Price elasticity of residential water demand: a Meta analysis of studies on water demand, (case study: Iran)

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Abstract:

Contrary to the traditional supply policies, the integrated water resources management concentrates mainly on demand policies in which water tariffs are the most effective tools in achieving economic efficiency through management of water consumption. It is therefore important for policy makers and water managers to understand price elasticity for water demand presenting how changes in water tariffs affect water consumption. In this study, we reviewed 21 empirical case studies in Iran, including journal articles, master thesis and PhD dissertations, from which 65 estimates of price elasticity for residual water demand were collected. Using t-tests, the collected estimates of price elasticity found to be statistically different. Applying the meta-analysis approach that is focused on the two main objectives of publication bias and publication heterogeneity, it is attempted to explain the heterogeneity in the reported studies. Publication bias was tested using different techniques of meta-analysis. Using meta regression, impacts of theoretical specification, model specification, data characteristics and population the heterogeneity across the reported elasticity estimates are examined. Inclusion of income, use of time-series datasets, natural logarithm function of demand and application of stone greay theory are all found to affect the estimate of the price elasticity. The population density and use of OLS technique to estimate the demand parameters do not significantly influence the estimate of the price elasticity.

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Keywords: Price elasticity; heterogeneity; Residual water demand

Introduction

In Iran, similar to many countries, the increasing demand of water has concerned authorities about managing and controlling water consumption and economists about controlling the demand through increasing the cost of water consumption. In order to set an effective policy to adjust water consumption, the economists attempted to estimate price elasticity for water demand in various regions of the country. The price elasticity of water demand is a dimensionless indicator presenting the percentage change in water demand due to a one percent change in water tariff. Considering changes in the price of a given good would change its demand quantity in the opposite direction, the sign of price elasticity is always negative. The absolute value of the price elasticity displays how consumption would react to a one percent change in the price. When the percentage change in the demand quantity is below the percentage change in the price, the demand is inelastic- the absolute value of price elasticity is below 1.0. In contrast, percentage changes in demand that exceed percentage changes in the price reflect elastic demand- the absolute value of the price elasticity is above 1.0. Considering elasticity estimates contain a level of redundancy, estimate accuracy –that is how closely the estimated elasticity is able to predict consumption changes- influences the success of a water tariff policy. For instance, Musavi (2007) estimated the water elasticity at -0.001 in Marvdasht region in 2009, while the elasticity for the same region was estimated at -1.23 in the next year [26]. The difference can have a significant influence on the expected outcome of a one percent change in the existing water tariff. In the 2009, the average of annual water consumption per a household was calculated at 334.44 cubic meters. Considering the water price elasticity at -0.001, the policy directed at a one percent increase in the water tariff expects to reduce the water consumption by 0.0033 cubic meters per household. Whilst the water consumption would be decreased by 4.11 cubic meters per household when the price elasticity is assumed at -1.23. If the quantities are adjusted for the number of households in the city – that is about 200,000 households- the expected reductions under the two estimates for the water elasticity are quite different. Therefore, the more accurate the elasticity estimate is the more successful the policy of water tariff is expected.

In the past 14 years, many studies measured the demand function of water and the associated price elasticity. The results from these studies are substantially different not only from county to county, but even for a particular region in different studies. Five different elasticity's including -0.47 [43], -0.57 [22], -0.44 [23], -0.12 [31] and -.23 [40] were reported for Tehran.

Heterogeneity in elasticity estimates is not a particular for Iran, as it has been observed in other regions. To clarify sources for this heterogeneity, meta-analysis based on statistical techniques to link inter-study differences as explanatory variables to the reported empirical estimates has been widely applied. The famous study of meta-analysis on residual water elaticities was conducted by [12, 5]. The study conducted by dynamics, and research design to the study outcomes. The tariff system (increasing or decreasing block rate systems) and the estimation approach (discrete or continuous) were found significant in explaining the observed heterogeneity in the study outcomes. The Espey 's study [12] indicates that climatic variables, inclusion of income to the demand function and the tariff system would significantly influence the price elasticity. The study conducted by Sebri (2014) found that price elasticity for summer and winter are different. Furthermore, use of water for outdoor and indoor activities influence the price elasticity for water demand.

Considering that a few studies on residual water demand used meta analysis approach [5,12,38] results obtained from this study can not only be inclusive , but has some innovations on application of new statistical techniques such as “Z-naïve”, inclusion of new variables – such as adjustment component- and application of other econometric models to investigate determinants of heterogeneity in price elasticity estimates. To analyse relationship between price elasticity for residual water demand and the survey structure, the previous studies applied simple statistical techniques. In this study, we, for the first time, apply fix effect model and PEESE to examine potential relationships between elasticity estimates and survey structure.

Furthermore, this study is a review of the published researches conducted in Iran-like many other developing countries- where the problem of water shortage has been growing. In those countries, higher water tariffs are considered as a mean to reduce water consumption in the recent years. If this policy is assumed to be effective, its implication requires to be based on an accurate understanding of consumers’ reactions to price changes. This study , in addition to provide insights into understanding influential factors on elasticity estimates, is useful to clarify the effect of increases in residual water tariff in Iran at reducing its consumption.

To sum up, the result of this meta analysis can be helpful for anyone interested in studying on water demand function. First, it provides a brief summary of some real cases of price elasticity for residual water demand. Second, it explains factors that affect estimated value of price elasticity for water demand. In this context, the results are particularly interesting for policy-making purposes in understating which factors associated with survey structure could influence elasticity estimates.

In this study, the reported elasticities were basically analyzed in the two common features of a meta analysis including publication bias and publication heterogeneity [42]. By publication bias, the study attempted at understanding if the reported studies were preferred a particular direction of results. For instance, elasticity estimates over -1 might be disregarded. On the other hand, by publication heterogeneity, the study looked for sources of heterogeneity in the elasticity estimates reported by different studies.

Section 2 describes the methodological framework that was used to collect the study data and to define the study variables. Section 3 explains a description of data sets we used for the analysis. This followed by the results obtained from the empirical study. The last section presents discussion and some policy implication from this study.

1. Meta analysis: methodological framework

Similar to meta-analysis studies, the two main steps of the methodology were collection and selection of the empirical studies and coding the deterministic factors and definition of the explanatory variables. The following describes the two steps in a more details.

1.1. Selection of the empirical studies

An in-depth research procedure was applied to collect all studies on residential water demand in Iran. First, academic databases, both international and Iranian, were searched applying extensive keywords associated with residential water demand in Iran. Second, a manual search using the available literature reviews and references provided by the collected studies were conducted. Due to difficulties to access to some sources, some studies were collected through a direct contact with the corresponding author. Finally, a set of all articles, papers, reports and dissertations studied on water demand in Iran was collected. It was interesting that all studies were written in Persian language, and thus only Iranian research databases and sources would contain studies on residential water demand in Iran.

In the next step, to get a general understating of the collected materials, all studies were briefly reviewed by the authors with a special emphasis on price elasticity. The studies, based on the availability of price elasticities, were determined into three sets. Some studies directly reported price elasticity, while for some others with double-log function the price elasticity could be easily withdrawn by the regression coefficients. There were also some studies on the demand function that elasticities neither was directly reported nor could be easily measurable. The last set was excluded from the empirical studies selected for this study. Hence, the main criterion for study selection was that the price elasticity could be easily withdrawn from either the direct report or the demand function. Accordingly, 21 studies including journal papers, master thesis and PhD dissertations with 64 price elasticity values were included in the meta-analysis. More details on the selected empirical studies are provided in the table1.

1.2. Coding the deterministic factors and definition of the explanatory variables

To have a general specification on differences across the selected studies, inductive coding aimed at defining any single factor that seemed to differ studies was conducted by the two authors, separately. The authors attempted to code any single factor that seemed to differ in the study. At the end, the separately coded factors were compared. The coding reliability was revealed in 95% of cases based on the agreement between the two authors. The coding disagreements between the two authors were resolved and final factors that may cause differences across the selected empirical studies was defined.

All included factors were defined in the form of either a dummy or a continuous variable. We then investigate variability for continuous variables, number of observations and frequencies for dummy values. Those variables that either were unique in a particular study or had very low frequencies were excluded. The final variables known as moderators are categorized into four groups including theoretical specification, model specification, data characteristics, and socio- geographical characteristics.

1.2.1. Theoretical specification

The variables refer to the theory based on which the demand function was derived. Many empirical studies applied Stone-Greay theory in which consumers who face certain levels of income and prices first purchase subsistence level of each good and allocate the rest to each good according to their preference parameters [6]. The main reason for which many researchers used the Stone-Greay theory to estimate the water demand function is the estimation of non-constant elasticities for various water tariffs across various blocks of water use. The theory is specifically helpful for the regions where water tariffs are non-constant across blocks of water use [7, 14]. The other alternative to estimate water demand is to apply the law of demand and estimate the relations using different techniques that are considered by the model specification.

1.2.2. Model specification

This refers to the variables associated within three sub-groups including “functional form”, “inclusion of moderators” and “estimation technique”. The “functional form” considers mathematical function used to estimate demand. Linear and double-log linear were the two mathematical functions that were applied in the empirical studies to estimate the relationship between demand and the explanatory variables. The main difference between the two forms is in the elasticity estimates that are not constant at all points on a linear function, while it is constant along the double-log function. The “inclusion of moderator” considers the difference among the empirical studies in control variables used to estimate the demand function. The empirical studies differ in inclusion of control variables such as income, population, household size, evapotranspiration, rainfall and temperature included to the demand function. While income was considered by a number of empirical studies, other variables were rarely observed in the studies. For this sub-group, we therefore defined two variables "inclusion of income" that is a dummy variable indicating whether the study included income or not and "inclusion of other variables" that is a dummy variable for considering if other variables were included or not. The "estimation technique" considers if a technique used to estimate water demand function can make a significant difference in water elasticity drawn from the demand function. Although a wide variety of different techniques could be applied to estimate the water demand function, the Ordinary Least Square (OLS) technique was mostly applied to estimate water demand function in Iran. The "estimation technique" was included to determine if there is any significant difference between elasticity values estimated by OLS techniques and those by non-OLS techniques. Hence, a dummy variable named "OLS", in which all studies used non-OLS techniques were given a 0 value, was included.

1.2.3. Data characteristic

This considers sources of data collection that may affect price elasticity's estimates. First, the data sets used in the empirical studies were time series, cross-sectional or pooled cross-sectional. As 26 studies used time series data, a dummy variable that takes 1 if the data set was time series and 0 for otherwise was considered. Second, the unit of data collection was person for some studies, while household for some others. A dummy variable with a value of 1 for data sets on household basis and 0 for otherwise is used. Third, the study year that was considered by the publication year was included as the proxy for the year when the study conducted. Fourth, empirical studies were also different in study duration that was considered by number of years for which the data set was collected. Fifth, some empirical studies estimated water demand for either specific season of spring, summer, autumn and winter or all four seasons, separately. In order to determine if water elasticity value depends on the season for which the elasticity was estimated, a dummy variable of "seasonal elasticity" were included. The variable was given 1 value if the study estimated the elasticity for a specific season and 0 if the reported elasticity was estimated for one year.

1.2.4. Socio-geographical characteristics

This considers differences across the study areas in climate, population and tariff rate. Since climate and weather condition was the same in the empirical studies used in the analysis, this factor was disregarded in our analysis. In general, based on the population density, the counties of Iran are categorized into four groups of metropolitan or town, city or big city [17]. The empirical studies whose water elasticities are used in this study conducted in either metropolitan or town, city or big city. In addition, counties of Iran are different in tariff rate and this variable was included in the analysis. The following describes rate structure and water tariff across counties in Iran.

1.3. Water tariff system for residual water consumption in Iran

In Iran, similar to other countries facing the problem of water scarcity, the water tariff aimed to reduce water consumption. The tariff system has been designed on increasing block rate pricing through which the unit price of water is not constant across different blocks of water use. Within the system, customers who use low volumes of water are charged by a cheaper unit price than what is for customers with high volume of water consumption. In addition to reduction in water consumption, the system is assumed to protect poor-households from high unit prices as the first blocks associated with the least water consumption has a very low price of water unit. Some scholars [35], however, argue that this purpose of the tariff system has not been practically satisfied as high-size households would be considered as high-income families. The fee for each block that is annually assigned by the ministry of energy is not constant for all counties and even for the cities of a particular county. The fee is measured based on an individual "adjustment coefficient" that is calculated by the ministry of energy. The coefficient calculation is based on the three elements of water quality, water operating costs and environmental criteria including geographical condition and population. Table 2 presents the adjustment coefficient and population density in 2013 for the selected empirical studies.

In order to determine if different water tariff across regions caused any difference in the elasticity's reported for the given regions, the "coefficient adjustment" was included into the model. Table3 presents a summary for each variable that was initially expected to cause differences in the reported estimates. Table3 illustrates a brief description of the selected variables.

2. Results

Through combining the results obtained from some independent studies, this study aimed at understanding the nature of price elasticities estimated for residual water demand in Iran by

(1) Comparing the published studies with the possible unpublished studies. This phenomenon is known as publication bias.

(2) Assessing possible heterogeneity in price elasticity estimates across different studies- that is publication heterogeneity.

2.1. Publication bias

Publication bias has been widely found within studies in the economics [13, 8, 11, 4, 28]. Publication bias occurs when there is an intention to publish studies with certain criteria. In the case of price elasticity, publication bias exists if studies with values in a particular range have a high chance to be published. The intention to publish studies with certain criteria that could be from different sources such as primary researchers, reviewers or journal editors causes the results of published studies to become prominent, even though unpublished results provide interesting and reliable information. Applying some techniques to estimate publication bias, the study attempted to compare the elasticity values reported by various studies with the possible unpublished studies.

2.2. Funnel graph

Figure 1 displays a funnel graph for all water price elasticities reported by the selected empirical studies. On the graph, the reported standard errors are arranged on the y-axis and the elasticity values on the x-axis. Although it sounds that more points are concentrated on the right-hand side of the graph, the graph looks symmetric and balanced, generally. Nevertheless, the null hypothesis of symmetric graph will be tested in the next section. If the statistical test is unable to fail the null hypothesis, the absence of publication bias- indicating the lack of bias in selecting the studies of residual water demand for publication- are proved. Furthermore, a large number of effects out of confidence interval indicate that unobservable factors caused a systematic and serious heterogeneity in the reported estimates. The possibility of publication heterogeneity will be also examined by some statistical procedures

2.3. Publication bias tests

We used the following statistical tests to decide the hypothesis that the funnel plot is symmetry indicating the absence of publication bias.

2.3.1. Funnel asymmetry and precision effect tests (FAT-PET analysis)

The FAT-PET analysis is aimed at the two purposes including a) to test the existence of publication bias in the empirical studies b) to correct the effect estimates for the publication bias.

The FAT test is based on the hypothesis that in the absence of publication bias the effect side estimates are randomly distributed around the real population value without any dependency on the precision. Therefore, existence of publication bias can be determined by estimating the following equation

$$E_i = b_1 + b_0(se_i) + e_i \qquad (1)$$

Where E_i is the effect estimate i and se_i is the associated standard errors. Since this regression is obviously heteroskedastic, the equation is adjusted by dividing the two variables by their associated standard errors. Thus, to test funnel plot asymmetry, the standardized equation as follow should be estimated

$$\frac{E_i}{SE_i} = b_1 \frac{1}{SE_i} + b_0 + v_i \qquad (2)$$

In the absent of publication bias, the null hypothesis on b_0 that is zero is accepted. This requires a linear relationship between the observed effects and their standard errors. Stanley's study [42], on the other hand, illustrated that the relationship between the observed effects and their standard errors can be most probably non-linear. The estimates to adjust the non-linear relationship is found by estimating the following equation known as "Precision-Effect Estimate with Standard Error" (PEESE)

$$\frac{E_i}{SE_i} = b_0 SE_i + b_1 \frac{1}{SE_i} + w_i \qquad (3)$$

Where b_0 is the coefficient to test funnel plot asymmetry and b_1 for the effect estimate corrected for publication bias. Table 4 summarizes four models –e.g. FAT and PEESE models- to test publication bias and the magnitude of elasticity corrected for publication bias. The FAT model is estimated by fixed-effect techniques and the PEESE is estimated by the Ordinary Least Squares (OLS). Since assumptions upon normality and heterokedacity is likely to be violated, OLS robust estimators of standard errors is also used and the fixed-effect model is also estimated using bootstrape standard errors.

The models with R-squared estimates around 0.93 are statistically significant. From the FAT-models, the associated coefficient to test the funnel plot symmetry (constant) is insignificant indicating that publication bias for our study sample can be negligible. The coefficient associated with precision that is unbiased estimate of elasticity corrected for publication bias is negative and statistically significant. From the PEESE model, the insignificant coefficient associated with precision accepts the hypothesis on the absence of publication bias. Furthermore, the elasticity estimate adjusted for publication bias is statistically different than zero and close to the estimates obtained from the two other models. With similar results obtained from the two types of models, it is concluded with assurance that publication bias is negligible and the price elasticity for residual water demand of Iran is between -0.3 and -0.45.

2.3.2. Trim-and-fill method

The "trim-and-fill" method is a famous technique to assess the degree of asymmetry in the funnel plot and to adjust the reported estimates to asymmetry in the case of publication bias. The method is conducted at two steps. At the first step, small studies causing funnel plot asymmetry are removed and adjusted summary effect based on only the large studies are estimated. At the second step, the excluded studies are replaced with their missing counterpart around the adjusted summary effect estimated at the first step. Filled studies to adjust a funnel plot can be measured based on both a random and a fixed effects [10, 9]. Differences between the "trim-and-fill" mean and the fixed and random effect mean are used to realize publication bias and heterogeneity. The difference between fixed effect mean with their adjusted mean estimates by trim and fill is used as an indicator to assess publication bias-that is the degree of asymmetry in the funnel plot. The difference between the trim and fill mean with the random effect mean is used as an indicator for publication heterogeneity. Publication bias or publication heterogeneity is recognized [19] as negligible, moderate and serious if the difference between the two estimates is less than 20%, between 20% and 40% and more than 40%. For our study, the figure2 presents the outcomes of applying the "trim-and-fill" method.

In our study sample, the trim-and-fill method imputed 13 missing studies – shown by little squares in the fig.2. Using the fixed effect estimation model, the trim and filled procedure reduced the elasticity mean by 6 percents, while the mean estimated by the random-effect model was decreased by 40 percent. Having the results of fixed and random effects considered, publication bias is negligible, while the publication heterogeneity tends to be serious.

Putting all results together, the hypothesis of funnel plot symmetry is accepted. This indicates that the publication bias for our study sample, if it is not zero, is statistically negligible. This implies that any value of price elasticity – regardless if its absolute value is high or low - had the same chance of being published. The problem of publication heterogeneity were recognized serious, indicating that the estimated value of price elasticity was significantly influenced by the study characteristics such as dataset characteristics, the theory applied for the estimation and so on. The hypothesis of publication heterogeneity is examined using more techniques, as below.

2.4. Publication heterogeneity

The funnel plot (fig.1) that presents a remarkable number of observations outside the 95% contours indicates strong evidence on heterogeneity between studies. The degree of heterogeneity is assessed by "Z-naïve" presenting the distribution of in-control estimates [41].

$$\hat{\phi} = \frac{1}{I}\sum_i \frac{(y_i - \theta_0)^2 \rho_i}{g(\theta_0)} = \frac{1}{I}\sum_i Z_i^{\,2} \qquad (4)$$

Where $\hat{\phi}$ denotes heterogeneity factor and I is the number of observations and Zi is the "naive" Z-score for the i^{th} observation calculating by the following formula.

$$Z_i = \frac{y_i - \theta_0}{\sqrt{V\,(Y \setminus \theta_0)}} \qquad (5)$$

Where z_i denotes the standardized Pearson residuals calculated by the expected values (Θ_0) and the associated variance ($\sqrt{V(Y|\theta_0)}$).

The value calculated for $\hat{\phi}$ indicates the degree of heterogeneity. If $\hat{\phi} > 1 + 2\sqrt{2 + I}$ the heterogeneity problem is statistically significant and explainable by its influential factors.

For our study, the $\hat{\phi}$ is estimated at 109.49 - that comparing to 1.35- indicating a strong evidence of heterogeneity among studies caused by the study characteristics. In order to realize the unobservable factors, the fixed-effect models assuming homogeneity between study results does not fit the data well and the alternative method "random-effect" model that is efficient at capturing effects of unobserved factors on the dispersion is more appropriate.

3. Meta regression models: Analysis of heterogeneity and publication bias

The heterogeneity problem refers to the fact that effects reported by various publications may be influenced by "study characteristics". A meta- regression model is used for an integrated analysis of "study characteristics"- known as publication heterogeneity- and "publication characteristics"- known as publication bias. The reduced form of MR model is presented as below:

$$\mathrm{Effect_i} = \beta_0 + \sum \beta\mathrm{KZK_i} + \beta_1\mathrm{SE_1} + \sum \mathrm{SE_i\,K_{ij}} + \varepsilon_\mathrm{i} \qquad (6)$$

Where Z indicates the variables associated with „study characteristics "such as theories and techniques used by the study and K for the factors associated with "publication characteristics" that influences researchers' decisions to report the given estimate [42]. Considering the possibility of heteroskedasticity, the values are weighted up based on precision squared ($1/SE^2$) [42]. Table 5 presents the results of five random-effect models using Fisher'Z effect sizes [15].

For the five models, the adjusted R-squared estimates –that are between 85% and 90%- indicates that a significant percent of the variation in the elasticity estimates are attributed to moderate variables. The random-effect variance component T^2 is estimated between 0.01 and 0.02. The constant term is insignificant at 5% confidence interval, indicating that publication bias is not a significant problem for the study sample.

To select the best model from a bunch of models with inclusion of various explanatory variables, the "General-To-Specific" approach [42] that led to selection of the five reported models was firstly used. Other models are also available on the request. Using the likelihood Ratio test (LR test), the fourth model was selected as the best. To have a robustness check on the result, differences between elasticity values predicated by the model and the actual ones were calculated for each five models, separately. The fourth model presented the least squares indicating the closest predicted values to the actual one.

Considering that most of the explanatory variables are dummies, the interpretation should be focused on their signs and significance rather than marginal values [12]. The following describes the main result obtained from the empirical models.

3.1. Data characteristics: Among the variables considered for socio-economic characteristics, the time period of dataset was found the most important. The study found a negative relationship between using time-series data and elasticity estimates. This indicates that the water elasticity is estimated smaller in studies used time-series data. This was somehow confirmed by other studies [38, 12, 5] indicating an insignificant, but a negative, influence of time series on water elasticity. Additionally, absolute values of water elasticity are larger for a long run than a short run. The result is precisely confirmed by other studies [12, 5, 38].

3.2. Theoretical specification: The positive coefficient associated to Stone-geary theory indicates that using the Stone-geary theory to estimate water demand would adjust elasticity estimates.

3.3. Model specification: Adding “income” variables into the demand function increases the absolute value of water elasticity. Drawing elasticity from a natural logarithm function adjusts the elasticity estimate inelastic. A similar impact was captured by [5, 38] studies, presenting a positive impact of including “income” variable to the model on the absolute value of price elasticity. The study results present that long-run water demand is more price-elastic than its short-run.

4. Analysis of price elasticity over years: a cumulative meta-analysis

Using the cumulative meta-analysis based on the study year, weighted means of price elasticities for different years were calculated. The absolute values of the estimated means indicate that the price elasticity reduced from 2000 to 2009, and then increased for two years (2010 and 2011) and again reduces recently for two years (2012 and 2013). The period of increasing price elasticity happened on the two years (2009 -2010) when the government increased energy and water consumption cost at least by 25%.

Conclusion

The present result strongly recommends the policy makers to consider both the nature of data sets and the applied model when they regard demand function and the drawn price-elasticity as an analytical tool to realize the impact of water tariff on water consumption habits. Regarding the influence of data set characteristics, using time series data is expected to render the water demand less price-elastic. In addition, price elasticises that are estimated using long-term datasets are expected to be high. Inclusion of any explanatory variable, in particular the variable of income, may affect the estimated value of price elasticity.

The interesting result of this empirical study refers to the publication bias that is insignificant in the reported estimates of the study sample. The absence of publication bias that is a main focus of meta-analysis literature [42] indicates that the magnitude of published price elasticities does not have a significant difference with the elasticities expected for unpublished studies. As the absence of publication bias in the studies of residual water demand was obtained by other study [38], it can be concluded that publications in the field of water demand are insensitive to the absolute values of price-elasticity.

The results also present that price elasticity for residual water in Iran is in a range between -0.428 and -0.312 indicating that residual demand is inelastic. A vast literature on residential water demand came to the same conclusion [29, 24, 30, 18]. The other interesting result is, however, the response of price elasticity to increasing water tariff. According to the results from the cumulative analysis, even the price elasticity increased in response to increasing water tariffs, after two years it returned to almost the former value. It is concluded that water is basically in-elastic at any cost. In general, a high water price is expected to reduce water consumption, however, it cannot adjust consumers' sensitivity to the price-e.g. water elasticity. The insignificance of the adjusted coefficient for the price confirms this conclusion.

Conflict of interest: All the three authors declare that they have no conflict of interest.

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