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Estimating the Budgetary Impact of Higher Willingness to Pay for Residential Water Using CVM: A Case Study of Mauritius

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Abstract: The paper attempts to ascertain the feasibility of reducing potable water deficits by charging residential consumers higher prices. The Contingent Valuation Method (CVM) is used to find out whether an upward revision of residential water tariffs would be compatible with consumer preferences and hence also politically feasible. Survey techniques using dichotomous choice format questions have been employed to elicit respondents' willingness to pay (WTP) for improved water services. The bid variable is found to be statistically significant in both the bivariate and multivariate logit models. Moreover, mean and median WTP estimates generated from these models are found to be much higher than what would be required by the first best standard (long run marginal cost) and the second best (average cost).

Key words: Public utility budgets, marginal cost pricing, contingent valuation methodology, Mauritius.

Introduction

In the literature, water prices based on long run marginal cost (LRMC) and average cost (AC) are treated as efficiency prices; price equal to LRMC as first best and price equal to AC as second best (Saunders, Warford and Mann, 1977). It is observed in Mauritius that potable water to domestic consumers is under-priced both by the first best and the second best standards, while potable water prices to other user categories, namely industry and business, and the government typically exceed efficiency levels (Madhoo, 2001). Thus, there is evidence of cross-subsidisation; non-residential sectors subsidise residential sector. However, cross-subsidisation is not to the extent that water utility breaks even, resulting in deficits in water budgets. Therefore, subsidised residential pricing policy has contributed overwhelmingly to overall budgetary deficits of water utility. The concern of this paper is to construct the first best and second best efficiency prices of water and work out the feasibility of their application in the light of consumers' willingness to pay.

The paper is organised as follows: At the start of discussion, we examine the trends in total budgetary deficits, using average cost and marginal cost approaches. We also highlight the trends in the pricing policy of residential water, having impact upon overall budgetary deficits. The next section starts with a presentation of the contingent valuation methodology (CVM) with a view to eliciting WTP of residential water consumers. The section then reviews the empirical findings with respect to WTP and CVM and discusses issues pertaining to design of the questionnaire and practice of CVM. In the penultimate section, we compare WTP with first best (long run marginal cost), second best (average cost) and current CWA prices and calculate the budgetary impact of upward residential price revision. The last section concludes the analysis with policy implications.

Budgetary Deficits under Average Cost Recovery and Marginal Cost Pricing

Charges based on long run marginal costs (LRMC) would be lower than those based on average costs (AC) when water industry is subject to increasing returns to scale. Deficits due to LRMC pricing would help to justify a part of budgetary deficits, which stem from lack of average cost recovery. While it is easy to compute average cost of production, we need to generate estimates of LRMC, which is more hypothetical in nature. In order to measure LRMC, we specify the following AC function by integrating the learning effect (see Berndt, 1991):

$$\ln AC = \ln k' + \varphi_1 \ln n + \varphi_2 \ln y + u \qquad (1)$$

where $\varphi_1 = (\alpha_c/r)$ and $\varphi_2 = (1 - r)/r$.

In Equation (1), r is the returns to scale parameter, k' is a technological coefficient, y is output level and n refers to cumulative volume of water. $r > = < 1$ indicates increasing, constant and decreasing returns to scale respectively. j_1 is learning effect on average cost and j_2 is returns to scale effect on average cost. LRMC is calculated as follows:

$$LRMC = AC + \varphi_2 AC \qquad (2)$$

To obtain φ_2, Equation (1) is estimated. Cost and water variables are taken from Annual Reports of CWA. Total amount of water produced in a given year is computed as the output per day from the Port-Louis, Mare Aux Vacoas and District water supply systems multiplied by the number of days in the year. Average cost is computed as total cost divided by amount produced. The cost figure is deflated using the GDP deflator, with 1987 as base year. Stationarity test results (reported in the Appendix) reveal that all variables in log form are integrated of order one. In other words, our data would become stationary after first differencing. Further, the results from Johansen's test for cointegration (not reported) provide no evidence for the existence of a cointegrating vector between average costs, cumulative output and current year's output. Lack of cointegration does not allow to undertake error correction modelling approach. Given the limited number of observations, Equation (1) is estimated using Ordinary Least Squares (OLS) technique with non-stationary data for the period 1975-1997. The regression results are displayed below:

$$\ln AC = 2.5300 + 0.2806 \ln n - 0.5144 \ln y$$

t-ratios (1.2625) (6.5148)*** (-2.3550)**

R-Bar Squared = 0.86 DW = 1.39 F-Stat = 66.98***

n: cumulative output; y: output in the current year; DW: Durbin Watson statistic

***, **, * denote significance at the 1%, 5% and 10% respectively.

All the variables in the above equation are generally statistically significant at the 1 % level and the functional form is found to be correct based on the Ramsey's test. Since the coefficient on 'y' is negative and significantly greater than zero, we can reject the possibility of constant returns to scale and accept the alternative hypothesis of increasing returns in the long run. We thus conclude that the water industry has natural monopoly characteristics. Moreover, the elasticity with respect to cumulative output is positive and statistically significant thereby indicating a positive learning effect on production. φ_2 is estimated at –0.5144, which is used to compute LRMC.

Table 1: Analysis of potable water deficits under average and marginal cost pricing (Rs million)

Year	*TC*	*LRTMC*	*TR*	*(TR–TC) /TR (percent)*	*(TR–LRTMC)/TR (percent)*
1980	70.27	55.16	74.75	5.99	26.21
1981	81.75	62.37	89.94	9.11	30.65
1982	101.38	75.28	91.24	–11.11	17.49
1983	113.60	86.78	113.50	–0.09	23.54
1984	136.80	104.45	123.74	–10.55	15.59
1985	156.47	120.74	155.99	–0.31	22.60
1986	160.69	131.96	173.37	7.31	23.89
1987	162.98	145.05	176.48	7.65	17.81
1988	215.48	194.57	181.30	–18.85	–7.32
1989	225.65	200.97	208.50	–8.23	3.61
1990	248.41	214.52	209.39	–18.64	–2.45
1991	303.64	265.49	212.47	–42.91	–24.95
1992	373.73	328.80	230.21	–62.34	–42.83
1993	442.36	368.01	296.01	–49.44	–24.32
1994	440.18	364.18	332.16	–32.52	–9.64
1995	440.40	362.81	340.52	–29.33	–6.55
1996	503.30	414.27	358.81	–40.27	–15.46
1997	528.91	439.21	367.69	–43.85	–19.45

Source: Computed. TC: total cost; LRTMC: long run total marginal cost; TR: total revenue.

Table 1 reports computed deficits on the basis of difference between total revenue (TR) and total cost (TC) to show deficits for the period 1980-1997 under average cost pricing (column 5). More specifically, the percentage difference between long run total marginal cost (LRTMC) and TR is presented to portray the trends in budgetary deficits based on LRMC pricing (column 6). With a few exceptions and minor fluctuations, deficits, based on average cost pricing, jumped more particularly after 1990, amounting to more than 40 percent in 1997.

If however deficits are computed using marginal cost pricing, there were surpluses during 1980-1987, ranging between 17 and 30 percent. In other words, the water utility was able to charge more than marginal cost prices. But such budgetary surpluses were not sustained; these surpluses were later converted into deficits varying between 6 and 43 percent. Thus, whereas water deficits under marginal cost pricing is lower than under average cost pricing when the industry is subject to with increasing returns to scale, water prices have not been able to collect efficiency prices in terms of long run marginal costs. The above trends in the budgetary management of water utility would have particular implication for the residential water sector, which is highly subsidised. To improve the financial viability of the utility, upward revisions of water tariffs for this sector are warranted. Any politically feasible policy change would require information on residential water users' willingness to pay higher water tariffs.

Estimating Willingness to Pay for Residential Water

Implementation of Contingent Valuation Methodology

The present paper employs a direct method of placing monetary values on non-marketed goods and is known as contingent valuation methodology (CVM). CVM is also referred to as a 'stated preference' method, because it asks people to directly state their values, rather than inferring values from actual choices, as the 'revealed preference' methods do. CVM has been used extensively in the water literature, more particularly in rural areas of developing countries in order to determine WTP for improved services or better water quality (see Griffin et al., 1995 for some interesting results).

The objective of this CVM exercise is to elicit WTP for residential water services in order to explore the feasibility of an increase in prices to efficiency levels. The public sample has been obtained using face-to-face interviews. Stratified random sampling technique has been used. A sample of 226 households, located in both rural and urban areas (in the approximate proportion of 60:40), was studied in order to be representative of the Mauritian population. The questionnaire underwent pre-testing by a group of thirty-five randomly selected individuals and pilot testing of several versions of the questionnaire. During the pre-testing exercise, it was discovered that water users did not want to pay higher charges for the existing water services. It was therefore decided to ask WTP for improved water services defined in terms of better quality of water and better services including reduced service interruptions, satisfactory water pressure and faster repairs and maintenance of the system. Since piped water is a familiar good, respondents largely comprehended the scenario. Information was obtained using open-ended questions on the maximum willingness to pay (MWTP) for improved water services to decide on the range of bid amounts to be asked in the final questionnaire.

Moreover, respondents preferred to pay for improvement in water services as a surcharge or premium upon their water bill rather than be taxed indirectly. The pilot survey also established that the presence of alternatives to piped water, such as bottled water and proximity of residence to water sources like rivers or water canals could influence respondents' WTP decisions. These aspects have been incorporated in the final layout of the questionnaire, which also elicits information on household heads' WTP for water services as well as other socioeconomic characteristics, including age, gender, education level, household size and income category.

Average revenue from households in 1997 was around Rs 4.22 per m^3 of water. Long run marginal cost or first best pricing, however, would have required setting price to Rs 5.60 per m^3 for domestic users, while average cost or second best pricing advocates a price of Rs 6.25 per m^3 in current terms. We want to know whether long run marginal cost pricing is compatible with individual preferences. Bid amounts in this exercise were assumed to include the premium paid for improving water services and varied from Rs 6.00 to Rs 12 per m^3. It is reasonable to expect that marginal costs of production would be around Rs 6.00 per m^3 in year 2001 and average cost would be exceeding Rs 6.25 per m^3.

The survey was conducted at the end of year 2000 and beginning of 2001. 226 households were interviewed and a highly satisfactory response rate of over 90% was obtained. Four households stated they had 'no opinion' and two resented the fact that they had to pay anything for water. Further, five protest responses were obtained from households who were against some aspect of the presented scenario. More specifically, some would not understand the hypothetical nature of the exercise and expressed concern as to whether the providing body would really implement the changes and some were generally against any government programme. These protest responses represent a rejection of the basic premise of a simulated market and were not retained.

Data Generated by Survey

Table 2 presents summary statistics on the socio-economic and demographic characteristics of the respondents that have been collected in the survey and used in the regressions models to obtain estimates of WTP. Since respondents are generally reluctant to reveal their income levels, they have been asked to which income bracket they belong. We distinguish between eight income groups. Income for each respondent is then assumed to correspond to the average within each income bracket. Mean income level in our sample is Rs 7,860 and is quite representative in the Mauritian context. The education variable is scalar with the lowest grade assigned to respondents having primary education as maximum educational attainment. The mean of our sample is 1.9, indicating that most respondents have studied till the secondary level.

Table 2: Variables used in the regressions, definitions and mean values

Variable	*Definition*	*Mean Value*
INCOME	Income of household head interviewed (The income level is taken as the average of the income range to which the respondent belongs, i.e, 0-2000, >2000 –5000, > 5000 – 7500, >7500 – 10000, >10000 – 15000, >15000 – 20000, >20000 – 30000, >30000)	7859.83
ALTERNATIVES	Alternative sources of water	0.3714
URBAN	Respondent lives in urban area (1 = yes, 0 = no)	0.4510
AGE	Age (in years) of respondent	42.8
GENDER	Sex of the respondent (1 = female, 0 = male)	0.3928
EDUC	Respondent's maximum education level (1 = primary, 2 = secondary, 3 = university or equivalent)	1.9714
HHSIZE	Household size	4.3518

Source: Author's computations from survey data

The mean value for the urban variable in the above table is 0.45, which may indicate that the population in our sample is slightly biased towards urban areas. Further, the 'ALT' (alternatives) variable is introduced as a dummy variable with a value of one assigned if the respondent or members of his/her household use other sources of water, such as rivers and lakes. Frequent use of bottled water would also imply that this variable takes a value of one. The mean of 'ALT' is 0.37 indicating that relatively few people use alternative sources of water. Similarly, the mean for the gender variable is 0.39 implying that the majority of respondents interviewed were males. Mean household size in our sample is 4.35, which is slightly higher than the average for the population in Mauritius, that is, 4.1 (Central Statistical Office).

Estimating WTP Using a Logistic Model

The indirect utility function, V, of a respondent can be expressed as:

$$V_i = V_i(p_i, z^i, y, \mathbf{s})$$

where p is the price of water, and z^i is the quality of water services with $i = 1$ when contingent valuation scenario is implemented, that is, improved water services are provided, and $i = 0$ for the status quo. Thus, $z^1 > z^0$ and $p_1 > p_0$. The individual's income in the above specification is denoted by y and $\mathbf{s}$ is an m-dimensional vector of household characteristics and attributes. Let A be the bid amount for improved water services such that $p_1 = p + A$, where $p = p_0$. The scenario contemplated involves measuring $V(p + A, z^1, y, \mathbf{s})$ and comparing it with $V(p, z^0, y, \mathbf{s})$. Converting to money, we see that the utility changes approximately equal to:

$$-x \times A + \mathrm{MWTP}(z^1 - z^0)$$

Thus, if the marginal willingness to pay (MWTP) for the quality improvement is greater than the increase in the cost of water, $x \times A$, the policy is an improvement.

In our exercise, A is varied across the population to econometrically estimate the utility function. It is assumed that A is the price such that the benefits and costs balance at the individual level. A respondent will answer "yes" to a price A if $V(p + A, z^1, y, \mathbf{s}) > V(p, z^0, y, \mathbf{s})$. The dichotomous choice format allows an analyst to statistically trace out a demand relationship between the probability of a "yes" response and the bid amount. The probability statement is expressed as:

$$\Pr(\text{yes}) = \Pr\left[V(p + A, z^1, y, \mathbf{s}) + \varepsilon_1 > V(p, z^0, y, \mathbf{s}) + \varepsilon_0\right]$$

Indirect utility in the above specification is assumed to be the sum of a deterministic component, which comprises arguments important to the contingent valuation scenario and ε, a stochastic component (Haab and McConnell, 2002). Evaluating this using a linear approximation implies that $\Pr(\beta_y y + \boldsymbol{\beta}_s \mathbf{s} - \beta_A A + \Delta z > \varepsilon)$ where $\varepsilon = \varepsilon_1 - \varepsilon_0$ and βs are parameters on the variables (Haab and McConnell, 2002). Since all individuals are faced with the same quality change, we can write:

$\Pr(\text{yes}) = \Pr(\beta_y y + \boldsymbol{\beta}_s \mathbf{s} - \beta A > \varepsilon) = 1 - F_\varepsilon(A)$

An estimable form of the basic relationship is postulated as:

$\Pr(\text{yes})_k = \log[(\text{yes})/(1 - \text{yes})] =$

$$1 - \{1 + e^{[\beta_0 - \beta_1 \overline{X}_1 + \beta_2 \overline{X}_2 + \cdots + \beta_j \overline{X}_j]}\}^{-1} \qquad (3)$$

where $\Pr_k$ is the probability observing a specific outcome of the dependent variable (i.e. the individual would be willing to pay the bid amount for water) given the independent variables X_j's. The βs are the coefficients to be estimated using logit statistical technique. From Equation (3), Hanemann (1989) (see also Loomis, 2000) provides a formula to calculate the expected value of WTP as:

$$\text{Mean WTP} = (1/\beta_1) \times \ln(1 + e^{[\beta_0 - \beta_1 \overline{X}_1 + \beta_2 \overline{X}_2 + \cdots + \beta_j \overline{X}_j]}) \qquad (4)$$

where β_1 is the coefficient on the bid amount variable.

The general model is formulated as follows: Probability (yes to the question) = log [(yes) / (1 – yes)]

$$= a0 + a1\, Y_i + a2\, \text{Gender}_i + a3\, \text{Age}_i + a4\, \text{Hsize}_i + a5\, \text{Educ}_i + a6\, \text{ALT}_i + a7\, \text{Bid}_i + \varepsilon_i \qquad (5)$$

where Y = monthly income of household head; Age = age of household head; Gender = gender of household head interviewed (= 1 if female; = 0 otherwise, i.e. if male); Hsize = household size; Educ = maximum education level (= 1 if primary; = 2 if secondary; = 3 if tertiary or equivalent); Bid = randomly varied water price; ALT = alternative water sources (1 = yes, 0 = no) and ε = error term.

Equation (5) postulates that the probability that an interviewed household head would respond 'yes' to a bid amount, would depend on his/her income, age, sex, household size and education level. As mentioned earlier, the bid amount has been varied across the sample. The a priori sign on its coefficient is negative. Further, theory suggests a positive relation to exist between income and WTP. We also expect the probability of a 'yes' response to be positively correlated with household size. This is because of the increasing block structure of water tariffs where larger households, being also higher volume water users, are already required to pay prices that are typically higher than average. A positive sign on the gender coefficient would indicate that females are more concerned about improved water reliability and would therefore be more willing to pay as compared to their male counterparts.

The impact of education on WTP is an empirical issue. We may expect a positive relation, which would reflect greater awareness of the benefits of improved water quality and therefore higher WTP, as people get more educated. In Mauritius, however, people's awareness concerning water benefits has heightened considerably in the recent years, irrespective of their educational levels, thanks to public campaigns and media. The 'ALT' variable in Equation (5) is a dummy variable, which indicates availability of substitutes for institutional water sources. Respondents were asked whether they frequently purchase bottled water and/or use other water sources, such as surface and underground. The sign on that coefficient is posited to be negative.

Empirical Results and WTP Estimates

Logit models are tested under two specifications, a bivariate model and a multivaritate one. The bivariate model seeks to explain probability of a 'yes' response as a function of the bid amount only while the multivariable model is as postulated in Equation (3). Income of a household in the latter model is taken as the average of the income category to which the individual respondent belongs. Both versions of the logit specifications are tested with survey data on 215 observations. Testing down procedure has been carried out in order to arrive at a more parsimonious specification of the multivariate model. Education, Gender, Location, ALT and Age are found to be statistically insignificant and have therefore been dropped. The best estimation results as well as computed average and mean WTP are presented in Table 3.

Table 3: WTP estimates (2000/01)
Bivariate and multivariate logistic regressions

Variable	*Bivariate model*	*Multivariate model*
Constant	1.687	1.2659
	(2.7307)***	(1.0322)
Bid (Rs/m^3/household)	–0.2234	–0.1988
	(2.2230)**	(–1.955)*
Income		0.0001
		(1.8150)*
Household Size		0.2019
		(1.9326)*
Log likelihood	–91.33	–102.06
Pseudo R^2	0.09	0.14

Source: Author's Computations t-statistics are in parentheses; ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

In both specifications, all coefficients generally are of the predicted sign. Household size, for instance, is statistically significant and has a positive coefficient as expected. Low significance of income variable can be explained by saying that as income increases demand for publicly provided water does not increase. Consumers may like to depend on other sources. This aspect requires more analysis and explanation. The pseudo R^2 in Table 3 indicates that 9% of the variation in responses is explained by bid amount alone (in the bivariate model) whereas the multivariate model explains 14% of the variation.

Budgetary Impact of Residential Price Revisions

A final step in this analysis is to compare WTP estimates generated from our models with the efficiency prices, namely long run marginal cost and average cost. This exercise is carried out using information contained in Table 4. WTP estimates are obtained through the methodology described in this paper. Prices charged by CWA are well below efficiency prices and the WTP estimates obtained from the bivariate and multivariate regression equations. Median and mean WTP are both found to exceed the first best AC prices in 1997.

Table 4: Comparison of WTP estimates with efficiency prices (Domestic users)

	Bivariate model	*Multivariate model*
Median WTP (2000-01)	7.55	7.55
Mean WTP (2000-01)	8.31	8.80
Efficiency Prices (in current Mauritian rupees)		
LRMC (1997)	5.60	5.60
AC (1997)	6.25	6.25
Residential Water Prices charged by CWA (1997)	4.22	4.22

Source: Author's Computations and Madhoo, 2001. LRMC: Long Run Marginal Cost; AC: Average Cost.

The excess of estimated WTP over efficiency prices may be attributed to a premium that households are willing to pay for improved services. These results indicate that a uniform increase in domestic water prices to long run marginal cost or average cost levels would tally with consumer preferences. In order to achieve the objective of equity, it would be necessary to design a system of increasing block charges. One such system in the context of our study would be to have a water tariff structure with three blocks. The minimum block would retain the lifeline water charge currently applicable to low volume water users. As discussed earlier, low-income water users have been found to be the major beneficiaries of the low price applicable to the minimum block (Madhoo, 2005). A unit water price corresponding to WTP estimates may be assigned to the larger second block for use of water above 15 m^3 and below 50 m^3. Finally, a higher price exceeding WTP may be charged to the third block for consumers using very high volume of water exceeding 50 m^3.

The results contained in Table 5 reveal that upward revision of current water tariffs to efficiency levels would reduce the existing budgetary deficits or produce surplus. If, however, revisions are designed in the light of the WTP estimates, substantial budgetary surpluses would be produced. This outcome is expected if water services are improved. In the absence of information on number of users of water under different block structures, we have conducted our study by assuming a uniform efficiency price applicable to all consumer categories. We conjecture, therefore, that any budgetary surplus emanating from our exercise may be slightly reduced under the increasing block scheme proposed. It is, however, instructive to note that since water consumers are willing to pay much higher prices for improved water services, it is possible to revise water tariffs to reach efficiency levels and eliminate deficits for the current quality of water services.

Table 5: Revenue impact of residential price revisions

	TR Domestic Rs Mn	*TR (all) Rs Mn*	*TC Rs Mn*	*Surplus/Deficit Rs Mn*	*Surplus/Deficit Rs/m^3*
Current CWA prices	273.34	358.81	528.91	–170.10	–2.01
Efficiency pricing					
AC (Rs 6.25/m^3)	415.88	528.91	528.91	0.00	0.00
LRMC (Rs 5.60/m^3)	372.62	459.66	528.91	–69.25	–0.82
WTP Estimates					
Median WTP (Rs 7.55/m^3)	502.38	589.41	528.91	60.50	0.72
Mean WTP1 (Rs 8.31/m^3)	552.95	639.98	528.91	111.07	1.31
Mean WTP2 (Rs 8.80/m^3)	585.55	672.58	528.91	143.67	1.70

Source: Author's computations

Conclusions for Water Policy and Management

A CVM exercise is conducted to ascertain willingness to pay higher prices for 'improved' water services in the residential sector. We estimate a logit model to obtain WTP. The data for the model are collected by directly asking people about their preferences. From the estimates, we find that WTP is much higher than what would be required by the first best standard (long run marginal cost) and second best standard (average cost). The objective of this exercise has been to explore the feasibility of an increase in residential water prices; no attempt has been made to estimate benefits accruing from improved water services.

The results show that upward revision of current water tariffs to efficiency levels would reduce the existing budgetary deficits and even produce surplus. In fact, if revisions are designed in the light of our WTP estimates, substantial budgetary surpluses would be produced. Keeping in view the fact that water consumers are willing to pay much higher prices for improved water services, it is possible to revise water tariffs to reach efficiency levels and eliminate budgetary deficits for the current quality of water services.

Revising residential water prices upwards would not conflict with equity goals. It is established in Madhoo (2005) that domestic water pricing policy in Mauritius effectively succeeds in redistributing income to poorer households. The results of this study highlights that water charges based on increasing block rates have increased the burden of richer water consumers due to large minimum consumption blocks, bigger family size of high income households, regional variations in demand and wide coverage of consumers through meters. It is important to note that such a finding challenges the conventional wisdom prevalent in developing and some developed countries (Whittington, 1992, 2003; Boland and Whittington, 2000). Thus, properly designed higher residential water prices would be progressive. The third argument for setting domestic water charges to efficiency level is based on the ground of political economy. A disaggregated analysis according to consumer categories provides weak evidence of political manipulation in the case of potable water prices (Madhoo, 2004). Nevertheless, this study finds some evidence of political manipulation in terms of subsidy allocation to the residential sector, which is the largest consumer category. In the light of these results it can be argued that as long as lower prices are allocated to low income groups, it would be politically feasible to charge higher prices to enhance the scale of cost recovery.

The above analysis demonstrates that residential consumers are generally concerned about improving water services in the island, irrespective of their income levels. This is shown by the low impact of income on willingness to pay and high value of WTP estimates generated. Since higher willingness to pay is contingent upon improvement of water services, the credibility of any water tariff reform would depend on visible improvements.

This may pose a problem to the policymaker. Any attempt to improve public services can usually be addressed in two ways. One way is to reduce X-inefficiency by lowering the cost of production. The other is to increase public expenditure on the service; the belief being that higher level of expenditure is synonymous to better service standards and higher quality. If the second route is implemented, the impact on water budget deficit discussed here remains ambiguous because higher unit costs to produce services that meet consumer preferences may or may not exceed WTP. The first route would however appear to be better but more problematic. These issues would warrant further investigation.

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Appendix
Results of Unit Root Tests on Data in the Cost Model (1975-97)

Table A.1: Unit root tests on cost data (level form)

Series	*ADF*	*P-value*	*PP*	*P-value*	*WS*	*P-value*
ln AC	–1.2576	[0.90]	–7.911	[0.59]	–1.3575	[0.93]
ln *n*	–4.8655	[0.00]	–7.038	[0.66]	–1.3392	[0.95]
ln *y*	–1.5962	[0.79]	–14.54	[0.20]	–2.1577	[0.54]

Table A.2: Unit root tests on cost data (first difference series)

Series	*ADF*	*P-value*	*PP*	*P-value*	*WS*	*P-value*
Δln AC	–3.0348	[0.03]	–23.34	[0.00]	–2.1757	[0.11]
Δln *n*	–4.3775	[0.00]	–12.75	[0.07]	–2.3215	[0.09]
Δln *y*	–2.5816	[0.10]	–27.71	[0.00]	–2.5751	[0.07]

Source: Computed ADF: Augmented Dickey Fuller; PP: Phillips Perron; WS: Weighted Symmetry. Unit root tests were conducted with trend and constant term; No of lags = 2.