ACCOUNTING INDUCED DISTORTIONS IN PUBLIC ENTERPRISE PRICING

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Certain government enterprises not subject to competition (e.g., municipal utilities, irrigation agencies) commonly aim to set prices at average cost. In periods of inflation, unadjusted accounting data understate the economic costs of fixed assets and, thus, generate inefficiently low prices and high consumption rates for outputs of these enterprises. Since dividends and taxes are not involved, the primary function of accounting is cost determination rather than profit measurement. We measure the nature and extent of undercosting and underpricing for a group of government owned water utilities in the arid western United States. Economic costs appear to be two to three times their accounting counterparts for the cases studied.

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1. Introduction

The lack of commensurability between economic costs and costs indicated by accounting data presents problems in the private and public sectors. Information and decision costs are raised if conventional accounting data must be adjusted or ignored when related economic choices are made. This gap between accounting and economic costs can become quite large in either sector, but we will argue in this paper that it tends to be larger and more sustained in the case of public sector enterprises.[1] Because of the differences in the institutional framework for price setting in the two sectors, the gap between accounting and economic costs creates more and larger distortions in pricing in the public than in the private sector. Public sector enterprises that hold to a zero profit pricing policy in this accounting context will charge inefficiently low prices. This will induce consumption of those services or facilities in wastefully large quantities. Whatever the merits of conventional accounting procedures for other purposes, they can induce excessive output even in a second best world.

In contrast, the relation between accounting costs and pricing in private sector firms is frequently very loose. Typically, market forces permit product prices which may well exceed costs based on accounting data for significant periods of time.[2] Unit cost data per accounts and prices may tend toward

[1]We focus on a particular group of public enterprises that are able to set prices relatively free of competition or constraining market forces. Such government enterprises in the United States seldom issue stock, pay conventional dividends, or pay taxes on profits.

[2]See the articles by Wright, Van Der Sijpp and others in the anthology, Replacement Costs for Managerial Purposes, or Bentson (1982, pp. 81-82). This literature warns against equating accounting data and corresponding economic concepts and indicates that cost data of any sort, including that provided by accounting records, serve to define a minimum or reservation price. The observed market price is set by markups over this reservation price, with the degree of markup determined by market conditions.

equality in the long run as the result of revaluation or recapitalizations associated with mergers or buyouts. Over the long run, per unit costs indicated by accounting data for private sector firms may follow per unit market price rather than the reverse.

Publicly owned water supply utilities typify the problem of measuring economic costs and determining efficient prices in public sector enterprises. In general, such enterprises are fiscally autonomous, neither receiving explicit subsidies from nor paying dividends to their "owners." They do not raise capital by selling stock to private investors. They usually do not exploit their monopoly position by charging prices that would result in significant accounting profits. Other examples in the public sector abound: Bonneville Power Administration, municipal power companies, irrigation agencies and toll bridges. Swan (1983) has commented on a similar confusion of accounting costs and economic costs in the case of electricity supply by government enterprises in Australia.

Not all government "enterprises" face this problem. Local transit service, recreational facilities, or convention centers use prices or user charges in only a token manner, if at all. These cases present their own price and subsidy determination problems, but inadequate accounting data plays only a small part. The same holds for labor intensive government enterprises, such as the post office. In these cases, unadjusted accounting data may also understate the implicit subsidies, but any pricing problems are generated by other policies.[3] Government enterprises that issue stock, pay dividends, and set prices in a competitive context also face different accounting and policy problems.

[3]Studies of the relative efficiency of public and private firms in the same economic activity have generally ignored possible differential inflation induced distortions of accounting data on their comparisons [e.g., McGuire and Ohsfeldt (1986) and Feigenbaum and Teeples (1983)] in the urban water provision industry.

Perverse costing and pricing effects arise primarily from the accounting treatment of capital costs in periods of inflation, as well as from ignoring costs associated with certain sources of contributed capital. Current operating costs involve goods or services purchased and used up within short accounting periods and so do not materially distort financial reports even with inflation. But inflation can grossly distort the real cost of depreciation or interest associated with long-lived fixed capital plant. The use of historical cost depreciation is the most obvious source of the problem.

Considerable attention and controversy has been associated with inflation adjustments for private sector firms. However loose the causal relation between accounting data and product prices, it has been argued that more meaningful accounting data remains important for stockholder reporting and taxation purposes.[4] In spite of this concern, private sector firms generally provide inflation adjusted data only on a supplementary, ad hoc basis, if at all.[5] The continued differences between books of account used by firms for stockholder reporting (SEC) purposes in contrast to tax purposes indicates the unresolved nature of this issue.

Inflation adjustments of financial data in the public sector, even for autonomous public enterprises, have not received the same attention. Better information about real economic costs would presumably provide insight for government budgets and national income accounts. Perhaps more important are the distorted price signals that result from applying an average cost pricing

[4]See Solomon (1978) for a review of United States experience and analysis concerning the adjustment of private sector accounting data in order to account for the distorting effects of inflation. Ernst and Whinney, Inc., (1979) describes Financial Accounting Standards Board rule 33 governing inflation corrections.

[5]There is evidence that even when available, accounting data corrected for the distorting effects of inflation have not influenced stock market valuations [see Watts and Zimmerman (1980)].

policy using only historical cost accounting data.[6]

Section 2 describes the adjustments required to express unit costs in current dollar terms reflecting the costs of constructing and financing the system under present circumstances. Section 3 applies these adjustments to the cost and accounting data of a panel of government owned urban water supply agencies in the Western U.S. We demonstrate that a large gap exists between unit costs derived from accounting data and the corrected current dollar cost figures. This establishes one policy reason for increasing water prices in the cities being studied, thus reducing consumption and delaying expensive additions to capacity.

2. Adjusting accounting data for inflation and implicit costs

The primary purpose of the adjustment described in this section is to convert costs derived from accounting data, expressed in historical dollar terms, to current year terms; that is, to what the costs would be if the capital plant had been put in place in some recent year.[7] Aside from correcting for obvious changes in construction cost levels it is necessary to determine what the current costs would be if the borrowing associated with the capital outlays had also been made in the current year. Both depreciation and interest cost items have to be scaled up accordingly. In effect we seek to estimate the capital cost of an additional unit of output in the current year at current prices. We do not recognize any windfalls to debtors in periods of unanticipated inflation

[6] Some economists have defended the use of average cost pricing by government enterprises, particularly in a second best world [e.g., Tresch (1981, pp. 206-218)]. However, since the undercosting problem documented in this paper has not been recognized, the more traditional economic case against average cost pricing remains strong.

[7] "Current year" refers to dollars of the year being considered, not necessarily the present year. The data used in the next section make 1980 the "current year."

since that adjustment is not relevant for identifying the costs that should determine current efficient unit prices.

Inflation

Among explicit costs, operating expenditures—wages, fuel, supplies and the like—need no adjustment. These items essentially get used up in the same time period they are purchased, before inflation has a chance to alter their nominal values. Thus, accounting records perforce reflect current dollar operating costs. Capital costs, by contrast, are what they are largely because of decisions made over many years cumulating to the present. In an inflationary environment, a machine purchased 20 years ago usually has a much higher replacement cost today even after recognition of productivity improvements. Adding the historical cost of the 20-year old machine to that of a similar machine purchased today thus presents a distorted picture of current costs.

To adjust costs, let C^h denote historical dollar costs for the current year t. C^h consists of operating costs C^o and the capital costs C^{cap}. (Each of these variables should have a time index, omitted here to avoid notational clutter). Capital costs in turn are composed of depreciation D^h and interest cost R^h. Hence,

$$
\begin{aligned}
C^h &= C^o + C^{cap} \\
&= C^o + D^h + R^h \,. \qquad (1)
\end{aligned}
$$

Depreciation

The base for depreciation is conventionally historical or book value of the capital in service, K^h. To convert depreciation to current (year t) dollars thus requires converting K^h to its current dollar equivalent. Since K^h is the simple sum of past years' investments, we have

$$K_t^h = \sum_{\tau=t_1}^{t} I_\tau \tag{2}$$

where I denotes investment and t_1 is the year in which the oldest equipment still in use in year t originally came into service. Given a price index P_t, then, current dollar value of capital in service is

$$K_t^c = \sum_{\tau=t_1}^{t} I_\tau/P_\tau \tag{3}$$

where P_τ is a price index constructed so that $P_\tau = 1.0$ for the current year $\tau = t$.[1] In effect, K^c is the value of the fixed capital stock as if it had been purchased in the current year. Some analysts call this the replacement value of the fixed capital plant. Since K^c is gross of depreciation, it should not be used as is for pricing purposes. However, K^c is the correct base on which to compute depreciation cost D^c which is relevant for costing and pricing. For consistency with current practice, assume common straight-line depreciation. With average life of n years, where n represents current practice,

$$D_t^c = K_t^c/n \; . \tag{4}$$

Interest

In historical dollar terms, this year's interest outlay is simply the sum of interest payments scheduled from all outstanding bond issues,

$$R_t^h = \sum_{\tau=t_2}^{t} i_\tau^h \, B_\tau^h \tag{5}$$

where R is total interest outlay in year t, i^h is nominal interest rate for bonds issued in year τ, B^h is face value of bonds (or other form of debt) issued in year τ and t_2 is the earliest year in which debt still outstanding in year t was originally incurred.

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[1]Alternatively, one could use an index based in any year. This would require multiplying I_τ by (P_t/P_τ) instead of just dividing by P_τ.

A variety of construction cost indices are available. Empirical work reported in the next section uses the implicit deflator for water supply facilities generated by the Bureau of Economic Analysis, U.S. Department of Commerce. Detailed data are available in the Survey of Current Business and Supplements.

In an inflationary period, the nominal interest outlay understates the opportunity cost in two ways: (1) the nominal interest rate rises as the rate of inflation rises and (2) inflation raises the costs of construction or equipment purchases, so the principal would have to have been higher. The interest rate problem is easily corrected by substituting the current nominal interest rate i^c for i^h in equation (5). The second problem is somewhat more complicated but can be handled in a manner similar to the process for capital in equation (3). Letting B denote the current dollar value of the utility's outstanding debt, then

$$B_t^c = \sum_{\tau=t}^{t} B_\tau^h / P_\tau \tag{6}$$

where as before, P_τ is an index based in the current year t. B^c represents an estimate of what the outstanding debt would be if the total plant had been put into service in the current year at current construction costs and using debt finance to the same degree as it was historically.

Interest cost in current dollar terms is then,

$$R_t^c = i_t^c B_t^c . \tag{7}$$

The point of this equation deserves emphasis. A conventional accounting adjustment, done with an eye to measuring real profits, would simply gross up historical debt figures by some index and apply the current real interest rate. Our problem, however, is to determine the current replacement cost, which requires both adjusting the principal and applying the current nominal interest rate.

Substituting into (1) from (4) and (7), total current dollar costs become

$$C_t^c = C_t^o + K_t^c/n + i_t^c B_t^c . \tag{8}$$

Imputed Opportunity Costs of Equity Capital

Equation (8) straightforwardly yields current dollar out-of-pocket cost C^c which is a current dollar analogue to the historic dollar cost concept used by public enterprises. However, publicly owned water systems use at least two other "resources" which they do not typically recognize for costing and rate-making purposes: equity capital and in situ water supply. Both resources are scarce and, as such, command some economic value, whether explicitly stated or not. The real cost of using these resources for supplying water is the earnings foregone by not using them in their best alternative uses, i.e., their opportunity cost.

Publicly owned enterprises, such as water utilities, usually carry on their balance sheets an accumulation from over the years of retained earnings and contributions-in-aid-of-construction. These items in effect make up the utility's equity capital. In the private sector a firm must earn a normal return on its "equity" capital or it will, in long run equilibrium, withdraw that capital from this market. This is a genuine cost for any viable business and so will be reflected in the firm's product price. Public sector enterprises, including water utilities, have no such market pressures and, thus, do not include the opportunity cost of equity capital either in the accounting costs of providing water or in its price. To this extent, pricing paradigms based on conventional cost underprice water.

Even though not costed out for pricing purposes, the amount of equity capital is usually explicit on the balance sheet of a semiautonomous public enterprise. As with other capital items, the magnitude on the balance sheet represents a hodgepodge of historical dollars, for example,

$$E_t^h = \sum_{\tau=0}^{t} A_\tau \tag{9}$$

where A = amount of retained earnings and other contributions added to the equity or net worth of the utility in year τ. The usual inflation adjustment yields

$$E_t^h = \sum_{\tau=0}^{t} A_\tau^c / P_\tau \tag{10}$$

Equation (10) estimates what the value of equity capital would be if it had been received this year (t) in current dollars. As such, E^c is commensurate with the revalued fixed assets K^c and outstanding debt at current dollar value B^c.

The opportunity cost of this equity capital is simply what could be earned by using the funds in alternative investments: the value E^c multiplied by an appropriate rate of return. Due to risk and other factors, the return on equity capital typically exceeds that of debt capital. However, for simplicity and to be conservative, we assume the same rate of interest i^c as for debt (see eq. [7]).[9] Hence the opportunity cost of equity capital is i^cE^c and total costs become

$$C_t^{ce} = C_t^o + K_t^c/n + i_t^cB_t^c + i_t^cE_t^c \; . \tag{11}$$

Scarcity Value of Source Supply

Scarce natural resources command a value above and beyond the costs of extraction (from the ground or from surface flows), treatment and distribution. Balance sheets and income statements in the public sector do not recognize this cost separately or explicitly, unless some payment was made for the <u>in situ</u> value of the resources involved. Estimating scarcity value is sufficiently complex to require separate treatment (see Moncur and Pollock, 1988), but to the extent omitted from financial statements, it requires no inflation adjustment. Letting S_t denote scarcity value yields the complete measure of total economic cost incurred by the government owned water utility:

$$C_t^{ce} = C_t^o + K_t^c/n + i_t^cB_t^c + i_t^cE_t^c + S_t . \tag{12}$$

Scarcity value should not be confused with a shift of focus from an average to a marginal cost concept. As with other costs outlined in this section, this discussion runs entirely in terms of total or average cost.

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[9] In the absence of stock prices and dividends, it is not clear what the rate of return on equity is or how it should be measured.

Water Price

Equation (12) provides the basis for determining the fully costed average cost price,

$$P_t^w = C_t^{ces}/Q_t \tag{13}$$

where Q_t denotes consumption during year t. If average costs rise as consumption grows in a system, then marginal cost is higher than average. In this case, the marginal cost counterpart of the total and average figures discussed here suggests even higher prices than (13) would generate. To avoid confusing the present question, we here assume constant costs both in this conceptual section and the empirical section which follows. If real unit costs increase over time the failure to use marginal cost pricing will result in additional undercosting beyond that noted here. In the classic case where real marginal costs are decreasing and below real average costs, conventional analysis would call for a price below the real average costs. While this may justify or rationalize some part of the undercosting and related underpricing in terms of average costs, it would not excuse the gross underpricing documented in the next section.

3. Urban water supply agencies: a case study

An empirical analysis of a group of municipal water supply agencies emphasizes the basic concepts considered in the last section. As fiscally autonomous government units, user charges provide their primary source of revenue. Their prices perform important rationing or signaling roles for water, a resource that is relatively "scarce" in most of the areas studied. No apparent economic reasons explain why the price charged should not reflect the full extraction and distribution costs involved in the "production" of water. The absence of externalities and income redistribution considerations add to the presumption that the price should reflect full costs. The prevalence of constant or increasing cost situations also argues against the use of prices below average economic costs.

Prices and Per Unit Accounting Costs

Table 1 presents various measures of unit cost and price of water. Columns 1 to 3 give information expressed in conventional, nominal dollar terms. The last three columns report current cost or replacement cost data per unit.

Column 1 indicates the average historical dollar unit costs, C/Q. Columns 2 and 3 show "price" data. Typically, water prices include a meter charge as well as one or more steps of a quantity charge structure and may vary by type of user—residential, industrial, commercial, municipal. The figure in column 2 is water sales revenue per unit delivered, regardless of type of user or form of price. Column 3 indicates either the quantity charge, or the first step of a multi-step schedule where block rates were in force. The data reported in these three columns indicate the general commensurability between average unit costs, per accounting data, and water prices. The linkage between the unit costs based on accounting data, and the average water prices being charged is indicated by a correlation coefficient of 0.79 between columns 1 and 2 in Table 1. The link between average costs and the quantity charge per se is not as close. However, given the many dimensions of the water user charge along with the state of the art of rate design, this is not surprising.

In 8 of the 10 publicly owned systems, average revenue exceeds reported average accounting costs suggesting the use of some sort of markup pricing policy.[10] While these enterprises apparently aim for some excess of revenue over accounting costs, the extent of the markup or augmentation varies consid-

[10]The "markup pricing" considered in this context should not be confused with the more formal or mechanistic "markup pricing" frequently referenced in accounting or microeconomics. The markup over identified accounting costs occurs but only in a broad generalized manner. To avoid confusion, we use a different label, augmented average cost pricing.

erably between enterprises, or even for the same enterprise over time. This variation stems from uncertainty of future demand, institutional or political lags and rigidities, differing emphasis on external vs. internal financing, and imperfect matching between the timing of construction outlays, on the one hand, and proceeds of bond sales, on the other. Table 2 illustrates this point, showing net income as a percentage of accounting costs. Nearly always positive, net income varies from virtually zero (Seattle in 1970) to almost equal to the accounting cost [East Bay Municipal Utility District (MUD) in 1960].

The frequency of relatively high augmentation stands out in Table 2. With a median of about 15%, net income exceeds one third of accounting costs in 12 of the 58 cases in the table; only four observations fall below 12%. Evidently, pricing policies are not aimed at zero "profit" in the strict sense of exactly equating price to average historical cost. Indeed, even considering variations across time for such factors as drought, the augmentations shown in Table 2 are remarkably high.

Comparison of Prices and Real Unit Costs

Even with relatively high augmentation, water prices still fall short of current-dollar cost figures shown in columns 4 to 6 of Table 1. Column 4, derived from equation (8), includes the same cost elements as the accounting figures in column 1, but corrected for inflation. This adjustment is relatively conservative since it covers only conventionally recognized explicit costs. The conversion of accounting cost data to real current costs follows the general procedures described in Section 2 of this paper.[11] Both depreciation and interest have been restated to reflect the levels that would prevail

[11]The implicit deflator for water supply facilities generated by the Bureau of Economic Analysis U.S. Department of Commerce is used as the construction cost index. The rise in construction costs has been so great it is not likely the use of alternative indices would materially affect the outcome.

if the system had been built at the construction costs prevailing in the indicated year. The current real unit costs also indicate what the interest cost would be if the outstanding bonds had been floated in the indicated year at the interest rates prevailing in that year. Moreover, the estimate of interest outlay takes into account the consideration that a larger amount of bonds would have to have been floated given the higher construction costs for the same capital plant had it been constructed at the present time.[12] Operating costs are perforce stated in current (1980) dollars and so need no adjustment. Other than this inflation adjustment, column 4 in Table 1 is directly comparable to column 1. This basic inflation adjustment in accounting cost data is consistent with conventional inflation adjustments of historic cost data in the private sector.

Data in columns 5 and 6 incorporate implicit costs not usually recognized and costed out. In private sector accounts, the effects of inflation and changes in real valuation eventually get reflected in market transactions as a natural result of occasional mergers, buyouts or stock offerings. Such actions lead to at least occasional revaluation of equity capital. And stock market fluctuations provide constant revaluation of firms' tangible and intangible assets that facilitates such changes in accounting values. By contrast, public enterprises go through no such market processes, and their accounts never have occasion to be adjusted for inflation.

Column 5, in conformance with equation (11), adds the opportunity cost of all equity items on a utility's balance sheet. Part of this equity, however, typically comes from development charges or other contributions-in-aid-of-construction. It might be argued that these costs should not be included in

[12]This recosting or revaluation of the existing plant, viewed in the aggregate, provides a reasonable estimate of the unit cost of replacing the present capacity as well as extending capacity at current construction and interest costs to provide a greater output.

the cost-basis for the quantity charge, since customers have paid them once already. Column 6 thus indicates the current dollar unit cost reflecting only the opportunity cost of the retained earnings portion of equity capital.[13]

A Measure of Underpricing: The R Ratios

The "underpricing ratios" in Table 3 indicate the extent to which real unit costs exceed the costs used for pricing purposes. The higher the value of the R ratio, the greater the extent of undercosting and underpricing and the less adequate the observed water price is as an indicator of the real economic cost of the water. Because of variations in the purpose and nature of adjustments, several variations of the R ratio are provided. The various ratios are defined as follows. The first compares the real current dollar cost (C_t) with its historical dollar analog,

$$R_{1t} = C_t^c / C_t^h \, . \qquad (14)$$

R_1 indicates the extent to which historical accounting data understate the current real cost of explicitly priced resources used in water supply. Unless the utility strictly sets prices at unit accounting cost, however, R_1 misstates the extent of underpricing. If, for example, a utility uses a simple augmentation pricing rule, then its gross revenue will be $GR_t = \psi C_t$ in year t, where $\psi > 1$ denotes the utility specific augmentation factor. Average revenue will be $P_t = AR_t = \psi C_t / Q_t$ where Q_t = quantity. Thus, a measure of undercosting and resulting underpricing is

$$R_{2t} = C_t^c / GR_t \, . \qquad (15)$$

The third and fourth "R" ratios incorporate the implicit cost of equity noted above as well as inflation and so provide more inclusive indicators of underpricing,

[13] Equation (12) also specifies an adjustment for scarcity value, S_t. The necessary data exist only for Honolulu, where S_t adds between \$0.58 and \$1.58 to the values in Table 1 (Moncur and Pollock, 1988).

$$R_{3t} = C_t^{ce}/C_t^h \quad (16)$$

and

$$R_{4t} = C_t^{ce}/GR_t \ , \quad (17)$$

where C^{ce} is from equation (11).

The median R_1 ratio of 1.44 suggests that inflation substantially affects estimates of the replacement cost of resources used in delivering urban water. R_2 recognizes that utilities do not use strict average cost pricing, but typically add some markup. Even so, all but one of the ratios in this column exceed unity. Even with augmentation, unit revenues fail to correct for the undercosting inherent in historical average cost figures. Adding the implicit cost of equity capital as in R_3 and R_4 reinforces the picture of underpricing given by R_1 and R_2. The values in columns 3 and 4 are consistently greater than one by large margins indicating an even larger degree of underpricing that is not corrected by the augmentations to average cost used by the enterprises.

Second-Best Considerations in Pricing

Some recent economic commentary suggests that marginal cost may not be the efficient price because prices charged for substitute or complementary goods and services may violate the price equals marginal cost rule.[14] However, this possibility does not seem to be relevant to urban water supply. The primary substitutes for water are capital intensive water conservation facilities or production techniques, such as water recycling systems, drip irrigation in agriculture, smaller yards and less intensive water appliances in houses. If water substitutes are fully costed and priced at marginal cost in current dollar terms, while water is undercosted and underpriced, water consumers have an incentive to use too much water and too little of the substitutes. If the

[14] Lipsey and Lancaster (1956) is the classic reference to this ever growing topic. See Rees (1968) for a more recent and relevant discussion.

substitutes for water were themselves undercosted and/or underpriced, one might make a case for continuing the underpricing of water to keep relative prices at efficient levels in a "second best" world. While the real-world U.S. economy probably does not universally satisfy the first-best requirements, there are strong reasons to believe that water substitutes are more likely to be correctly priced than is water itself. These reasons stem from the fact that most water substitutes are produced in the private sector, while water comes predominantly from publicly owned or regulated private enterprises. And the degree of undercosting and resulting underpricing is likely to be much less in the private sector than in the public sector[15] because

1. A private firm must regognize all capital inputs, including its equity, in costing and pricing its output
2. Mergers, sales, stock issue, and reorganizations by private firms provide them opportunities for reestablishing current values of their assets, including elements of goodwill
3. Any market imperfections in the private sector would tend to raise, not lower, a private firm's price relative to its underlying real economic cost
4. Water utilities are relatively capital-intensive operations, so that a greater proportion of their costs are subject to distortions between historical and current dollar costs as compared to private sector manufacturing
5. The capital plant in service of a water utility is relatively long-lived; for other enterprises, shorter lived capital means a more rapid rate of capital turnover and consequently more frequent recosting during inflation

[15] R ratios will tend to be closer to unity in the private sector than in the public sector.

6. The costs of production of private sector plants built recently at higher inflated prices tend to determine the prices charged for output produced at older plants; i.e., the costs at the newer facilities provide a price umbrella for all output regardless of place of production

7. To the extent that private sector firms pass forward any taxes, R ratios like those in Table 3 will be lower than for untaxed public water utilities.

Actual computations of ratios like those in Table 3 for other sectors of the economy go beyond the scope of this study.[16] But a priori evidence suggests that the computations would include the differential R ratio values between the public and private sector posited here; high R ratios in public sector enterprises and lower (unitary) R ratios in the private sector.

4. Summary and conclusions

The water utilities studied here clearly set user charges too low to cover the real economic cost of goods and services used in "producing" the water, even recognizing the rough nature of our data. As shown in Table 1, inflation and unrecognized equity capital account for significant undercosting and thus, with conventional average cost pricing principles, underpricing. Al-

[16] The very accounting adjustments characteristic of private sector firms make it difficult if not impossible to determine meaningful R ratios for nonregulated private sector firms. The revaluations and aggregations associated with goodwill, mergers, buyouts, spin-offs, and expansion by purchase of existing assets all preclude the sort of consistent, tractable accounts available for the public sector enterprises considered in this study. The choice of cost deflation indices also presents more problems than in the case of public sector firms. Indices of consumer prices may even be relevant for privately held firms, given the ultimate consumption purpose of private investing. But economic theory and these more specific factors considered in this section provide a strong presumption that comparable R ratios in private sectors would tend toward one even in periods of inflation. Additional empirical work would be premature until the validity of the broader proposition advanced in this paper is recognized and accepted.

though not estimated here, the scarcity value of source supply also contributes to this undercosting and underpricing.

The resulting underpricing accommodates political pressures to keep rates low but also carries several negative implications for efficiency and equity. First, low prices lead consumers to use excessive amounts of water, speeding the growth of system demand and necessitating excessive investment in system capacity.[17] Second, the distortions in relative prices lead to insufficient use of substitutes for water such as less water intensive appliances, gardens and production techniques. Third, the failure to recoup capital costs commensurate with current replacement values complicates the problem of financing infrastructure replacement and expansion and tends to generate pressures for subsidies from non-users or general taxpayers.

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[17]Numerous demand studies suggest that residential water consumption has an elasticity coefficient of between -0.1 and -0.5. The R_2 ratio in Table 3 suggests a 45% increase in price for Honolulu, which with the lower elasticity estimate implies a 4.5% decline in quantity consumed, at least by residential users. The R_4 figure of 2.41 similarly implies a decrease in the rate of consumption of 14.1%.

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Table 1

Comparison of unit cost and prices for a panel of urban water utilities, 1980

Publicly owned urban water utilities	Nominal dollars			Current dollars (1980)		
	Reported average accounting cost	Revenue	Quantity portion of user charge	Explicit accounting costs only	Accounting costs plus implicit equity costs: All equity, C^{ce}	Accounting costs plus implicit equity costs: Retained earnings
	($/1000 gal delivered)					
	(1)	(2)	(3)	(4)	(5)‡	(6)
Honolulu, HI*	0.65	0.74	0.77	1.08	1.78	1.22
Seattle, WA	0.42	0.36	0.63†	0.67	1.14	0.88
Tacoma, WA	0.32	0.37	0.35	0.37	0.70	0.49
Portland, OR	0.45	0.51	0.41	0.64	1.13	1.04
San Francisco, CA	0.41	0.46	0.55	0.58	0.89	0.89
East Bay MUD, CA*	0.60	0.74	0.51	1.23	2.35	2.02
Los Angeles, CA*	0.59	0.64	0.69	0.98	1.28	1.14
San Diego, CA*	0.61	0.68	0.56	0.74	1.44	1.01
Helix, OR*	0.90	0.78	0.62	1.24	2.02	1.52
Denver, CO	0.44	0.71	0.68†	1.00	1.65	....

NOTE: Because of the different dimensions of the typical schedule of urban water charges, an overall price other than the quantity charge is difficult to measure (col. 3). However, since the quantity charge is only one dimension of the charging mode, which itself may change over the range of some blocks, a more aggregative or representative measure of average water price is necessary. This is the role of the average unit revenue (col. 2).

*Pure retail operation.

†First step in declining block.

‡Full current cost per unit value.

Table 2

Annual net income as a percentage of total accounting costs for selected urban water supply utilities

Publicly owned utilities	Annual net income (loss) as % of total accounting costs				
	1960	1965	1970	1975	1980
Honolulu	0.1	0.8	9.3	0.7	27.7
Seattle	24.1	3.4	0.2	26.9	7.2
Tacoma	14.3	15.6	4.1	34.4	18.1
Portland	47.3	25.8	35.9	22.7	12.6
San Francisco	37.9	34.4	34.6	4.8	20.8
East Bay	98.4	20.0	30.5	46.2	62.9
Los Angeles	20.2	15.9	15.2	6.5	17.0
San Diego	31.9	7.5	12.9	2.9	24.8
Helix	(1.9)	...	10.9	10.5	0.08
Denver	75.7	15.7	64.7	57.5	....

NOTE: The data in each cell can be viewed as the generalized mark-up factor or degree of average cost augmentation discussed in the text.

Table 3

Underpricing ratios (R ratios) for a panel of urban water utilities, 1980

Publicly owned urban water supply utilities	Ratios of entries from column (x), table 1 (4) ÷ (1) R_1 (1)	(4) ÷ (2) R_2 (2)	(5) ÷ (1) R_3 (3)	(5) ÷ (2) R_4 (4)
Honolulu*	1.66	1.45	2.73	2.41
Seattle	1.59	1.86	2.70	3.17
Tacoma	1.15	1.00	2.19	1.89
Portland	1.44	1.25	2.51	2.21
San Francisco	1.41	1.26	2.17	1.93
East Bay MUD*	2.05	1.66	3.92	3.18
Los Angeles*	1.66	1.53	2.17	2.00
San Diego*	1.21	1.08	2.36	2.12
Helix	1.38	1.59	2.24	2.59
Denver	2.27	1.40	3.75	2.32

NOTE: R ratios are defined in equations (14) through (17):

$R_{1t} = C_t^c/C_t^h$, where C_t^h = total cost in historical or accounting dollars;

C_t^c = total cost in current dollars (i.e., replacement value)

$R_{2t} = C_t^c/GR_t$, where $GR_t = \psi C_t$; ψ is the mark-up factor

$R_{3t} = C_t^{ce}/C_t^h$, where $C^{ce} = C^c$ + imputed interest on retained earnings and contributions

$R_{4t} = C_t^{ce}/GR_t$.

*Pure retail operation.