Utility Performance and Consumer Willingness to Pay for Water in the early 1990s: Case Study of Trinidad

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Abstract

Throughout the developing world there are numerous examples of high levels of Government spending on water infrastructure while maintaining low tariffs and subsidies. The supply-focus approach has proven to be wasteful. A strong case is advanced for a demand-oriented approach, which emphasizes expenditure in relation to demand, and the adoption of demand management techniques such as pricing.

It is difficult to ignore daily problems in obtaining water for domestic purposes when there is a threat to public health and economic productivity. Given the undisputed importance of water, this paper attempts to examine the major problems of water supply in urban Trinidad and to analyse factors determining

consumer willingness to pay for service improvements in the early 1990s. The willingness to pay model for water supply showed that domestic consumers' willingness to pay more for an improved service was influenced by household income, the price of water, number of service hours, and housing and land tenure.[1]

Keywords: Water demand; Willingness to pay; Cost recovery; Contingent valuation; Contingent ranking; Stated preference; Household production function; Revealed reference

Background

Trinidad, with a population of 1.28 million people, is an oil rich country that enjoyed a spurt of growth in the 1970s. This followed the fortuitous quadrupling of world oil prices created by the energy crisis stemming from the decision of the Organisation of Petroleum Exporting Countries in 1973 to limit supply in order to raise oil prices. In 1982, per capita gross national product was US$6,600, but by 1994 it had declined by almost half (US$3,700) following a global economic recession starting around the mid-1980s. At the end of the 1990s, unemployment was in the region of 20% to 25% and absolute poverty about 18% to 20%. Although capital investments and water production levels increased during the years of economic prosperity and there was almost universal access to potable water [1], less than half the population in the 1990s had a housetap

[1] This paper draws from the author's Ph.D. thesis on Water Provision Improvements: A Case Study of Trinidad completed in 1995. When the survey for this research was conducted in 1993 the Government had not yet taken steps to introduce a semi-private management team and to award a contract to the English water company known as Severn Trent International, with the aim of assisting the water and sewerage authority in improving its service.

service and less than fifty percent of all consumers had a full day's supply. Internationally, reservations that people simply could not afford to pay for water were countered by arguments that in spite of disturbing statistics on global poverty [2, 3], millions of people in developing countries were already paying a high price for often sub-standard water services [4]. Improved services meant that in many cases people would pay less than they were then paying, and would receive a more effective service [2, 5, 6, 7, 8, 9, 10, 11, 12]. The question was whether Trinidad's consumers were willing to pay more for an improved water service. Trinidad's Water and Sewerage Authority (WASA) was in a crisis by the 1990s and consumers were suffering from its failure to provide a reliable supply of water. The following section examines the financing and management crisis of the early 1990s prior to the initiatives of the semi-private management team called the Institutional Strengthening Team and the water company known as Severn Trent International.

Financing and Management Crisis

Among the lessons learnt worldwide, failure to maintain investments in water infrastructure leads to unaccounted-for-water (UFW); the difference between the volume delivered to a supply system and the volume of water accounted for by legitimate consumption. While the extent of leakage in Trinidad cannot be accurately measured in the absence of universal metering, the Japan International Cooperation Agency [13] estimated that 50% of the water produced

was lost.[2] High levels of UFW along with malfunctioning booster pumps significantly impacted on the reliability of water services. As only 45% of WASA's customers received a 24-hour supply, unreliability was widespread to the extent that almost three-quarters of domestic users had constructed private water storage facilities.

Although legislative provisions permited WASA to recover operating, maintenance and certain capital costs the agency was unwilling to pursue policies in this strategic direction. Instead, Government's paternalistic policies failed in encouraging WASA to improve revenue generation or control expenditure. The residual effect was an entrenched perception of water as a free good that left the agency virtually bankrupt in the 1990s.

An antiquated system of water charges, WASA's inability to get rate adjustments and high amounts of uncollected arrears provide some explanation of WASA's revenue deficiencies in the 1990s. Water rates are a small percentage of the Annual Rateable Value (ARV); the assessed market rental value of buildings and land. In effect, water charges are not based on actual consumption (volumetric charges), but on a proxy measure, whereby the value of the property is used as a barometer of income and potential household water consumption. As

[2] Yepes [14] found that the average UFW for the more efficient Latin American companies was 34%, European companies 22%, the USA 13% and Canada 12%. System losses in the Caribbean can be quite high with figures ranging from 50-70% for Jamaica to as low as 25% in the Bahamas and St. Kitts and Nevis.

a pricing mechanism, the ARV does not generate maximum revenue to meet costs of services and is ineffective in rationing consumption patterns.

Infrequent rate adjustments also contributed significantly to a deterioration in WASA's revenue position. Up to 1995, non-metered domestic consumers, who were in the majority, had only two water rate increases in 60 years; one in 1985, and another in 1994. Political interference [15] and inordinate delays in processing rate increase applications were the main reasons for infrequent price changes. Additionally, the utility's revenue lagged behind income growth and increases in the general price level. Investigations revealed that inflation made assessment rolls obsolete, especially since there was a long time lag before new buildings were added to the roll, which was further compounded by understaffing in the Valuation Division and inefficiently updated assessment data using unskilled labour.

WASA allowed arrears for up to 3 months that also helped create the perception that water was not an economic good and should be provided free of charge. The utility's unwillingness to crack down on delinquent customers was explained by the high costs of disconnection it had to incur. However, a passive disconnection policy lessened the fear of sanctions for non-payment or delayed payments.

Apart from low revenue collection, WASA's financial predicament was also linked to its pattern of capital and recurrent expenditure. Usually, fixed assets are financed by Government grants and contributions from other agencies, but WASA engaged in the practice of dipping into these funds allocated for capital expenditure to meet daily cash requirements because it was cash strapped. This led to an erosion of its asset base, unreliable service and public outcry over water shortages.

The practice of price subsidization, aimed at encouraging industrial growth and meeting basic human needs meant that production costs were not covered by rates. In 1993, the estimated cost of producing a cubic metre of water was TT$2.45 but all categories of users paid between TT$0.17 and TT$2.06 per cubic metre. The lesson learnt by service providers all over the world is that low tariffs are insufficient to offset operating costs, provide funding for routine maintenance, upgrade the system, expand the services into new areas, and discourage waste by users. Drastically reduced expenditure on operation and maintenance of plant equipment, partly prompted by the fact that asset maintenance lacked the political glamour associated with the development of new water works, left WASA's assets in a state of disrepair. Consistent neglect of operation and maintenance forced WASA in 1994 to seek emergency funding from the World Bank for system rehabilitation.

Another feature of WASA's operations was the high percentage of expenditure on human resources. Personnel costs made up close to 50% of total operating expenses. In 1994, the ratio of staff per 1000 water connections was 16 to 18; 2 to 3 times higher than the ratio found in well-run utilities. High personnel costs along with low productivity made it impossible to improve water services when only half the total operating budget was available for system maintenance. [3]

Policymakers have contended that WASA's financial crisis could not be easily offset by a price increase. To demystify whether WASA could not implement a rate hike, research was conducted on consumers' willingness to pay, the details of which are presented below.

Research Design

Economic theory suggests that an individual's demand for a product is a function of the price of the product, price of substitutes and complementary products, and the individual's income and tastes. Accordingly, the research objectives were to determine from the demand-side: (1) whether households were willing to pay (wtp) for water service improvements; (2) how much they were wtp; (3) the variables that explain the consumer's wtp for improvements in water reliability, pressure and quality; and (4) the preferences of urban households

[3] In England, France, Germany and Spain the ratio of personnel costs to operating costs was under 30% [13].

regarding the management of water delivery. An additional objective was to test and validate the contingent valuation method as a potential tool for planners and water agencies in order to improve their decision-making on appropriate levels of service, cost recovery policies, and water pricing.

In 1993, a survey was conducted in the most urbanized zone of Trinidad known as the Capital Region, which is a linear concentration of settlements stretching from west to east of Port-of Spain. Census data for 1990 showed that 41% (455,035 persons) of the population lived in the Capital Region. This region formed a large cluster that was further divided into six smaller clusters of settlements from west to east. The aim of cluster sampling was to select clusters that were as heterogeneous as possible, and small enough to reduce travel costs.

Enumeration District maps of each settlement were used as the sampling frame for selecting the strata of households in each area. The survey used a sample size of 360 households because of limited time and high costs of hiring interviewers to conduct face-to-face interviews. Stratified sampling was used to improve the efficiency of the sampling design. Slope, elevation and income characteristics were the criteria for stratification. These characteristics are non-collinear because both rich and poor urban households live in sloping, highly elevated areas. Further, slope and land elevation were selected to differentiate settlements since such factors were expected to impact on water pressure and reliability. Proportional stratified sampling

was also selected to ensure that the sample was representative. The sampling fraction for each stratum was equal to one in every four houses.

Methodologies

Unlike previous work that focused on the use of one technique, this research used a combined methodology of direct surveys (contingent valuation and contingent ranking) and an indirect survey (revealed preference) to determine household willingness to pay (wtp) for improvements. The contingent valuation method asked respondents to place a value on a set of possible improvements in the water service. The description of the hypothetical choice included a presentation of all relevant characteristics of a piped service (reliability, pressure and quality) and the prices under which the service should be available. Respondents were shown a payment card of the prices charged by WASA to domestic users on a quarterly basis, and were instructed to use these in guiding their responses. They were informed it was not necessary to choose any of the amounts shown on the card, but to indicate the maximum amount they were wtp per month for the increment of improved supply.

Since the respondents were unable to attach a monetary value to the various parameters of water supply for example reliability, pressure and quality, the contingent ranking method asked them to rank these parameters in the order of priority, contingent upon those aspects of improvement for which they were wtp the most. Additionally, the household production function was used. The household

production function posits that consumers purchase marketed goods that are combined with household inputs, to produce the goods and services that ultimately generate household utility. The willingness to pay for improved water supply may therefore be estimated using the observed production activity/behaviour of consumers. To assist in extrapolating investment amounts respondents were asked whether they installed water tanks, how many were installed, the storage capacity of the tanks, and the amount invested on the storage tanks to determine how much they were wtp for reliability. They were also asked if they had water filters or boiled water for drinking and cooking to determine how much they were wtp for improved water quality.

The field research used the in-person survey method for it offered a number of advantages:

a) It allowed the use of the visual aid of the payment card;

b) It gave the interviewer the opportunity to explain the questionnaire;

c) It also allowed close control over the pace and sequence of the interview; and

d) It allowed the interviewer to probe unclear answers and provide observational data, which were useful since the survey employed observed behaviour as well as verbal responses.

Statistical Analysis of Willingness to Pay Data

The model tested assumed that a household's willingness to pay for an improved water supply depends on:

(a) Characteristics of the water supply system such as the existing levels of service and sources of supply;

(b) Price currently charged for water;

(c) Perceptions of water problems (reliability, pressure and quality);

(d) Price of other goods and services;

(e) Household socio-economic characteristics (gender, age, household size, education, occupation, income, assets and expenditures);

(f) Housing characteristics;

(g) Household water consumption patterns; and

(h) Attitudes of the household which may serve as proxies for taste [16].

This implies that an individual's willingness to pay for an improvement in water services will be a function of the proposed change in the attributes of the service, and of all other factors which influence the individual's valuation of that change.

A correlation analysis was carried out for all variables in order to identify the key variables with relatively strong inter-dependencies. This provides some insights into how each variable impacts on willingness to pay (dependent

variable) but, more importantly, intercorrelations between the independent variables themselves can substantially affect the results of multiple regression analysis so these correlations must be noted and accounted for. Pearson correlation coefficients for some of the most closely related variables are given in Table 1.1. For example, income is highly interdependent with the age and education of the respondent, household size, and number of water tanks owned. The Pearson correlation coefficient between income and these variables is equal to or greater than 0.85 and the significance probability of the correlation under the null hypothesis that the correlation is zero is 0.0001 to 0.0003. The number of water tanks and hours of water service were also highly correlated.

Table 1.1

Summary of Pearson's Correlation Coefficient

for Highly Interdependent Variables

Variables Highly Interdependent Variables	**Pearson's Correlation Coefficient**	**Probability>R Under HO: RHO=0**
Age of Respondent and Income	0.88	0.0001
Education of Respondent and Income	0.85	0.0001
Household Size and Income	0.86	0.0003
Number of Tanks and Income	0.88	0.0001
Number of Tanks and Hours of Service	0.85	0.0001

A reduced data-set for multiple regression analysis was formed from the total set of all variables by using the interdependencies to exclude all but one variable of any group of highly correlated variables. Further, variable selection was obtained by using the "forward selection" technique to identify a subgroup of the reduced set of variables that are good predictors for willingness to pay.

Table 1.2 contains information on the explanatory variables actually included in the model. The regression model is given by the equation:

Willingness to Pay=24.9+2.51 Income+0.34 Current Price+6.65 Hours of Service+5.26 Housing and Land Tenure.

Table 1.2
Summary of Regression Model for Household Willingness to Pay

Dependent Variable: Willingness to Pay

Independent Variables	Parameter Estimates	T for HO: Parameter=0	Pr>T
Intercept	24.9	4.59	0.0001
Household Income	2.51	4.65	0.0001
Price currently paid for water	0.34	4.57	0.0001
No. of Hours of Water	6.65	2.49	0.0003
House and Land Ownership	5.26	2.16	0.2724
Expenditure on Electricity	-0.0	-0.05	0.9634
Expenditure on Telephones	0.03	0.73	0.4673
Summary of Statistics Number of Observations 360 Mean of the dependent variable $67 Percentage predicted correctly 27%			

NB* Parameter estimate gives the intercept estimate and regression coefficients for each independent variable.

T for HO: Parameter=0 means the t value for testing the null hypothesis that the parameter equals zero.
PR>T is the probability of getting a larger value of T
T values at 0.5000 significance level.

Results

The results show that willingness to pay is related to the socio-economic characteristics of the household and the respondent in ways suggested by consumer demand theory. Four explanatory variables with consistently significant effects on willingness to pay have clear economic interpretations: *household income, the price of water, number of hours of service (reliability problems), and housing and land tenure. The main findings of the research were:*

a) For every TT$1000 rise in household income, there is a willingness to pay an average of TT$2.51 per month more in water rates for service improvements;
b) Willingness to pay is influenced by whether households are paying water rates and the price they are being charged. For every additional TT$1.00 households currently pay, households are inclined to pay TT$0.34 for a better supply;
c) Water problems affected the household's willingness to pay for improvements. With every extra hour of reliable service that a household is currently enjoying, the monthly amount that it is willing to pay for an improved service is increased by a mean value of TT$6.65 per month; and

d) Homeowners and landowners were willing to pay a base value per month of TT$5.26 more than tenants and squatters.

The regression (R^2) value for the model was 0.2684. Although the R^2 value indicates that much (73%) of the variation in willingness to pay cannot be explained by the model, this value is high for data from contingent valuation surveys and compares favourably with the results of contingent valuation studies carried out in the US, Western Europe, Ghana, Haiti and Pakistan.[4] Mitchell and Carson [17] suggest that the reliability of a contingent valuation study which fails to show an R^2 of at least 0.15, using only a few key variables is acceptable. The survey results were in agreement with Mitchell and Carson's suggested standard.

To enhance the reliability of results from contingent valuation surveys a median value was also used. Differences in these median values for households with different socio-economic characteristics are examined in order to identify possible key areas where policy changes might lead to improvements in the system that are most valued by the population studied.

The majority of households (80%) in the survey were wtp twice the amount they were currently charged for a better service delivery. These households paid a median value of TT$31 per month and were wtp a monthly fee

4 Whittington *et al*.[18] had similar results for their survey of household demand for improved sanitation services in Kumasi, Ghana, with values ranging from 0.32 for sewer to 0.47 for water. Altaf and Hughes [19]) in their study of willingness to pay for improved sanitation in Ouagadougou, Burkina Faso had a value of 0.35 for water.

of TT$67, which represented a dramatic change in attitude to wtp for service improvements since 1985, when a survey conducted by the Public Utilities Commission concluded that more than half of Trinidad's residential consumers were unwilling to pay higher rates. Table 1.3 shows that those households wtp more, were currently spending on average TT$40 per month and were wtp TT$83 per month, those receiving free water were willing to spend TT$50 per month, while consumers paying the most for the service were wtp half the amount they were charged.

Table 1.3

Amount Currently Paid and WTP for Water Improvements

	%Respondents	Median CP	Median WTP	WTP-CP Difference
WTP>CP				
Where CP=0	21	0	$50	+$50
Where CP>0	60	$40	$83	+$43
WTP=CP	11	$41	$41	0
WTP<CP	8	$55	$28	-$27

* WTP is Willingness to Pay; CP is Price Currently Paid

Willingness to pay also varied depending on the level of service to which users have access. The median amount house tap consumers were wtp per month was TT$69, standpipe users TT$55 and yard tap users TT$53. However, as a

percentage of the amount currently paid, standpipe users were willing to pay 588% more for an improved service, yard tap users 212% and house tap users 77%. The percentage difference in willingness to pay between standpipe users and the rest may reflect a strategic response; an effort to influence WASA to provide a house tap service in their area. In addition, standpipe users were wtp more for an improvement in water delivery because of *costs, inconvenience and time lost,* including travel time, queue time and fill time especially since they were spending an hour or more collecting water.

Wtp for service improvements is also influenced by the characteristics of the water service (regularity of supply, pressure and quality) confirmed by all three methods of investigation; the contingent valuation, contingent ranking and the household production function. Reliability, which is defined as the number of hours of service in a day, undoubtedly influences wtp among house tap users, particularly since it is the major problem encountered. The contingent valuation results showed that WASA's unresponsiveness to user demand for reliability has influenced investment decisions in the private augmentation of the public water system. There is clear evidence that investments have been made in small-scale infrastructure such as water tanks and pumps, yet respondents are wtp more for a better supply. One possible explanation is that water storage tanks cannot be filled when there is an interrupted supply. Consequently, households still suffer from water shortages and are prepared to pay more if this would result in an improved service. This is consistent with consumer demand theory in that if few alternative

sources of water supply exist, households are wtp more for the publicly provided piped water, although the case study of Gujranwala (Pakistan) yielded different results [20] in that households were wtp 50% less than the price they were currently paying because they were unconvinced of relief from private expenditures on supplementary devices, if they agreed to a higher tariff on the promise of an improved water supply. This reaction was understandable because private wells were an alternative supply to the public water system. A second reason that Trinidad households are wtp more despite high capital outlays including higher electricity and water treatment costs, is the loss of time caused by unreliability.

Tests were run using contingent ranking to ensure that the results on reliability and wtp were consistent. These tests also confirmed Briscoe, Ferranti and Whittington et al [9, 16] research that households valued reliability highly and were wtp more for this. Additionally, use was made of the household production function (revealed preference) which observed how much households actually spent to offset water problems, as private expenditures incurred in mitigating water problems is indicative of the actual consumer's wtp for a reliable water supply. The field evidence revealed that households have privately replicated a water storage and distribution system illustrated by seventy five percent (75%) of the respondents in the survey that purchased and installed tanks and water pumps. Households in the survey were in effect joint consumers and producers.

Tanks varied in size from 100 gallons to 2500 gallons, but the most popular tank size was 420 gallons. On average, the capital cost of a 420 gallon water tank and pump is TT$4,343 and the maintenance cost is approximately TT$368 per annum which covers changing of filters, servicing of pumps and tank cleaning. Assuming that the economic life of this tank is 10 years and 10% interest rate, capital and maintenance costs would be TT$66.86 per month which is equal to the median amount of TT$67 per month households are willing to pay for an improved service. The household production function, which used actual expenditure/consumer behaviour confirmed that the amount customers were actually spending to offset water problems was TT$66.86 per month based upon the above assumptions.

It was not unusual to find that housing and land tenure also influence wtp. The survey found that permanency of housing tenure influences willingness to spend more on water improvements. Landowners were willing to pay more than households were renting properties, leasing or squatting on land. Most landowners indicated that they would pay TT$75 per month, whereas the majority of households with impermanent tenurial arrangements were wtp TT$25-$35.

As expected, the level of satisfaction with the water service influences wtp. Respondents dissatisfied with the water supply were wtp 25% to 38% more than those who were either very satisfied or satisfied. Dissatisfied residents

questioned WASA's request for a rate increase, arguing that rate paying consumers affected by water shortages were still paying private trucks for water delivery.

Conclusion

Increased capital expenditure by the Water and Sewerage Authority brought little relief to interruptions in water supply suffered by households. Part of the problem was the result of a policy of price subsidisation extended to domestic users, which had the effect of limiting the revenue-earning and cost recovery potential of the agency and its ability to undertake on-going plant maintenance. It has been argued that the Government was hesitant to approve rate increases because of anticipated public resistance and the impact on the cost of living.

The combined methodologies of contingent valuation, contingent ranking and household production function, confirmed that consumers were willing to pay more for an improved water supply, particularly reliability. Both the stated preference (contingent valuation) and the revealed preference (household production function) were the same amount. Households stated they were willing to pay TT$67 per month for a better service and the amount households were actually spending for reliability by way of investing in water tanks and pumps was a monthly sum of TT$66.86.

Further, the willingness to pay model for water supply in Trinidad showed that domestic consumers' willingness to pay more for an improved service was influenced by household income, the price of water, number of service hours, and housing and land tenure. These findings are consistent with consumer demand theory.

In the final analysis, the results of the Trinidad case study indicate that although the potential for cost recovery and revenue generation exists, a new paradigm in water provision is needed; one which essentially advances policies that are demand-driven rather than supply oriented. It is necessary to work simultaneously at all aspects of water service provision: to introduce measures that improve production efficiency, including those that improve the institutional framework, and incentive system for managers, and gradually to implement a pricing system which provides a reasonable balance of efficiency, equity, financial and administrative feasibility, and political acceptability. Such intervention is not easy for it is not always possible to know the most desirable trade-offs. It may entail difficult matters of judgement. Even when these steps are taken, implementing the "right" decisions may be painful and call for political will of a high order.

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