PRICING TO ENCOURAGE CONSERVATION: WHICH PRICE? WHICH RATE STRUCTURE?

Jeffrey L. Jordan
Professor
University of Georgia

INTRODUCTION

If economists agree on one thing, it is the law of demand: if the price of a good increases, demand will decrease, all other things held constant. This simple, but powerful observation is at the heart of using prices to manage urban water demands: as the price of water increases, the demand should decrease. In short, pricing can be a useful tool in efforts to conserve water. Yet studies on the price responsiveness of water demand have produced various results. While price elasticities of demand for water have usually been found to be very inelastic, some studies have suggested much more elastic demands, depending on season or region of the county. When price is included in a demand model, it postulates a relationship between how much water a consumer uses and the price they pay for water. The economic question is, which price variable should be included in the model? Put another way, which price is the one that consumers use to judge how much water to buy?

Economic theory is clear that marginal price should be used since consumers, in achieving equilibrium, equate benefits with the cost at the margin (Taylor, 1975). The marginal price is the price for another unit. Howe (1993) states that the correct definition of price should be "... the amount paid per unit of water withdrawn from the supply system for the *next* (or marginal) unit withdrawn." Howe calls this a *behaviorally relevant* measure of the cost incurred by the water user in using one more unit (emphasis in original). It is the cost, says Howe, that a rational user will compare with marginal benefits in deciding how much water to apply. However rational, marginal price information is rarely available to water customers at decision time. If a person goes to a store to buy a product, the marginal price is clear. For water, what is the marginal price and do consumers have the information to determine the price at the margin? Usually, the block in the rate structure where the consumer's water use is observed represents the marginal price (Howe, 1982). For example, in a rate structure that charges $1.50 per thousand for the first 3,000 gallons and $2.00 per thousand for use between 3,000 and 10,000 gallons, the marginal price for a customer using 8,000 gallons is $2.00. However, studies have shown that people are not aware of the marginal price of water (Nieswiadomy and Molina, 1991).

While many studies say marginal price should be used in any demand estimation when block prices exit, Foster and Beattie (1981) believe that the perfect-knowledge postulate implicit in marginal price models does not apply to water. They believe that average price is the motivating price for consumer response. Foster and Beattie concluded that, given billing procedures and the high cost for consumers to gain and act on information about actual water rates, the use of marginal price models does not reflect consumer actions. Few people would gather information necessary to apply a marginal cost decision model.

WATER PRICES

However, even the use of average price may fall victim to the same knowledge constraints as noticed by Foster and Beattie. When a person goes to a store to buy a good, the choice is discrete --- do they buy another unit or not (table 1)? Consumers know the marginal price since it is the price marked, as is the average price. The consumer can decide to buy one, or ten or any known amount and they make payment before use. For water, a consumer does not buy in discrete units like gallons, but in bulk. The consumer does not know the marginal price for every use of water or the amount used at any one time. Finally, water bills come after use. Consumers cannot adjust the quantity demanded at discrete block boundaries. Knowing consumption during the billing period is difficult since a consumer cannot easily check the meter.

Table 1. Water vs. Other Goods Price Decisions

Other goods	Water
Discrete choice	Bulk Buying
Known marginal price	Do not know marginal price
Known average price	Do not know average price
Known amount purchased	Do not know amount purchased at time of use
Pay before use	Pay after use

Further, water bills often do not carry information needed to make decisions. They also often convey so much unrelated information that sorting it out is difficult. In a survey in Tulsa a lack of rate structure knowledge was evident (Agthe, et al, 1988). Only 21 percent of those surveyed were aware that there was a block rate structure at all. To get information on blocks, consumers had to contact the utility. It was found that the complexity of the structure confused customers and prevented information acquisition.

In a 1992 survey in Georgia, 400 people were asked if they knew how much they paid for water in an average month. Of those, 62 percent knew their water bill and provided an answer that, when checked, approximated their true water bills. Another 26 percent did not know their bills because they included it in rent. Only 12 percent had no idea of their water bill. When the same people were asked if they knew their water rate or rate structure, only twelve people answered yes and of those, eight were wrong.

It is not only water customers that are confused about rates. In a 1995 survey, water utility managers in Georgia were asked to check the rate structure currently used. Later in the survey, they were asked to show the exact rate structures using prices per thousand. When the two answers were cross-checked, 48 percent of the managers misidentified the rate structure in use.

Often, the complexity of the bill itself is a hindrance to information collection. Figure 1 shows an actual water bill for a local utility. This utility shows water charges along with wastewater, storm water, electric, garbage disposal and collection and other charges. The bill arrived March 3 and showed the recipient of this bill that water consumption for January 1999 was 43 gallons, with average consumption 1.483 gallons. What is a consumer to think about these figures? Did they consume 43 gallons, or 4,300 gallons as the bill is supposed to convey? What is the marginal price charged for the last unit consumed? On the other end of the spectrum, Figure 2 shows a water utility bill with little information. Here, it is shown that 7,700 gallons were consumed but information on rates, structures, or charges is lacking.

Figure 1. Example of a Local Water Utility Bill - 1

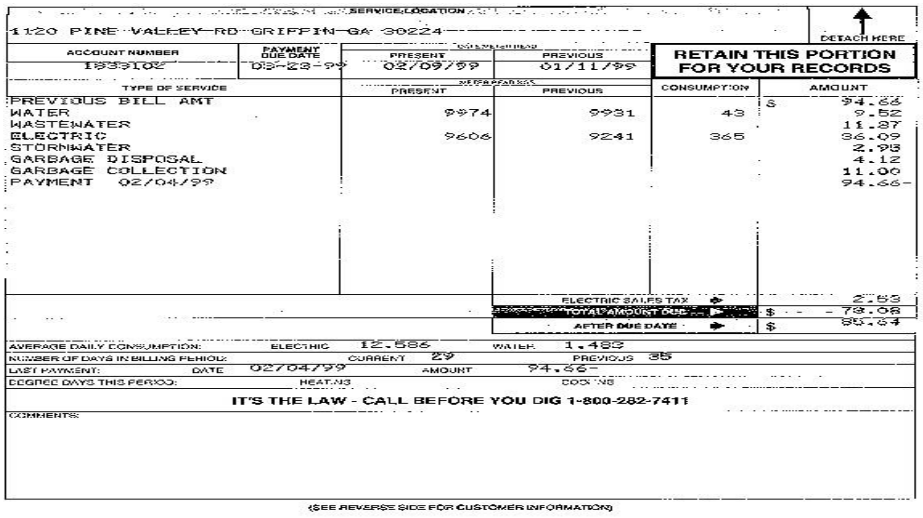
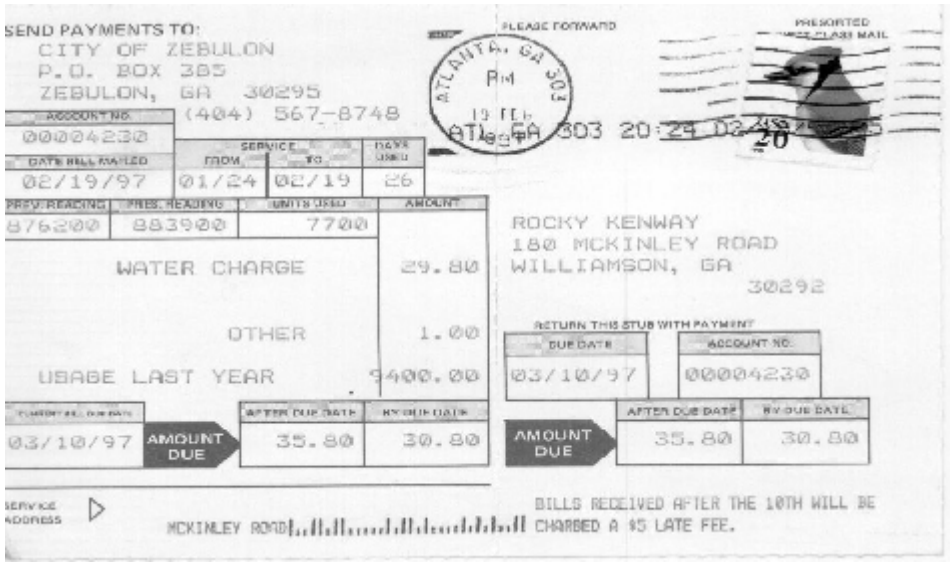

SERVICE LOCATION
1120 PINE VALLEY RD GRIFFIN GA 30224
DETACH HERE
ACCOUNT NUMBER 133102
PAYMENT DUE DATE 02-23-99
PRESENT 02/09/99
PREVIOUS 01/11/99
RETAIN THIS PORTION FOR YOUR RECORDS
TYPE OF SERVICE | METER READINGS PRESENT | PREVIOUS | CONSUMPTION | AMOUNT
PREVIOUS BILL AMT $ 94.66
WATER 9974 9931 43 9.52
WASTEWATER 11.97
ELECTRIC 9606 9241 365 36.09
STORMWATER 2.98
GARBAGE DISPOSAL 4.12
GARBAGE COLLECTION 11.00
PAYMENT 02/04/99 94.66-
ELECTRIC SALES TAX 2.53
TOTAL AMOUNT DUE $ 78.08
AFTER DUE DATE $ 80.64
AVERAGE DAILY CONSUMPTION: ELECTRIC 12.586 WATER 1.483
NUMBER OF DAYS IN BILLING PERIOD: CURRENT 29 PREVIOUS 35
LAST PAYMENT: DATE 02/04/99 AMOUNT 94.66-
ESTIMATED DAYS THIS PERIOD: HEATING COOLING
IT'S THE LAW - CALL BEFORE YOU DIG 1-800-282-7411
COMMENTS:
(SEE REVERSE SIDE FOR CUSTOMER INFORMATION)

Figure 2. Example of Local Water Utility Bill - 2



While what works in models does affect economic research, consumers clearly do not make water decisions based on marginal price, average price or some price differential. The only information consumers have is their total water bill, usually lagged one month. Of course, when looking at the bill in figure 1, how do consumers react to the "total bill?" Is it the price of water only, water plus wastewater, or all utilities? In a recent survey of 89 water utilities across the US on experiences using conservation water rates (Albani and Jordan, 1999) almost all of the respondents charge for water and wastewater on the same bill and nearly half have some type of garbage collection charge. Gas charges were included on the bills of 8 percent of the utility respondents, along with electric (12 percent), cable (2 percent), storm water (31 percent), and other (20 percent). With deregulation of gas delivery, more local governments will be including that charge along with new telecommunication charges. Bill consolidation is presenting customers with larger single bills with water only one item. If, as is believed, customers respond more to the total amount of the bill rather than any one item, the use of water pricing alone to provide conservation incentives may become less effective. While bill consolidation is a savings to local governments, the sacrifice may be in the ability to use pricing for any one utility item to send conservation incentives. Further, while nearly two-thirds of the surveyed utilities used monthly billing (79 percent non-residential), non-monthly billing is still significant. Again, to use water bills to send conservation-incentive signals requires timely information to the consumer. It is interesting that as more utilities seem to be using price as an incentive for conservation, the changes in bill practices may make such use less effective.

PEAK AND SEASONAL PRICING

While it is uncertain what prices consumers respond to, and whether they respond to specific rate structures, there is evidence that peak pricing does give a clear economic signal and can produce the desired consequences.

Lyman (1992) found peak period price elasticity was more than twice the off-peak elasticity. Lyman estimated peak elasticity of about -1.35 compared with an inelastic off-peak elasticity of -0.44. Thus, peak prices are more elastic than nonpeak. Lyman also found cross-price effects between peak and off-peak periods. This effect was similar to an income effect where peak charges affect water use in the nonpeak period. For example, peak charges could cause people to buy water efficient durable goods like dishwashers or washing machines that cut off-peak water use. With all else constant, Lyman found that the long-run effect of a variable influencing demand will be 24.5 percent greater in the peak vs. off-peak period. Lyman concluded that although the literature on conservation pricing focuses on block price schemes, utilities may find it better to consider peak and off-peak effects.

Seasonal pricing, a form of peak pricing, is also an effective method of using marginal cost to price water. Griffin and Chang (1991) found that summer residential demand is more price responsive than winter demand. Consequently, price can be a more effective allocative tool in the summer than winter. Summer price sensitivity can be as great as 30 percent more than winter price responses.

CONCLUSION

So where does this leave the question of which price? or which rate structure? The conclusions drawn from the survey of experiences from water utilities may help in using prices to manage urban water demand:

1. It appears that rates, as part of a conservation program, can best be used to reduce peak demands. This suggests that the economic penalty of excess use or seasonal use can be an effective method of providing consumers the incentive to reduce peak water use. Conservation rates may be less effective in reducing "base level" (indoor) water use.

2. This suggests that the use of permanent or complex increasing rate structures may be less effective than simple uniform rates with excess or seasonal charges. Such rates provide consumers with a direct and apparent economic charge for peak water use. However, the impact of peak charges on revenues is unclear and may be less predictable than other rates.

3. Since most systems use other methods to encourage conservation, these findings suggest that while rates may be effective in peak usage, other programs (like low-flow fixtures, education, etc.) can be best targeted at reducing the base demand.

However the price signal is sent, perhaps as long as increased water use produces higher water bills, the use of pricing as a conservation measure is useful. So, while price matters, it may be that rate structures do not, particularly for residential water use.

REFERENCES

Agthe, D. E., B. Billings, and J. M. Dworkin. 1988. Effects of Rate Structure Knowledge on Household Water Use. *Water Resources Bulletin*. 24(3): 627-630.

Albani, R. and J. L. Jordan. 1999. A Survey of Experiences Using Conservation Rate Structures. *Proceedings of the 1999 American Water Works Association Annual Meeting*.

Foster, H. S. and B. R. Beattie. 1981. On the Specification of Price in Studies of Consumer Demand Under Block Price Scheduling. *Land Economics* 57(4):624-629.

Griffin, R. C. and C. Chang. 1991. Seasonality in Community Water Demand. *Western J. Ag. Econ.* 16(2):207-217.

Howe, C. W. 1982. The Impact of Price on Residential Water Demand: Some New Insights. *Water Resources Research.* 18(4):713-716.

Howe, C. W. 1993. Water Pricing: An Overview. *Update Water Resources UCOWR*, 92(summer):3-6.

Lyman, R. A. 1992. Peak and Off-Peak Residential Water Demand. *Water Resources Research.* 28(9):2159-2167.

Nieswiadomy, M. L. and D. J. Molina. 1991. A Note on Price Perception in Water Demand Models. *Land Economics.* 67(3):352-359.

Taylor, L. D. 1975. The Demand for Electricity: A Survey. *Bell J. of Econ.* 6:74-110.

Jeffrey L. Jordan is a Professor in the Department of Agricultural and Applied Economics, the University of Georgia. Jordan is Chair of the Planning and Evaluation Committee of the AWWA's Conservation Division and is Chair of the AWWA's WaterWise Steering Committee.