Virtual	0.15	0.56	0.26	0.0348
QNW	Virtual	0.73	0.60	1.21	0.1736
C	Intercept	7.77	3.37	2.31	--
	Logarithm of likelihood function	-65.63			
	McFadden's Coefficient of Determination	0.17			
	Percentage of the correct prediction	68.10			

The percentage of correct prediction of the estimated model is 68.10%, which means that approximately 68.10% of the respondents have allotted the predicted YES or NO willingness to pay by providing perfect ratio of information. Based on the methodology, the total economic value was calculated by integrating the surface under the logit probability distribution curve and then divided by the average household water consumption in a month (33.40 cubic meters) to get the value of each cubic meter of water. The results indicated that the economic value of each cubic meter of plumping water for households at Najafabad urban areas is IRR 5664.

4.3. Results of Water Discrete-Continuous Demand Function Estimation

In order to analyze water demand, the discrete-continuous choice model of the demand function was used.

Table 8. Results of the parameters estimation in the discrete-continuous choice pattern for all urban households

Maximized by BFGS Method				
Convergence with 56 times, Final Criterion 0.0001				
Variable	**Coefficients**	**Standard Deviation**	**Statistic t**	**Sig.**
AGE	0.03	0.01	2.75	0.00*
D1	-0.93	0.39	-2.39	0.01*
D2	-0.93	0.27	-3.39	0.00*
D3	-0.56	0.25	-2.17	0.02*
INC	0.0003	0.0001	2.02	0.04*
MEM	0.11	0.06	1.63	0.10**
P	-1.83	0.05	-34.64	0.00*
NUMBER	0.04	0.001	36.75	0.00*
C	2.83	0.53	5.26	0.00*
η_i	0.26	0.04	6.32	0.00*
ε_i	2.60	0.43	5.99	0.00*

* Significant at .05 ** Significant at .001

Regarding the demand function for the total consumption levels, the income and price conditional elasticity of the households in Najafabad are 0.2750 and 0.317, respectively. The nonzero price elasticity of water shows that pricing policies can be used as a way to reduce water consumption. The resulted income elasticity represents a low share of water in the household income, regarding the block price of water and the fact that water has no substitute (an essential and low elasticity commodity). Further, the standard deviation of the heterogeneity error of household preferences is smaller than that of the perceived error ($\sigma_{\varepsilon i}>\sigma_{\eta i}$), indicating that the difference in household preferences did not have a large share in the unexplained changes of water consumption during the period under review. In other words, the heterogeneity of households was greatly eliminated by categorizing the block, and households with similar characteristics were placed in a block. Thus, the difference of preferences in the same blocks and as a result, its effect on the unexplained changes decreased.

5. Conclusions and Policy Recommendations

Based on the Targeted Subsidies Law, the government intends to reduce water tariff subsidies for various sectors including the household sector, and bring tariffs closer to its final costs. On the other hand, the government is not interested in disrupting and reducing social welfare in the society. In the present study, the households' willingness to pay and/or the price of water demand was examined to assist the evaluation of this issue. Accordingly, as shown in Table 9, there is a difference between the average water rate payment by the households in the city of Najafabad and their willingness to pay. Thus, regarding the total of urban households, the average willingness to pay is IRR 7688 and the average water rate payment is IRR 1498 per cubic meter. In other words, the rate of willingness to pay is about five times of the water rate payment, which varies between different groups of consumption.

Table 9. Comparison of the willingness to pay and the average payment of urban households in different levels

Consumption Blocks	Economic Value (IRR)	Average Water Rate Payment (IRR)	Ratio of Willingness to Pay to Water Rate Payment	Difference of Water Rate Payment and Willingness to Pay (IRR)
Low Consumption	9379	974	9.6	8405
Average Consumption	7948	1250	6.4	6698
High Consumption	5664	2389	2.4	3275
Total Subscribers	7688	1498	5.1	6190

Based on the results, the economic value of water in all levels is higher than the average water rate payment of the households. Further, the price and income elasticity of the households in the consumption blocks is less than one, which indicates the necessity of water, as well as the low vulnerability of consumers to current prices. Furthermore, consumers are placed in the domain of low elasticity of the demand function.

In fact, based on the results and the review of the studies, it can be concluded that at the current level in Iran, water is a low-elasticity product in household consumption (price elasticity between zero and one). However, the question raised is whether the pricing policy is effective when water is a low-elasticity commodity or not. Based on the definition of price elasticity of water, demand and consumption decrease as prices rise. Since water has nonzero elasticity in household consumption, the person will reduce consumption by moving from the low elasticity domain to the domain of being elasticity if a suitable price is proposed. Thus, based on the results, modification and increasing the price of domestic water, along with the discrimination between the levels, is recommended in the form of a suitable tariff structure. However, the determination of this structure and the proposed price requires additional studies.

In addition, based on the results of the patterns and towards correction of the of consumption patterns and management of surplus consumption on the essential needs of urban households, since price changes may be time-consuming for placing the consumer in the elasticity domain, and/or there is no possibility to increase the prices for income and welfare interests of the low-income households. Therefore, it is recommended to apply non-pricing policies such as behavioral economics and/or other measures to reduce water losses, along with price correction.

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