Estimation of Static and Dynamic Demand Function of Household Water in Qazvin Province and Review of the Rate of Change in Consumer Behavior Over Time

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Abstract:

In this research, the demand function of drinkable water in Qazvin Province was estimated using dynamic and static methods. The required data were collected from the data of the provinces of Qazvin in the time period (1996-2016) and collected by referring to the statistical system of Statistics Center of Iran and the provincial planning and budget organization of Qazvin Province. The explanatory variables used in the model include household income, temperature (minimum and maximum), urban population, water price, rainfall, number of subscribers.

The method used to estimate the static model, generalized least squares, and in the dynamic model, is a two-step generalized moment method. The results showed that the water price coefficient in the static and dynamic model is -0.217 and -0.19, respectively, which is a negative sign of the correctness of the demand law and less than one indicative of the low elasticity of water. The variable coefficient of household income in the static and dynamic model was 0.2 and 0.15, respectively, which positive and less than one, respectively, indicating the normality and necessity of water in the drinkable sector. In relation to the price of other goods, the coefficient was estimated in both negative models were -0.72 and -0.9, respectively, which indicates that water is a complementary product. Finally, the value of the variable coefficient was 0.5, which indicates that the demand for water is 0.5 times the demand for water last year.

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Introduction

Over the past 100 years, cities have been receiving a large percentage of the world's population. According to United Nations forecasts, by the year 2030 more than 60% of the world's population will live in urban areas. Though cities occupy only about 2 percent of the Earth's surface, they hold more than half the world's population, rising at around 55 million tons a year. They consume three quarters of the world's resources and are the main producers of waste in the world (Egger, 2005). Urbanism can be defined as the expansion of a city, population growth, or the area of urban areas over time (Usha, 2002). Rapid urbanism threatens the sustainable life of the world with its negative effects on environmental parameters of water, air and soil (Todaro, 2006). On the other hand, with the expansion of cities, the need for water consumption will increase.

The problem is that Iran is in an arid and semi-arid region. The climate of Qazvin province is also semi-arid and the average annual precipitation is about 317 mm.

Groundwater resources of the province include the groundwater resources of the aquifer of Qazvin plain, part of Gheydar plain in Avaj district and very small local aquifers with limited potential in different regions such as lower Tarom Sofla, Alamout and Avaj. Qazvin plain was considered by internal and external experts in water resources in the year 1963, and the operation was identified and then the operation of the plain began. Experts have already announced the potential of this plain to 300 million cubic meters, some 500 million cubic meters a few years later, and now, after 42 years since the start of its operation, there are more than 1.5 billion cubic meters of water evacuated, which of course this harvest is much higher than its potential, causing a drop in groundwater levels and a build-up of a reservoir deficit. According to the reservoir deficit of 320 million cubic meters and the volume of discharges carried out, the potential of Qazvin plain is estimated at 1.2 billion cubic meters. The storage factor of this plain is between 5% and 6%, and its storage is estimated to be between 18-16 billion cubic meters, according to the report of the aquifer consulting engineers, so water resources face a serious constraint. Due to the limited annual volume of water and the increasing competition of various economic sectors in order to use this scarce resource, water demand management is important. The most important issue in managing and utilizing water resources is to establish a reasonable balance between the supply and demand of water in various sectors of the economy (Qazvin province regional water company, 2016).

Table1. Statistical data of Qazvin province

City Name	Distance from the center of the province (km)	Population (people)	Area (km)
Abyek	60.2	94536	**1302**
Buin Zahra	59	122934	**3003**
Alborz	4.6	222765	**403**
Qazvin	-	596932	**5689**
Takestan	44.4	172636	**2538**
Avaj	119.4	43798	**2691**

Source: Statistics Center of Iran

In the water year (2015-2016), the annual discharge from underground water sources is about 2010 million cubic meters, which has not changed compared to the water year in past but from the 408,000 items of water branch in the province, 290,000 items were associated with urban areas which has increased by 3.6% compared to last year (Qazvin province regional water company, 2016).

Table 2. Number of wells, discharge rate and household consumption in Qazvin province separated by city (Item-million cubic meters)

City Name	Household consumption	Discharge rate	Number of wells (aqueduct)
Abyek	3.8	(2.73)219.47	(22)926
Buin Zahra	3.5	(23.42)769.11	(83)3232
Alborz	12.7	(1.71)179.89	(16)401
Qazvin	28.280	(23.17)222.2	(103)2349
Takestan	6.3	(6.25)433.75	(73)1501
Avaj	0.65	(2.25)	(16)

Source: Qazvin province regional water company

Table 3. Statistical mean of model variable separated by city

City Name/variable Name	Avaj	Takestan	Qazvin	Alborz	Buin Zahra	Abyek
Water consumption (million square meter)	0.45	5.3	27.27	7.9	3.1	**3.2**
Water price index	234.6	234.6	234.6	234.6	234.6	**234.6**
Household income (million rials)	91.8	91.8	91.8	91.8	91.8	**91.8**
Precipitation (Mm)	355	211	295	300	261	**281**
Minimum temperature (Celsius)	-17.7	-11.6	-12.5	-12.3	-15.4	**-11.5**
Maximumtemperature (Celsius)	34.8	40.2	40.5	40.5	40.8	**40.9**
Number of subscribers (1000 items)	2.3	21.7	112.3	32.2	13.7	**11.5**
Urban population (1000 people)	9.2	95.1	441	159	46.4	**50.2**
The price index of other goods	249.2	249.2	249.2	249.2	249.2	**249.2**

Reference: Researcher results

Research Literature

In the context of estimating the demand function of water in the household sector, numerous studies have been carried out both inside and outside the country. Among them, we can mention the following:

Mohammadi and Akbari (2000) estimated the demand function of drinkable water in Kerman. They calculated the price elasticity of drinkable water demand between 0.17 and 0.36, indicating the low demand for drinkable water in relation to the price in this region, as well as the income elasticity was calculated between 0.01 and 0.12, indicating the indispensability of this good in the household basket. Pejouyan and Hosseini (2003) estimated the demand for water in the Tehran as demand price elasticity of 8% and 12%, and the demand income elasticity of 13% and 20% respectively, and in general, the low elasticity of household water demand in the Tehran city was confirmed. Sajjadifar and Kheyabani (2011) estimated the demand function of Arak household water. In general, the low elasticity of household water demand relative to income and price, as well as the completeness of water with other goods was confirmed.

Also, the results showed that the price elasticity and the income of the summer season (the successor to external costs) were almost twice the price elasticity and the income of the winter season (the successor to household consumption), and the long-term demand elasticity was calculated more short-term type. Adipour and Shirazshiani (2014) estimated the demand function of drinkable water in Golestan province. The results showed that the price elasticity of water demand is 0.26, income elasiticity is 0.95, and crossover price elasticity is 0.2, that is, water is a necessary and complementary good. The minimum water requirement for a Golestan subscriber was also achieved at a rate of 687 l/d.

Among foreign studies, the following cases can be mentioned: Hoglund (1999) in a study to estimate the household water demand function and to examine the effect of the potential tax on household water consumption in Sweden. The results showed that long-term price elasticity in the final price models was 0.1 and in the average price model of 0.2. The research findings indicated that the tax rate for one a currency (Kronor) for cubic meter of water consumption, which is roughly equivalent to a 5% increase in average water prices, would generate 600 million Kronor annual tax revenues, while water consumption decreases by 1%. Cader et al. (2004) conducted a research on the prediction of household water consumption under a blocked price structure in Kansas. In this study, they studied water consumption at macro level, while previous research was conducted at micro level. The results showed that water per capita consumption in eight areas is significantly different. The share of low consumption block is decreasing and high consumption block is increasing.

Cheesman et al (2008) studied the estimation of household water demand using open and conditional behaviors in Vietnam. The results showed that households are much more in demand in urban demand than prices, but in the case of combined urban and household water demand, they are more elasticity to the price, but it is still no elasticity, that is to say, household water demand and urban water demand are successors together. The results also showed that household water consumption is influenced by factors such as the amount of the amount of water saved, supply infrastructure, income, and the social and economic characteristics of each community. Dharmaratna and Harris (2012) in a study to estimate the household water demand function in Sri Lanka. The results showed that the share of water consumption per month that did not show any sensitivity to price changes that was between 0.64 and 1.06. The results also indicated that reducing water use through the price tools in developed countries is more successful than developing countries. The price elasticity ranges from -0.11 to -0.14 and income elasticity ranges from 0.11 to 0.14. It is therefore concluded that policy makers in developing countries should not rely solely on price instruments to reduce water consumption. Andre and Carvalho (2014) conducted a study titled "Spatial Factors in Urban Water Demand in Fortaleza of Brazil".

They used three econometric models to achieve the research objectives. These models include Spatial Error Model (SEM), Spatial Autoregressive model (SAR) and Spatial Autoregressive Moving Average model (SARMA). The results indicate that the SARMA model is the best model in terms of time series tests.

The results obtained in this study are contradictory with previous studies, which means that among the other factors, these uncontrollable spatial factors are a key fault and ignoring the effects of almost all variables in the model.

Sometimes these differences are very high at 24.66% and 13.32%, respectively, in relation to the average price elasticity and McFadden models. Ahmad et al (2016) studied the demand for household water in urban areas and in Faisalabad, Pakistan. The results indicated that the price elasticity and incomes were different among different groups. Price elasticity ranged from -0.25 to -0.45 and income elasticity ranged from 0.005 to 0.15. In the end, it is suggested that pricing policies in developing countries restrict the freedom to act in relation to the pattern of water consumption in households. Therefore, the use of non-price tools such as water saving measures will be more useful in water utilization.

Internal studies on the estimation of household water demand function			
Mohammadi and Akbari (2000)	Combined data	Econometric method (The Stone–Geary utility function)	Estimation of demand for drinkable water in Kerman
Pejouyan and Hosseini (2003)	Time series data	Econometric method (The Stone–Geary utility function)	Estimation of Household Water Demand Function (Case Study of Tehran)
Khosh-Akhlagh and Shahraki (2008)	Time series data	Econometric method (The Stone–Geary utility function)	Estimation of Household Water Demand Function in Zahedan
Abdoli and Dizaji (2009)	Time series data	Econometric method (The Stone–Geary utility function)	Estimation of water demand function in Urmia
Sajjadifar and Kheyabani (2011)	Combined data	Econometric method (The Stone–Geary utility function)	Modeling of Household Water Demand Using a Randomized Model Method, Case Study: Arak
Adippour and Shirashiani (2014)	Time series data	Econometric method (The Stone–Geary utility function)	Estimation of Golestan Water Demand Function
External studies on the estimation of household water demand function			
Hoglund (1999)	Combined data	Econometric	Household demand for water in Sweden with implications of a potential tax on water use
Bithas and Stoforos (2006)	Time series data	Econometric method (The Stone–Geary utility function)	Estimating urban residential water demand determinants and forecasting water demand for Athens metropolitan area
Cheesman et al (2008)	Combined data	Econometric	Estimating household water demand using revealed and contingent behaviors: Evidence from Vietnam
Arbués et al (2010)	Combined data	Econometric	Urban water demand for service and industrial use
Dharmaratna and Harris (2012)	Time series data	Econometric	Estimating residential water demand using the stone geary functional form: the case of Sri Lanka
Andre and Carvalho (2014)	Cross sectional data	Econometric	Spatial Determinants of Urban Residential Water Demand in Fortaleza
Ahmad et al (2016)	Cross sectional data	Econometric	Analysing Household Water Demand in Urban Areas: Empirical Evidence from Faisalabad, the Industrial City of Pakistan

By examining the these studies, it is clear that household water consumption is inversely related to the price and has a direct relationship with household income. The consumption with time-delay is also considered in this study using a dynamic model.

The theory of the function of household water demand

The household water demand can be made in two ways:

1. Demand as input: Industrial and agricultural demand from water, as the optimal amount of it is derived from the condition of maximizing production relative to cost constraints.
2. Demand as the final goods: Demand for households with water is the demand for the final goods, in which the optimal demand for water is obtained using the optimization conditions of the utility function relative to the budget constraint. The proper function in most studies is the Stone–Geary utility function, since its results are consistent with the theory of water economics

(water as an essential goods and low elasticity). In order to extract the household water demand function, the principles of microeconomics and maximizing the utility of the consumer are used according to the budget. There are various utility functions in this direction, such as the Acanem, Klein-Rubin, and several other functions, such as the ideal AIDS function. The Acanem function is suitable for estimating non- essential demand function coefficients, although in some cases it is also used to estimate the demand for essential goods. Other functions are not suitable for estimating the water demand function. The proper function in these conditions is the Stone–Geary utility function. Stone- Geary uses the Klein-Rubin utility function as below (Hendeson and koa, 1980):

$$u = \prod_{i=1}^{n} (Q_i - S_i)^{\beta_i} \qquad i = 1, 2, 3, \dots n \qquad (1)$$

In the above equation is $0 < \beta_i < 1$ *and* $Q_i > S_i$ and $\sum_{i=1}^{n} \beta_i = 1$ which Q_i is the amount of consumption of goods i and S_i are the minimum consumption of goods I, and β_i is the final share of goods i. Suppose there are two goods (i = 2): water and other goods (w = water, g = goods) taken from the sides of the logarithm on the basis of the Neper number:

$$U = lnu = \beta_1 ln(Q_w - S_w) + \beta_2 ln(Q_w - S_w) \qquad (2)$$

In order to achieve the household water demand function, the utility function of equation () is maximized to the budget limit as follows:

$$\text{MAX} \quad U = \ln u = \beta_1 \ln(Q_w - S_w) + \beta_2 \ln(Q_g - S_g) \qquad (3)$$

$$\text{S. to} \quad \rightarrow p_w Q_w + p_g Q_g = I \qquad (4)$$

By forming a Lagrange function equal to zero, placing the first order derivatives, the function of household water demand is obtained

$$L = \beta_1 \ln(Q_w - S_w) + \beta_2 \ln(Q_g - S_g) + \theta(I - p_w Q_w - p_g Q_g) \qquad (5)$$

$$\frac{\partial l}{\partial Q_w} = 0 \qquad (6)$$

$$\frac{\partial l}{\partial Q_g} = 0 \qquad (7)$$

$$\frac{\partial l}{\partial \theta} = 0 \qquad (8)$$

In equation (9), Q_w is a water demand function that is a function of the water price, the price of other goods, household income and other variables (x_j), including other variables that affect consumer demand. If the logarithm is derived from this equation, then the estimation of the model of the calculated coefficients will be the same elasticity.

$$LnQ_w = \mu_0 + \mu_1 lnp_g - 2\mu_2 lnp_w + \mu_3 lnI + \sum_{r=4}^{7} \mu_r lnp_g \qquad (10)$$

Study area and required data

Required data including the spatial dimension of the cities of Qazvin province and the temporal dimension of annual data during the time interval (1996-2016) by referring to regional water, water and sewage companies, Qazvin Meteorological Organization and the Iranian Statistics Center has been collected.

The variables used to estimate the household water demand function include household income, urbanism, minimum and maximum temperature, precipitation, water consumption, number of subscribers and price index of water.

Analyze

Given that the data has a spatial and temporal dimension, a test must be made regarding the type of data to be panel or consolidation. According to table (1), the test probability value of F Limer is less than 5%, therefore the Null hypothesis based on the consolidation data is rejected.

Table 1. F Limer test

Test name	Test probability value	Results
F Limer test	0.00	Panel data

In this study, two dynamic and static models were used to estimate the water demand function. After determining the type of data, the type of model should be investigated for both random effects and dynamic effects. In this regard, the Hausman test is used. As Table 2 shows, the test probability value in both static and dynamic models is less than 5%, so the Null hypothesis is rejected and the model has fixed effects.

Table 2. Hausman test

Test name	Model	Test probability value	Results
Hausman	Static	0.02	Fixed effect model
Hausman	Dynamic	0.00	Fixed effect model

Of the other cases that violates the classical hypothesis is the existence of variance non-coextensive in distorted sentences. To test this problem, the Wald test is used, the results of which are presented in Table (3). The probability of the

Null hypothesis of this test is that the coextensive of variance in both static and dynamic models is more than 5%, so the Null hypothesis is accepted.

Table 3.Wald test

Test name	Model	Test probability value	Results
Wald	Static	0.69	Existence of variance coextensive
Wald	Dynamic	0.51	Existence of variance coextensive

Of the other cases that violates the classical hypothesis, the self-correlation between distorted sentences are discussed in the static model using the Wooldridge test. The result of the test according to table (4) is that the it is rejected as Null hypothesis, since the test probability value is less than 5%, indicating that the distorted sentences are self-correlation.

Table 4. Wooldridge test

Test name	Model	Test probability value	Results
Wooldridge	Static	0.002	Existence of correlation

When dealing with time series data, unit root test is one of the most important tests to make regressions incorrect. For this purpose, the generalized Dickey Fuller test has been used, which rejects the Null hypothesis, which implies the variability of the variables over time. As the results of Table 5 show, the minimum temperature, maximum temperature, precipitation and urbanism variables are non-durability and other variables such as water demand, water price index, price index of other goods, household income and the number of subscribers are durability. In order to eliminate the variables non-durability, there are two approaches, firstly, the first order difference of the variables is introduced into the model, and if non-durability is not resolved, a higher degree of difference is made. The problem with this approach is that it is impossible to examine the effect of the dependent variable on the level of the non-durability independent variables. The second approach is to investigate the Cointegration test of distorted sentences if the model is cumulative. Non-durability variables do not create a problem in model estimation. As shown in Table (6), the CAO Cointegration test indicates that the model is cumulative, since the probability of a Null hypothesis of this test is greater than 5%, so this hypothesis is accepted.

Table 5. Generalized Dickey- Fuller Test

Variable name	Test probability value	Results
Water demand	0.95	Existence of unit root
Water price index	0.99	Existence of unit root
Other goods price index	0.81	Existence of unit root
Minimum temperature	0.00	Lack of unit root
Maximum temperature	0.002	Lack of unit root
Precipitation	0.01	Lack of unit root
Household income	0.87	Existence of unit root
Urbanism	0.00	Lack of unit root
Number of subscribers	0.65	Existence of unit root

Table 6. Cointegration test

Test name	Test probability value	Results
Cao	0.002	Existence of Cointegration

As stated in the previous sections, in this study the function of household water demand was estimated in both static and dynamic conditions. The superiority of the dynamic model to the static model is that the effect of the past behavior of the dependent variable is considered in the model, which is used in this study from a time lag. That is, the demand for water by citizens in this year depends on the size of the lag variable coefficient of demand for water in last year. The method used to estimate the static model is FGLS, since the Wooldridge test showed self-correlation in distorted sentences, which would no longer be required to resolve the distorted sentences. The results of Table 7 provide static estimation of the model. All coefficients in Table (7) represent elasticity marks, with the exception of the water price coefficient, which is twice the price elasticity of water. The price elasticity of water is estimated at 0.217, which is compatible with economic theories and previous studies. First of all, this elasticity is less than one, which implies the lack of water demand, and the negative is also the law of demand, meaning that by increasing the unit price of water, the demand will decrease by as much as 0.217. The price elasticity of other goods, which is considered as a goods and composite goods, has a value of 0.12, that is, firstly is negative, and secondly absolute value is less than one. The negative value indicates that the relationship between water and other goods is an complementary relationship, meaning that by increasing the unit price of other goods, the demand for water is reduced by as much as 0.12, while the decrease is lower than the price increase of other goods, and in fact it is a low elasticity product. The income elasticity of water demand was also calculated to be 0.2.

A positive income elasticity show that household water is a ordinary, and less than its being, it indicates the necessity of this goods in the household basket. The minimum temperature variable in this model is not significant, while the maximum temperature has a direct relation with water demand, so if it increases by one unit, water demand will increase by 0.33

Urbanism and the number of subscribers also have a direct impact on water demand, if any increases by one unit, water demand will increase by 0.1 and 0.43. The precipitation variable has an inverse relationship with water demand, so that if a unit increases, the water demand will decrease by 0.08.

Table 7. Estimation of static model by FGLS method

Variable name	Coefficient value	Probability value	Acceptance level
Width from source	-7.95	0.00	**
Lag in water consumption	-0.435	0.00	***
Water price	-0.72	0.00	***
Other goods price	0.05	0.8	-
Minimum temperature	0.33	0.046	**
Maximum temperature	-0.088	0.08	*
Precipitation	0.2	0.00	***
Household income	0.1	0.016	**
Urbanism	0.43	0.65	***

*show significantly at the level of 10%, ** show significantly at the level of 5%, *** show significantly at the level of 1%.

The results of the dynamic model are summarized in Table (8). The difference between this table and the table (7) is that the lag dependent variable is also included in the model and that the minimum temperature variable in this model is significant on the static model. The dynamic model is estimated using two-step GMM method. The advantage of this approach to the GMM method is to avoid the dependence between tool variables and distortion clauses. However, the Sargan test was used to test the existence of this correlation. As can be seen in Table (9), the probability of the Null hypothesis of this test is based on the lack of correlation of the tools with the remainder of more than 5%, so the Null hypothesis is accepted.

In a dynamic model, like the static model, the coefficients express the elasticity. The value of the coefficients in this model is less than the static state, and the reason is the existence of a dependent variable that turns a part of the variation of independent variables into itself. The value of the variable coefficient of demand for water is 0.5. That is, if the amount of water demand in the past year increases by one unit, the change in demand for water this year will increase by 0.5 units or to another interpretation, 0.5 units of water demand in year t is related to water demand in year t-1. The value of the price elasticity of water was estimated at 0.195, which implies compliance with the demand law and the low elasticity of water demand. On the other hand, the amount of water elasticity in the dynamic model is less than of the static model, which means that over time, the flexibility of water demand is lower than its price, and this decrease can be due to lack of suitable substitute for drinkable water and scarcity of this product over time. The price elasticity of other goods is 0.9, which like the static model is indicative of a complementary relationship between water and other goods. The amount of income elasticity of the demand for water is 0.15, which indicates the normal and essential water. Independent variables of maximum temperature, urbanism rate and number of subscribers had a direct effect on water demand, and the coefficients of each were estimated to be 0.04, 0.21 and 0.31, respectively. The other two independent variables, the minimum temperature and precipitation, also had a negative effect on water demand, so that by increasing each one unit, water consumption would decrease by 0.025 and 0.045.

Table 8 - Dynamic Model Estimation by Two-step GMM Method

Variable name	Coefficient value	Probability value	Acceptance level
Width from source	-7.95	0.00	**
Lag in water consumption	0.5	0.00	***
Water price	-0.39	0.03	***
Other goods price	-0.9	0.04	***
Minimum temperature	-0.025	0.01	*
Maximum temperature	0.04	0.016	**
Precipitation	-0.042	0.007	*
Household income	0.15	0.04	***
Urbanism	0.21	0.011	**
Number of subscribers	0.31	0.05	***

* show significantly at the level of 10%, ** show significantly at the level of 5%, *** show significantly at the level of 1%.

Table 9. Sargan test

Test name	Test probability value	Result
Sargan	0.21	Lack of correlation

Conclusions and Suggestions

Insider price elasticity in both static and dynamic models indicate that, firstly, water is a low elasticity good relative to its price, since its value is less than one, and secondly, the value is negative, indicating an inverse relationship between the price of water and demand for it. On the other hand, the value of the elasticity of the water price in the dynamic model is less than the static model, which means that over time, the demand for water becomes less flexible than its price, and this decrease can be due to lack of suitable substitute for drinkable water and the scarcity of this product over time. The crossover price elasticity is also less than one and negative in both models, which indicates that the low elasticity of demand for water compared with the price of other goods, and the complementary relationship of water with other goods, meaning that water is no alternative good. Also, income elasticity in both the static and dynamic models had a value of less than one and a positive, indicating that the low elasticity of demand for water compared with the household income, and it is normal and necessary.

Finally, the coefficients in the dynamic model are less than the static state, and the its reason is the existence of a lag dependent variable that generates a portion of the variation of the independent variables to itself. The value of the coefficient of lag variation is a positive water demand, which states that water demand in t-1 period will have a direct and positive effect on water demand during t period.

Finally, by studying elasticity, we can propose methods for optimal water use in the household sector, which can be implemented by policy makers:

1. Price elasticity: the price elasticity of demand for water is less than one, that is, if the price increases, demand for it falls below the price. Therefore, price tools can be used to save on consumption.
2. Income elasticity: With this coefficient, subsidies paid to consumers can be tailored to the amount of optimal water demand. For example, if the government reduces its subsidy payments, household income will also decrease and demand for water will decrease.
3. Crossover price elasticity: The price of other goods can also be achieved with the goals of optimal water consumption. However, this is an approximate indicator because it is the product of combining hundreds of goods at different prices with a good and an approximate price.
4. Elasticity related to atmospheric factors: Considering the estimated coefficients, measures can be taken in relation to climate change. For example, when temperature rises, measures are to be taken to minimize the difference between the demand level of household customers and the amount of water resources.
5. Elasticity related to urbanism: By using a coefficient of urbanism, an interactive relationship between water consumption and population growth is obtained.
6. Elasticity related to past consumer behavior: This way, it will be possible to anticipate future consumers' behavior from the current year's demand for water.

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تخمین تابع تقاضای ایستا و پویای آب خانوارها در استان قزوین و بررسی نرخ تغییرات رفتار مصرف کنندگان

چکیده

توسعه شهری یکی از پدیده‌های اجتناب ناپذیر در کشورهای در حال توسعه است که پیامدهای زیادی را به دنبال دارد. یکی از آن‌ها، افزایش تقاضای آب در بخش خانگی می‌باشد. لذا مدیریت تقاضا و عرضه آب در این بخش باید به طور جدی مورد بررسی قرار گیرد. در این تحقیق تابع تقاضای آب شرب استان قزوین به دو روش پویا و ایستا برآورد شد. اطلاعات در دوره زمانی (1375-1395) از مرکز آمار ایران و سازمان برنامه و بودجه استان جمع‌آوری شد. متغیرهای توضیحی مدل شامل درآمد خانوار، درجه حرارت، جمعیت شهری، قیمت آب، بارش، تعداد مشترکین می‌باشد. به منظور برآورد مدل ایستا، از روش حداقل مربعات تعمیم‌یافته و در مدل پویا از روش گشتاورهای تعمیم‌یفته دو مرحله‌ای استفاده شد. نتایج نشان داد که ضریب قیمت آب در مدل ایستا و پویا به ترتیب 0.217- و 0.19- است که علامت منفی آن صحت قانون تقاضا و کمتر از یک بودن آن دلالت بر کم‌کشش بودن کالای آب دارد. ضریب درآمد خانوار در مدل ایستا و پویا به ترتیب 0.2 و 0.15 محاسبه شد که مثبت بودن و کمتر از یک بودن آن به ترتیب حاکی از نرمال بودن و ضروری بودن کالای آب در بخش شرب می‌باشد. ضریب قیمت سایر کالاها در هر دو مدل منفی و به ترتیب مقدار 0.72- و 0.9- برآورد شد که نشان می‌دهد آب یک کالای مکمل است. ضریب متغیر باوقفه 0.5 به دست آمد که نشان می‌دهد تقاضای آب در هر سال اثر مثبت بر تقاضای آب در سال آتی دارد.