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Abstract

This paper uses suburb-level quarterly data to model residential water demand in Brisbane, Australia from 1998 to 2003. In this system, residential consumption is charged using a fixed annual service fee with no water entitlement followed by a fixed volumetric charge per kilolitre. Water demand is specified as average quarterly household water consumption and the demand characteristics include the marginal price of water, household income and size, and the number of rainy and warm days. The findings not only confirm residential water as price and income inelastic, but also that the price and income elasticity of demand in owner-occupied households is higher than in rented households. The results also show that weather, particularly summer months and the number of rainy days, exerts a strong influence on residential water consumption.

Keywords

Water management & policy, demand analysis, utility regulation & pricing

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Urban water demand with fixed volumetric charging in a large municipality: the case of Brisbane, Australia*

Mark Hoffmann, Andrew Worthington and Helen Higgs†

This paper uses suburb-level quarterly data to model residential water demand in Brisbane, Australia from 1998 to 2003. In this system, residential consumption is charged using a fixed annual service fee with no water entitlement followed by a fixed volumetric charge per kilolitre. Water demand is specified as average quarterly household water consumption and the demand characteristics include the marginal price of water, household income and size, and the number of rainy and warm days. The findings not only confirm residential water as price and income inelastic, but also that the price and income elasticity of demand in owner-occupied households is higher than in rented households. The results also show that weather, particularly summer months and the number of rainy days, exerts a strong influence on residential water consumption.

Keywords: Water management & policy, demand analysis, utility regulation & pricing

1. Introduction

Water supply efficiency and demand management are increasingly important issues for residential water supply authorities throughout the world. Population growth, coupled with the reduction in fresh water supplies, has prompted suppliers to place renewed emphasis on demand management through pricing structures and other strategies. In the United States, for example, Ipe and Bhagwat (2002) found that water sources in Chicago are reaching exhaustion while population and per-capita water use is increasing. In Israel, Klawitter (2003) concluded that the Tel Aviv water utility is economically unsustainable because water is over-consumed as the price does not send appropriate welfare signals to users. Lastly, Dalhuisen *et al*. (2001) summarises the trend in most OECD economies towards metering, increasing block prices and reduced subsidies for residential water supply.

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In Australia too, there have been longstanding efforts to improve residential water demand management. These have received renewed impetus with the sustained drought in the eastern states and the critical level of water reservoirs supplying large urban centres. As far back as 1994, *The Strategic Framework for the Efficient and Sustainable Reform of the Australian Water Industry* was endorsed at the meeting of the Council of Australian Governments. This framework required councils to introduce two-part tariffs for water pricing (where cost-effective to do so), with fully transparent community subsidies (if any) and the minimal free allocation of water. In practice, these two-part tariff systems generally consist of a fixed annual service or access charge, with or without a 'free' water entitlement, and a volumetric component or user-pays charge with a single block (flat rate).

Clearly, the introduction of two-part tariffs throughout Australia may have affected residential water consumption. In Tasmania, the Government Prices Oversight Commission (2003a) suggested that a fifteen percent fall in consumption could be anticipated following the introduction of two-part tariffs. In Queensland, Marsden Jacob Associates (1997) provided anecdotal evidence of a twenty percent reduction in per capita consumption in the first year of implementing two-part tariffs. Work of a similar nature includes IPART (2003), Essential Services Commission of Victoria (2004) and Government Prices Oversight Commission Tasmania (2003b). But apart from these, remarkably little empirical effort has been directed at the modelling of residential water demand in Australia [for exceptions, see Barkatullah (1996), Creedy *et al*. (1998) and Higgs and Worthington (2001)].

The purpose of this paper is to address this imbalance. A key objective is to provide estimates of the price and income elasticity of residential water demand. These provide key inputs into optimal tariff design and demand side management strategies. For example, while economists generally agree that prices are a way of reducing demand during periods of limited water supply, others argue that water demand is price inelastic, and therefore an ineffective tool for regulating consumption. Supporters of this viewpoint would perhaps suggest that more appropriate mechanisms for regulating residential water consumption are non-price strategies, encompassing public education campaigns, rationing, water restrictions and subsidisation of programs aimed at adopting water efficient technologies.

The paper itself is organised as follows. The second section discusses the environmental and institutional context of the empirical analysis. The third section presents the model for estimation of water demand and the set of independent variables included. A brief descriptive analysis is provided in the fourth section. The fifth section presents the results of the estimation. The paper ends with some brief concluding remarks

2. Data context

The information for the demand estimation is obtained from the Brisbane City Council, Australia's largest local government. Brisbane, the capital city of the state of Queensland, is a moderately-sized city covering an area of 1,367 square kilometres with approximately 950,000 residents. The city has a subtropical climate, lying as it does 27.5° south of the equator. Centred on the Brisbane River, fifteen kilometres inland from the Pacific Ocean, Brisbane has mild dry winters and hot wet summers: the average daily maximum temperature is 26.3°C, the average daily minimum temperature is 15.3°C and average daily rainfall is 2.69 mm. In line with high population growth in the rest of south-eastern Queensland, the city has grown steadily since the mid-1990s, with population increasing by 9.4 percent and residential dwellings by 12.3 percent. As a result, the average household size, currently 2.57 persons, has fallen by 2.6 percent.

Brisbane's water was supplied under a fixed access charge until 1993. In 1995/96 water meters and optional volumetric pricing were first introduced [see Higgs and Worthington (2001) for an analysis of this policy change] with two-part tariffs made compulsory in July 1997. Since then, all residential consumption has been charged using a fixed annual service fee with no free entitlement and a fixed (or flat) volumetric charge per kilolitre. Over the period 1997/98 to 2003/04 residential water has been billed quarterly with an annual access charge of $100 and a volumetric rate rising from $0.60 in 1997/98, $0.70 from 1998/99 to 1999/00, $0.80 from 2000/01 to 2001/02, $0.82 in 2002/03 and $0.84 in 2003/04. In addition, the council has imposed outdoor water use restrictions in the form of alternate fixed sprinkling days for more than twenty years, as well as a high publicity 'Water Wise' education campaign. Brisbane, however, has generally less severe water restrictions than other Australian state capitals. For example, Sydney Water (responsible for the greater Sydney metropolitan, suburban and satellite area) has standing prohibitions on fixed garden irrigation systems and hosing of 'hard surfaces' (including cars, footpaths, paving and buildings).

3. Demand estimation and model specification

Water demand equations generally take a form where the quantity of water demanded (more likely consumed) is expressed as a function of price, income and other demand factors. The specification actually employed depends heavily on the data available and whether this is available at the household level or higher. Unfortunately, and in common with most previous

studies of water demand, there are limited data available at the micro level in Australia [see Arbués *et al*. (2003) for a useful survey of water demand estimation]. Accordingly, in this study a suburb-level model is specified where the average quantity of water consumed per household per quarter in each suburb is specified as the dependent variable in a regression (expected sign of the estimated coefficient in brackets) against the marginal price of water per kilolitre (-), average household income in dollars for each suburb (+), the average size of each suburb's households (+), the number of rainy (-) and warm (+) days per quarter and whether the quarter is in summer (+) or otherwise.

Starting with the dependent variable, the quantity of water demanded (*DMD*) can be measured either at the household level via user metering or by the main line meter at the water substation. If measurement is at the bulk meter, system losses and other consumption such as industrial, commercial, community and rural use must be accounted for prior to estimation. The Queensland Department of Natural Resources and Mines provided quarterly residential water consumption data by suburb. The data comprises two separate records: 'Tariff 02' records which pertain to water supplied to all residential premises rated as owner occupied, and 'Tariff 70' records which relate to water supplied to all residential premises rated as non-owner occupied (tenanted or rented). Under the Queensland *Residential Tenancies Act 1994*, tenants are entitled to a free allocation of a 'reasonable' amount of water by their landlords so it can be expected that renting households may be less price-sensitive than owner-occupier households. Data for both renting and owner-occupied households are collected quarterly from September 1998 to June 2003 and includes the total number of bills and total billed water consumption for each suburb. With this information in hand, average household water consumption for owner-occupied and rental housing in the fifty-three Brisbane suburbs is calculated for the sample period of twenty quarters.

The first independent variable specified is the marginal price (*PCE*) of water in Brisbane. A key feature of demand side management policies is the pricing structure and a variety of alternative forms have been employed in Australia and elsewhere (Dinar and Subramanian 1998; Bartoszczuk and Nakamori 2004). These include: a fixed charge invariant to the level of consumption; a fixed charge with a free allowance followed by some excess charge for consumption over a particular level; a two-part tariff consisting of a fixed access charge and a cost per unit based on the volume of water consumed (as in Brisbane) or a cost per unit that varies when consumption reaches certain thresholds, in such a way that the tariff consists of sequence of marginal prices for different consumption blocks. In turn, block prices can increase or decrease with each successive block of water use.

Different pricing structures can complicate the calculation of a marginal price, as reflected by the variation in pricing specification in the literature. For example, Nieswiadomy (1992) and García and Reynaud (2003) specify marginal prices, Barkatullah (1996) and Renwick et al. (1998) use the marginal price less the difference between what the typical consumer actually pays for water and what would be paid if all the water were purchased at the marginal rate [or Nordin's (1976) difference], Gaudin *et al*. (2001) includes the average price, Pashardes and Hajispyrou (2002) specify the marginal price in the highest tariff block and Martínez-Espiñeira (2003) employs the average marginal price. Fortunately, in Brisbane there is a single fixed price per kilolitre with no free water allowance at all levels of consumption. This means the price specification is relatively straightforward. Pricing information is provided by the Brisbane City Council. This variable changes over time, but not across suburbs.

The second independent variable is lagged demand (*LAG*) in each suburb. In the case of water consumption, it is reasonable to assume that the current period's water use will be related to the previous period. Therefore, the inclusion of the previous quarter's consumption should capture any unobservable determinants, including past changes in water-saving behaviour and technology. By including a lagged term for consumption, the model is effectively estimating the long-run price elasticity (Dandy *et al*. 1997). The third independent variable is each suburb's average household income (*INC*). One consideration is that water consumption, as a normal good, should be positively related to income. This is especially so since income is also positively related to many water-using goods, including swimming pools, in-ground irrigation systems and dishwashing machines. A second consideration is that income, through its positive relationship with education, may be reflective of water conservation measures taken by the household through the purchase of water-conserving appliances and planting of drought-tolerant gardens. A negative coefficient would then be hypothesised. Regardless, most studies have found that the income elasticity of demand is in fact positive (Agthe and Billings 1987; Thomas and Syme 1988; Renwick and Archibald 1998; Rietveld *et al*. 2000). The data on household income are sourced from the Australian Taxation Office, which provides mean incomes by postcode area (corresponding roughly to suburbs). While there is inevitability some bias with this information – individuals without group certificates are not obliged to lodge returns, taxable income is less than total income because of tax deductions, etc. – it is generally acceptable. This variable changes over time and across suburbs.

The fourth independent variable is each suburb's average household size (*SZE*). The basic argument is water consumption is positively related to the number of household members. But Arbués *et al*. (2000) found that water use is less than proportional to the increase in household size or population because of economies of scale in discretionary and nondiscretionary water usage, including cooking, cleaning, car washing and gardening. Höglund (1999) also found that if the average number of persons per households increases from two to three in a community, demand for water per person declines by some 27 to 35 percent. The average size of households is taken from the Australian Bureau of Statistics 2001 Census. This information is grouped by Statistical Local Area, which again corresponds roughly to suburbs. As a result, the household size variable is fixed over time but varies by suburb.

The next three independent variables are weather-related factors. These have been shown to effect residential water use in a number of ways. The amount of rainfall, for example, has an influence on garden watering, and also on other activities such as washing cars, laundry and topping-up swimming pools. Temperature has also been shown to influence water consumption, with hotter days implying higher consumption through increased garden watering and topping-up of swimming pools. Daily weather information is sourced from the Australian Bureau of Meteorology. To include weather and temperature factors, variables are specified for the number of rainy days in each quarter (where rainfall exceeds zero millimetres) (*RNY*) and the number of warm days in each quarter (those with a daily maximum in the uppermost quartile of all daily temperatures) (*WRM*). For warm days, the effective cut-off is temperatures greater than 28.5°C. The final variable specified takes a value of one for summer; otherwise zero (*SUM*). All weather variables are fixed across suburbs, but vary over time.

The estimation of the urban demand equations for water in Brisbane comprises two forms: a linear and a non-linear (or log-log) model. Billings and Agthe (1980) and Miaou (1990) also specified linear and log-log models, while Foster and Beattie (1981) and Hewitt and Hanemann (1995) employed a log-log transformation. These functional forms are applied to three separate groups: all households, owner-occupied households and rental households. For *i* suburbs, the linear model is:

$$DMD_t = \alpha_0 + \alpha_1 PCE_t + \alpha_2 LAG_t + \alpha_3 INC_t + \alpha_4 SZE_t + \alpha_5 RNY_t + \alpha_6 WRM_t + \alpha_7 SUM_t \quad (1)$$

And the log-log model is:

$$LnDMD_t = \beta_0 + \beta_1 LnPCE_t + \beta_2 LnLAG_t + \beta_3 LnINC_t + \beta_4 LnSZE_t + \beta_5 LnRNY_t + \beta_6 LnWRM_t + \beta_7 SUM_t \quad (2)$$

where t is the time period and all other variables are as previously defined. For the linear model, the short-run elasticities are calculated at the means, with the exception of the lagged demand term. The lagged demand coefficient is used to determine the long-run price elasticity of demand of $\alpha_1/(1 - \alpha_2)$ at the mean. The short-run elasticity for the log-log model is simply the value of the estimated coefficient with the long-run price elasticity of demand as $\beta_1/(1 - \beta_2)$.

4. Descriptive statistics

Table 1 presents a summary of descriptive statistics across the fifty-three Brisbane suburbs from September 1998 to June 2003. Sample means, maximums, minimums, standard deviations, skewness and kurtosis are reported. Also included are decompositions of these variables into their mean, seasonal and time series components. As shown, household quarterly water consumption averaged 73.11 kilolitres with owner-occupied households averaging 75.36 kilolitres and renter households averaging 65.45 kilolitres. There is clearly a strong seasonal component with household water consumption being 17.91 kilolitres higher in the December quarter and 4.49 kilolitres lower in the June quarter. Consumption per quarter has also trended upwards over the entire sample period by 0.58 kilolitres across all households: 0.35 kilolitres in renter households and 0.67 kilolitres in owner-occupied households. Across all suburbs and quarters, the marginal water price averages 76 cents per kilolitre, the average household income if $12,495 and the number of rainy and warm days per quarter are 34 days (37 percent) and 23 (25 percent) days respectively. Of course, there is wide seasonal variation in these variables, with fewer rainy days in the September quarter and more in the March quarter, and more warm days in the March quarter and fewer in the June quarter.

<TABLE 1 HERE>

5. Empirical results

Table 2 provides the estimated coefficients, standard errors and p-values of the null hypotheses that the individual coefficients are equal to zero and the short and long-run elasticities (at the means) of the parameters detailed in Equation (1). Since the cross-sections (i.e. suburbs) are drawn from a small geographic region with many socioeconomic commonalities (i.e. Brisbane), cross-sectional variation in demand is likely to be small and

identifiers for each suburb are regarded as unnecessary: a common effects panel data model is used. The results of six separate regressions are presented. The upper panel includes the estimated results of a linear form and the lower panel a non-linear form with log-log transformation. The three sets of estimated results for the linear and non-linear forms are for all households, owner-occupied household and rental households, respectively.

Also included in Table 2 are statistics for R^2 and adjusted R^2 and F-statistics and p-values for joint hypothesis tests that all slope coefficients are zero. The R^2 for the linear models include Gujarati's (2003: 221) adjustment to allow direct comparison with the R^2 from the log-log models. Typically for panel data, the R^2 of all six regressions have relatively high explanatory power, ranging from 0.648 to 0.704 for the linear models and 0.698 and 0.776 for the non-linear models. To test for multicollinearity, variance inflation factors (VIF) are calculated (not shown). As a rule of thumb, a VIF greater than ten indicates the presence of harmful collinearity. Among the independent variables, the highest VIFs are for lagged demand (3.002), rainy days (2.016) and household income (2.089). This suggests that multicollinearity, while present, will not bias the estimated coefficients. In terms of the residuals, White's chi-squared test of the null hypothesis of homoskedasticity is rejected (statistic = 203.827, p-value = 0.000), so the standard errors and p-values in Table 2 all incorporate White's corrections for heteroskedasticity of an unknown form.

<TABLE 2 HERE>

The models first discussed are those employing a linear specification. For all households, the estimated coefficients for all parameters are significant at the 1 percent level of significance or lower and conform to *a priori* expectations. Using the F-statistic the null hypothesis that all slope coefficients are jointly zero is also rejected at the 1 percent level. The largest effects on water consumption are clearly the water price and lagged demand. The short-run price elasticity of demand at the mean is -0.588 (inelastic) indicating that a ten percent increase in the price of water is associated with a 5.88 percent decrease in the quantity demanded in the short-run. Long-run price elasticity at the means of -1.442 suggests a ten percent increase in price will reduce consumption by 14.42 percent implying the price elasticity of demand is more elastic in the long-run than the short-run. The income elasticity of 0.239 (inelastic) indicates that a ten percent increase in income is associated with a 2.39 percent increase in the quantity of water demanded. By way of comparison, Agthe and Billings (1987) calculated a price elasticity of -0.56 and an income elasticity of 0.46,

Barkatullah (1996) -0.21 and 0.07, Dandy *et al*. (1997) -0.78 and 0.38, García and Renaud (2003) -0.25 and 0.00 and Gaudin *et al*. (2001) -0.47 and 0.19.

The impact on water demand of changes in the number of rainy and warm days are significantly negative and positive, respectively. The elasticities indicate that a ten percent increase in rainy days is associated with a 2.59 percent fall in water consumption for the quarter; while a ten percent increase in warm days is associated with a 0.01 percent increase in water consumption for the quarter. There is broad agreement between the separate regressions for owner-occupier and rental households, with the exception that for owner-occupied households the price elasticity is higher (-0.607 compared to -0.399) and income elasticity is lower (0.234 compared to 0.276).

The lower panel in Table 2 presented the estimated coefficients, standard errors and *p*-values of the null hypothesis that the individual parameters are equal to zero and the short and long-run elasticities for the non-linear models. On the basis of R^2 the non-linear models are preferred, accounting for up to 78 percent of the variation in the quantity of water demanded. All of the estimated coefficients are significant at the 1 percent level of significance and conform to *a priori* expectations. The short-run price elasticity of demand across all households is -0.507 indicating that a ten percent increase in the price of water is associated with a 5.07 percent decrease in the quantity of water demanded, while the long-run price elasticity of demand is -1.167 suggesting a ten percent increase in price is associated with a 11.67 percent decrease in the quantity of water demanded. The long-run price elasticity of demand is again more elastic than the short-run. The income elasticity of demand of 0.235 suggests that a ten percent increase in income is associated with a 2.35 percent increase in the quantity of water demanded.

The price and income elasticities of demand are again lower for renter households when compared to owner-occupied households. The difference in price elasticity between owner-occupied and renter households is unsurprising. Under the Queensland *Residential Tenancies Act 1994*, tenants are entitled to a free allocation of a ‘reasonable’ amount of water by their landlords, after which negotiations are necessary to resolve payment. In practice, the benchmark for reasonableness set by the Brisbane City Council is 90 kilolitres per quarter, well above average household consumption. Since the transaction and enforcement costs of negotiation is likely to be large relative to the benefits (the variable component of water bills for rental households in the sample averaged just $49.74), the potential reimbursement of ‘unreasonable’ water expense is unlikely.

6. Concluding remarks and policy recommendations

The present study uses linear and non-linear regression techniques to model household residential water demand. The data are drawn from the Brisbane City Council, Australia's largest local government area, where two-part tariffs consisting of a fixed access charge with no free entitlement of water and a constant volumetric charge per kilolitre are in place. As far as the authors are aware, this is the first attempt to derive formal models of household water demand in Queensland, and one of few conducted in Australia. This represents a sizeable advance over projects of a similar nature conducted in Australia, including IPART (2003), Essential Services Commission of Victoria (2004), and Government Prices Oversight Commission Tasmania (2003a; 2003b), which have tended to rely on relatively simple comparisons between changes in water pricing structures and changes in water consumption to formulate policy.

The most important finding is that the short-run price elasticity of demand, though inelastic, is larger than previously thought. The price elasticity of demand is also more elastic in the long-run than in the short-run. This implies that the price mechanism can be an effective tool for managing the demand and consumption of residential water. It also suggests that there is lag between changes in water prices and their eventual impact on the quantity demanded. Depending upon the model specified, a ten percent increase in the price of water is associated with a reduction in the quantity demanded of about five percent. In other terms, a price rise of just $0.08 per kilolitre would have prevented Brisbane household water consumption trending upwards by 580 litres per household over the period 1998-2003. This would amount to water saving of 789 thousand kilolitres per year across Brisbane.

Unfortunately, it is not possible to comment on the effectiveness of price relative to non-price controls, including public education campaigns and water restrictions, as most programs of this type had been in place and unchanged during the period under consideration. However, evidence elsewhere suggests that constraints placed on discretionary water use (gardening, car washing, filling/topping up of swimming pools) can have an equal, if not more sizeable, impact on water demand. In the current analysis, the number of rainy days has a major impact on residential water demand through discretionary consumption (i.e. garden irrigation) and this implies that restrictions on irrigation and outside use are likely to be effective demand management strategies. A second finding is that the price elasticity of demand is lower for renter households than owner-occupier households. One likely reason is that under current tenancy legislation renter households in Queensland are only obliged to pay for 'excess' water

usage and this obscures, contrary to all economic principles regarding pricing transparency, the marginal cost of water consumption in these households. This is a clear omission in the legislation.

The final finding is that factors beyond the control of water authorities also have an influence on residential water demand. That is, there is a significant increase in water demand in summer months, this is only partially moderated by a fall on rainy days, and made worse with a rise on warm days. When combined with strong population growth and the continuing fall in average household size in south-eastern Queensland, the (in-sample) trending upwards of warm days (by one day per quarter every sixteen years) and downwards in rainy days (by one day per quarter every three years) suggests that residential water demand in Brisbane will continue to grow. This highlights the need for efficient and effective demand side management strategies in conjunction with improvements in water-related infrastructure.

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Table 1 Descriptive statistics

		All consumption (kL)	Owner-occupied consumption (kL)	Rental consumption (kL)	Water price ($/kL)	Household income ($)	Rainy days (n)	Warm days (n)
Central tendency and distribution	Mean	73.11	75.36	65.45	0.76	12495.35	33.70	22.65
	Std. dev.	21.46	22.41	18.68	0.05	3241.51	9.98	21.84
	Minimum	23.31	7.75	13.75	0.70	7531.14	15.00	0.00
	Maximum	211.91	214.47	302.36	0.82	24992.42	51.00	72.00
	Kurtosis	9.91	9.35	33.50	1.21	4.36	2.28	2.34
	Skewness	1.99	1.83	3.70	-0.35	1.17	-0.40	0.67
Seasonal and time decomposition	Intercept	67.06	68.36	61.79	0.68	11191.00	41.50	37.89
	Time trend	0.58	0.67	0.35	0.01	124.00	-0.74	0.32
	March quarter	2.90	3.57	1.72	0.09	1379.00	-2.70	9.80
	June quarter	-4.49	-4.23	-4.46	0.09	1528.00	-4.90	-38.55
	September	7.88	9.22	3.94	0.09	1081.00	-15.70	-14.31
	December quarter	17.91	19.41	13.44	0.09	1230.00	-7.90	0.32

Table 2 Estimated linear and non-linear regression models

		All households				Owner-occupier households				Renter households			
	Variable	Coefficient	Std. error	p-value	Elasticity	Coefficient	Std. error	p-value	Elasticity	Coefficient	Std. error	p-value	Elasticity
Linear demand equation	Constant	50.469	8.546	0.000	–	56.542	6.786	0.000	–	24.313	18.211	0.182	–
	Water price ($/kL)	-56.256	8.537	0.000	-0.588	-59.888	7.377	0.000	-0.607	-34.165	16.278	0.036	-0.399
	Lagged demand (kL)	0.592	0.059	0.000	-1.442	0.616	0.055	0.000	-1.579	0.393	0.144	0.006	-0.658
	Household income ($)	0.001	0.000	0.000	0.239	0.001	0.000	0.000	0.234	0.001	0.000	0.000	0.276
	Household size (n)	6.129	1.540	0.000	0.212	5.030	1.317	0.000	0.169	10.685	3.457	0.002	0.414
	Rainy days (n)	-0.567	0.046	0.000	-0.259	-0.617	0.046	0.000	-0.273	-0.348	0.063	0.000	-0.177
	Warm days (n)	0.031	0.019	0.106	0.009	0.022	0.019	0.264	0.006	0.089	0.034	0.009	0.030
	Summer	15.751	0.713	0.000	–	16.574	0.745	0.000	–	12.493	0.884	0.000	–
	R-squared	0.745	–	–	–	0.703	–	–	–	0.648	–	–	–
	Adjusted *R*-squared	0.744	–	–	–	0.703	–	–	–	0.647	–	–	–
	F-statistic	451.889	–	0.000	–	479.039	–	0.000	–	200.718	–	0.000	–
Non-linear demand equation	Constant	-0.077	0.183	0.676	–	-0.258	0.226	0.254	–	0.310	0.178	0.083	–
	Water price ($/kL)	-0.507	0.073	0.000	-0.507	-0.455	0.084	0.000	-0.455	-0.391	0.099	0.000	-0.391
	Lagged demand (kL)	0.566	0.048	0.000	-1.167	0.486	0.083	0.000	-0.884	0.502	0.078	0.000	-0.785
	Household income ($)	0.235	0.029	0.000	0.235	0.298	0.048	0.000	0.298	0.191	0.033	0.000	0.191
	Household size (n)	0.211	0.046	0.000	0.211	0.210	0.053	0.000	0.210	0.327	0.074	0.000	0.327
	Rainy days (n)	-0.218	0.014	0.000	-0.218	-0.234	0.019	0.000	-0.234	-0.168	0.017	0.000	-0.168
	Warm days (n)	0.020	0.004	0.000	0.020	0.027	0.006	0.000	0.027	0.025	0.005	0.000	0.025
	Summer	0.197	0.010	0.000	–	0.193	0.013	0.000	–	0.166	0.011	0.000	–
	R-squared	0.776	–	–	–	0.720	–	–	–	0.698	–	–	–
	Adjusted *R*-squared	0.775	–	–	–	0.718	–	–	–	0.696	–	–	–
	F-statistic	494.829	–	0.000	–	366.181	–	0.000	–	329.254	–	0.000	–