Residential Water Demand of Small Communities in New York State: A Note

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RESIDENTIAL WATER DEMAND OF SMALL COMMUNITIES IN NEW YORK STATE: A NOTE*

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A number of studies have indicated that the demand for water is price elastic. This being the case, it has been argued that appropriate pricing policies would provide a means for conserving this valuable resource. The present study, however, reveals that the residential water demand of small communities in New York State is neither price nor income elastic and that conservation measures should focus upon alternative procedures. Circumstances in Nebraska, however, are likely to be considerably at variance with those typical of New York, and it is suggested that a similar study carried out in Nebraska could be beneficial.

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INTRODUCTION

Efforts aimed at adequately allocating water supplies to consumers have traditionally been accomplished by manipulating the volume of the water resource itself. In short, the notion has typically been that water should be considered a free good in excess supply (Henderson and Quandt, 1971), or at least should be provided at only a nominal fee. A contrary idea expressed by Rees (1969) and Gysi (1972) is that society might find it more beneficial to treat water as a standard or scarce economic commodity. Proposals aimed at realigning pricing policies in favor of competitive marginal cost considerations ultimately may be viewed as logical extensions of this thesis (Hanke and Davis, 1973; Turvey, 1976).

Several studies have emphasized the significance of the price of water as a potential policy instrument for regulating consumer demand. It is not surprising to discover, therefore, that increased attention is being focused upon estimates of the price elasticity of demand for water. Inspection of the summaries of Chiogioji and Chiogioji (1973) and Wong (1972), together with the analyses conducted by Howe and Linaweaver (1967) and Grima (1972), strongly indicate that the demand for water is significantly price responsive or elastic. If this state of affairs is prevalent, it follows that pricing policies ought to be able to effectively adjust the demand for water to the particular level desired.

Notwithstanding this empirical evidence, however, Callegari, et al. (1976) were unable to substantiate this trend with respect to results obtained for New York City. Because their findings were inconclusive, the present authors decided to consider the simplified case of the demand for water exercised by residents of New York State's smaller communities. In particular an attempt was made to determine whether or not water demand was price elastic in these areas and thus amenable to regulatory pricing policies designed to encourage its conservation.

METHODOLOGY

The approach adopted in the present study is similar to

*This research was undertaken during the summer of 1977 while Dr. Hubbard was employed as a Research Assistant with the College of Environmental Science and Forestry, State University of New York at Syracuse. The study was supported by a grant from the New York State Health Research Council.

that employed by Grunewald, et al. (1976) in that it focuses upon communities evidencing only small population levels. Under these circumstances it is considerably easier to isolate the demand for water exerted by industrial concerns, and thus concentrate more directly upon residential requirements. The spatial units investigated were those water districts in New York State which encompassed between 50 and 2,500 customers.

The general functional form of the water demand model utilized in the research was as follows:

$$PCC = f(WB, PCI, PM, u) \tag{1}$$

where,

PCC = the per capita water consumption of residents in gallons per day

WB = the per capita water bill in dollars per year

PCI = the per capita income of residents in thousands of dollars per year

PM = the percent of households whose water consumption is metered

u = a stochastic error term

These data were obtained from various sources. Water consumption data (PCC), and the percentage of consumers metered within each district (PM) were abstracted from the New York State Department of Health (1974). Certain water bill data (WB) were made available from the files of the New York State Public Service Commission. This information was incomplete, however, because it involved only the private utilities operating within the state, and because no centralized source for public utilities water rates or revenues exists. Data concerning the public utilities were therefore furnished from the various Comprehensive Water Supply Studies (New York State, 1964-1974) which were undertaken for the counties of New York State. In order to maintain the desired temporal consistency for the cross-section model, only data from the most recent of these studies were included. Per capita income (PCI) information was garnered from the Population Census (1970). Water Districts which were readily identifiable as containing large industrial sectors were excluded from the analysis. This process resulted in some 159 districts being eligible for inclusion in the present examination.

The hypotheses embodied in the general model (1) are enunciated below. As may be expected, a negative relationship should be in evidence when investigating the interaction between water consumption (demand) and water bill (price) variables. This relationship follows directly from the observation that, in the absence of Giffen goods and the like, demand curves should have a negative slope. Moreover, if water is treated as a normal economic good, then a direct relationship should be displayed between the level of water demand and the income of the individual consumer. Finally, an inverse association ought to be revealed between water demand and the percent of residences metered, reflecting the fact that information availability as to the price (cost) of water should indicate to consumers the economies to be realized if conservation practices are adopted.

RESULTS OF THE STUDY

The general form of the water demand model presented in equation (1) obviously needs to be specified more accurately in order to derive the ordinary least squares (OLS) estimates of the parameters involved. A multiplicative variant of the water demand model was consequently utilized:

$$PCC_i = \beta_1 WB_{1i}^{\,a} PCI_{2i}^{\,b} PM_{3i}^{\,c} u_i \tag{2}$$

To facilitate estimation, equation (2) was converted into logarithmic form and the signs of the hypothesized relationships previously discussed were included as follows:

$$\begin{aligned} \text{Log } PCC_i = {} & \text{Log}\beta_1 - a \text{ Log } WB_{1i} + b\text{Log } PCI_{2i} - \\ & c\text{Log } PM_{3i} + \text{Log } u_i \end{aligned} \tag{3}$$

The advantages of employing a logarithmic model are twofold: first, the multiplicative model may be transformed into a simple linear, additive one, and second, the logarithmic parameters provide direct estimates of the elasticities of the independent variables incorporated in the equation.

A multiple regression analysis performed on equation (3) yielded the estimates (elasticities) with standard errors given in parentheses.

$$\begin{aligned} \text{Log } PCC_i = \text{Log } 3.231 & + \underset{(0.093)}{0.031} \text{ Log } WB_{1i} + \underset{(0.324)}{0.143} \text{ Log } PCI_{2i} \\ & + \underset{(0.029)}{0.026} \text{ Log } PM_{3i} \end{aligned} \tag{4}$$

$$F = 0.513$$

$$R^2 = 0.009, \bar{R}^2 = 0.009$$

Examination of these results clearly indicates that the demand for water in residential New York State is neither price sensitive nor income elastic. Consequently, attempts aimed at regulating or conserving water supplies within this region probably would be served better by policies other than those relying upon price controls. Indeed, all three of the independent variables employed in this empirical study are of inconsequential importance in determining water demand, as the F - ratios and coefficients of multiple determination attest. For example, per capita income, although it responds in the direction hypothesized, is not statistically significant in its role as a determinant of water demand. Similarly, the percent of metered households exerts no pronounced influence upon water consumption levels and behaves in an opposite direction to that expected to be the case. Alternatively expressed, the amount of water that rural New Yorkers demand and consume evidently is not determined by any of the orthodox factors considered in this study.

CONCLUSIONS

The results obtained in this study should be interpreted with some caution because they are essentially contrary to the empirical evidence provided by other authors working in different regions. Several conditions might account for the present findings supporting the absence of a relationship (elastic or inelastic) between the demand for water and its price. First, after refinement of data availability and/or the inclusion of additional explanatory variables, it is possible that subsequent regression analyses may render a significant structural relationship between quantity demanded and the price of water. Second, the inhabitants of smaller communities may respond differently to water price changes than do those residing within larger urban complexes. In the case of New York City, for example, a large proportion of the area is not metered and there are indications that gross leakages occur in the water systems. Given these findings it could reasonably be construed that the results obtained from investigations in New York City are inappropriate even for purposes of comparison with other major urban areas, not to mention comparison between the city itself and essentially rural districts.

A third problem in modeling water demand is the need for adequate variability in the price data so that a meaningful regression analysis may be run. Although there is some variability in water prices the amount involved may often be too small to encourage formal examination. In the current study it is possible that the degree of dispersion in water prices was too restricted to induce appropriate responses on the part of the consumer. Water demand may indeed be price elastic, but not at the present artificially low rates. A further problem to be considered is of an economic-statistical nature: namely, one could be faced with difficulties arising from the influence of seemingly unrelated regression equations and/or a simultaneous equations bias. Under these circumstances the OLS estimates do not possess their full set of desirable properties.

Finally, in view of the fact that other studies have generally revealed a significant association between the price of water and the demand for its use, a special case for New York could perhaps be proposed since no strong structural relationship has so far been recorded in any part of the state. Thus, for example, Callegari, et al. (1976) demonstrated the absence of influential price elasticities for the New York Metropolitan Area, while the present endeavor has indicated a lack of importance for both price and income elasticities for essentially rural areas of the state. Needless to say, however, there are quite pronounced regional differences in water consumption patterns. For instance, it could reasonably be expected that due to climatic considerations, the residential demand for water in small Nebraska communities may well exhibit significant price and income elasticities. These significant elasticities could, for example, be induced as a result of a heavier emphasis on summer sprinkling requirements. On the other hand, it should be acknowledged that within a Nebraska context, the proportion of water that could possibly be conserved as a result of appropriate pricing policies on residential demand is likely to be negligible in comparison with agricultural water demand. Indeed, it is suggested here that a study of the price and income sensitivity of Nebraska agribusiness water demand could perhaps be beneficial to the state. Finally, however, it should be borne in mind that (marginal cost) pricing policies designed to conserve water utilized in the agribusiness sector will likely encounter substantial legal and political obstacles.

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