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SHORT COMMUNICATION (III)

Income and Price Elasticities of Demand for Domestic Water: A Case Study of Alor Setar, Kedah.

RINGKASAN

Satu analisa rentasan untuk isi-isi rumah di Alor Setar, Kedah, menunjukkan yang keluarga berpendapatan tinggi mempunyai keanjalan pendapatan permintaan air lima kali ganda lebih dari keluarga-keluarga berpendapatan rendah. Keanjalan harga dalam jangka pendek dengan menggunakan analisa siri-masa juga menunjukkan perbezaan yang sama antara gulungan berpendapatan tinggi dan rendah. Keputusan kajian menunjukkan yang harga air boleh digunakan sebagai satu cara yang berkesan dalam pengagihan dan perancangan pembekalan air.

INTRODUCTION

During the Third Malaysia Plan period, a total of $496 million will be spent for development of piped water supplies. Water demand for irrigation, industrial and domestic use in Malaysia will increase by 2.3, 8 and 2 times respectively in the year 2000 relative to 1975 (United Nations, 1976). In most urban areas cheap sources of water supply have already been well developed and additional sources of supply will have to be developed at higher costs (Katzman, 1977). One possible solution to the problem is to reduce wastage and control demand.

Howe and Linaweaver (1967) using cross sectional analysis estimated that income elasticity and price elasticity for residential water demand in the United States were between 0.35 to 1.40 and between −0.23 to −1.60 respectively. Gottlieb (1963) obtained an income elasticity of 0.45 to 0.58 and a price elasticity of −1.23 to −0.68 for residential water in Kansas. Foster and Beattie (1979) also using cross sectional analysis estimated an elasticity of −0.35 to −0.67. The only available local study on domestic water demand elasticities by Katzman (1977) gives an income elasticity of demand of 0.2 to 0.4 and a price elasticity of demand of −0.1 to −0.2.

The present study attempts to examine the impact of price of water and income of consumers on the consumption of water for domestic purposes in Alor Setar, Kedah. Primary data on the socio-economic variables of the consumers were obtained from a stratified random sample survey of 101 households. Secondary data on water consumption of the individual households included in the survey were obtained from the record books of the Alor Setar Water Works Department. Regression equations were used to arrive at the price and income elasticities of demand for water. The elasticity coefficients indicate the extent to which price can be used as a policy tool in reducing water wastage and consumption.

INCOME ELASTICITY OF DEMAND

Linear and logarithmic linear equations were estimated as shown below; the t-statistics are given in brackets.

$$\text{linear: } Qc = \underset{}{1.10} + \underset{(4.12)}{0.018X_1} + \underset{(10.36)}{7.67X_2} + \underset{(3.49)}{6.15X_3} + \underset{(1.342)}{0.09X_4} + \underset{(0.089)}{0.49X_5} + \underset{(0.273)}{0.62X_6} \quad (1)$$

$$\bar{R}^2 = 0.63 \qquad F = 24.43 \qquad n = 101$$

$$\text{log linear: } \log Qc = \underset{}{1.20} + \underset{(3.86)}{0.301 \log X_1} + \underset{(5.20)}{0.54 \log X_2} \quad (2)$$

$$\bar{R}^2 = 0.37 \qquad F = 25.17 \qquad n = 101$$

where Qc = quantity of water consumed in thousands of gallons per year.
X_1 = household income per month in dollars.
X_2 = household size in adult equivalents.
X_3 = number of water supply outlets in the household.
X_4 = sprinkling area frequency (sprinkling area multiplied by number of times watering of garden done in a week).
X_5 = 1 if sample is a Chinese household. 0 if sample is a Malay or Indian household.
X_6 = 1 if sample is a Malay household. 0 if sample is a Chinese or Indian household.
$\bar{R}^2$ = adjusted R^2

Income was significant at one per cent level in both the linear and logarithmic linear equations. The average income elasticities of demand from equations (1) and (2) are 0.24 and 0.30 respectively. Income elasticities were also computed for five income groups as shown in Table 1.

Generally income elasticity increases as income of household increases. For the very poor, the income elasticity ranges from 0.05 to 0.09 while that of the very rich ranges from 0.29 to 0.40.

PRICE ELASTICITY OF DEMAND

The effect of a price change on the quantity consumed was estimated using the following model:

$$Cit = a_0 + a_1X + b_0R_t + b_2XR_t + c_0t + U_t$$

where Cit = water consumption in thousands of gallons in month t for group i.

X = 0, before price increase, i.e. when $t \leq 8$.
1, after price increase, i.e. when $t > 8$.

R_t = rainfall in hundreds of millimetres.

t = bimonthly period, setting January 1975 = 1, March 1975 = 2 ...etc.

U_t = stochastic disturbance term.

In March 1976, the Alor Setar Water Utility Board announced an increase in water rates with effect from April 1976. The actual increase in price was about twenty per cent for those consuming more than 3,000 gallons per month.[1]

Monthly water consumption from January 1975 to July 1977 was collected for each consumer. The period covers one year and four months before and after the price increase. Individuals were classified into five income groups and the mean consumption of each group for each month was computed. The regression coefficients obtained are summarised in Table 2.

In all the five equations, the coefficients of the dummy variable were found to be negative, indicating that there was a fall in water consumption for all income groups when price increased. None of the rainfall coefficients was significant at the ten per cent level. The negative sign obtained for the trend variable indicates that over time consumption tend, to decrease as price increases.

The price elasticity of demand for the respective income groups was calculated using their mean consumptions before and after the price increase. The period studied covered sixteen months before and sixteen months after the price increase. In calculating the percentage change in the quantity consumed, only quantities above 3,000 gallons were considered since the effective price change of 20 per cent per thousand gallons only applies to quantities above 3,000 gallons. The results for all income groups are shown in Table 3.

The price elasticity ranges from −0.09 for the poorest group to −0.62 for the richest group. Increasing elasticity with income level suggests that higher income families are able to conserve or reduce consumption in response to the price increase.

DISCUSSION OF RESULTS AND CONCLUSIONS

Results of the study are generally consistent with those obtained by Katzman (1977) and by researchers in the United States cited earlier.

TABLE 1
Income elasticities of demand for different income groups. Alor Setar, Kedah, 1979

Household Income ($ per month)	Income Elasticities of Demand	
	linear	log linear
0 – 350 (very poor group)	0.05–0.09	0.03
351 – 550 (poor group)	0.10–0.12	0.23
551 – 750 (middle group)	0.16–0.22	0.31
751 – 1000 (rich group)	0.27–0.30	0.16
>1000 (very rich group)	0.29–0.40	0.21

1 The price in 1975 was $1.00 per 1,000 gallons per month. The price in April 1976 was $1.00 per 1,000 gallons per month for the first 3,000 gallons and $1.20 per 1,000 gallons for additional gallons consumed.

TABLE 2

Determinants of household water consumption time series 1975–1977: regression coefficients, t-statistics in brackets

Income Group	Constant	Dummy x	Rainfall R^t	Rainfall Dummy xR^t	Time t	R^2	$\bar{R}^2$	Durbin Watson Statistics
Very poor	9.989	−0.089* (1.442)	0.142 (0.965)	−0.014 (0.063)	−0.207** (2.751)	0.54	0.37**	1.711
Poor	11.377	−0.092 (0.964)	0.102 (0.445)	−0.216* (1.771)	−0.074 (0.630)	0.31	0.05	1.335
Middle	11.099	−0.103 (0.835)	0.058 (0.445)	−0.345* (1.760)	−0.043 (0.647)	0.34	0.10	1.582
Rich	14.136	−0.137** (2.579)	0.080 (0.497)	−0.480* (1.981)	−0.349** (4.268)	0.76	0.68**	1.915
Very rich	15.660	−0.314** (2.629)	0.074 (0.345)	−0.533** (2.876)	−0.308** (2.814)	0.64	0.51**	2.322

* Significant at 10 per cent level, one tail test.
** Significant at 5 per cent level.

TABLE 3

Price elasticities by income group, Alor Setar, 1979

Income Group $/month	Mean monthly consumption in thousands of gallons				Change in mean consumption '000 gallons		Calculated t values	% change in quantity*	% change in price*	Price elasticity of demand
	Before		After							
	$\bar{x}_1$	s_1	$\bar{x}_2$	s_2	$\bar{x}_1 - \bar{x}_2$	$S(\bar{x}_1 - \bar{x}_2)$				
0–350	8.701	0.096	8.598	0.020	0.103	0.121	1.02	−1.80	20	−0.090
351–550	11.235	0.047	10.793	0.030	0.442	0.098	4.51**	−5.36	20	−0.268
551–750	11.014	0.139	10.225	0.066	0.789	0.160	4.91**	−9.84	20	−0.492
751–1000	12.415	0.035	11.292	0.056	1.123	0.107	8.66**	−11.93	20	−0.597
> 1000	14.410	0.085	12.989	0.068	1.421	0.138	10.26**	−12.45	20	−0.623

* the percentage calculated is for quantities above 3,000 gallons.
** significant at one per cent level, one tail test.
S refers to the respective standard deviations.

They indicate that consumers of water in Alor Setar, Kedah, do adjust downwards the quantities consumed as price increases in particular for higher income groups.

Investments made by water authorities will depend on the demand and since the demand in turn depends on the price charged, a direct relationship between pricing policy and amount of investment to be made is implied. Water pricing, therefore, has great potential of being an effective policy tool for water supply authorities. Price could be used as a tool to distribute and use water efficiently and could play a major role in the long run planning and conservation of water supplies. In areas where consumers have high incomes, an increase in the price of water could help delay required capacity expansion. It is suggested that an incremental block pricing policy should be employed. Such a pricing policy could be based on succeedingly higher unit prices in discrete ranges of quantities consumed. It would result in higher demand sectors paying a higher average price of water. The distributional advantage of the policy is a lower average unit price for low water users who are usually the low income consumers.

Results of the study also generally support the view that price and income elasticities of demand for water should be incorporated in any

projection of water demand. Future studies should concentrate on the relevant ranges of price changes that will make significant differences in the design systems and storage capacities of a water utility.

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