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On Turvey's Benefit-Cost "Short-Cut": A Study of Water Meters

Steve H. Hanke

Ralph Turvey (1974) presented a "short-cut" procedure for the conduct of benefit-cost analysis. In his article, Turvey stated: "My aim is to restate received doctrine in a way which is simpler and intuitively more acceptable than the exposition in most of the relevant literature" (Turvey 1974, p. 825). The purpose of this note is to demonstrate the validity of Turvey's assertion. We accomplish this by first adapting Turvey's procedure to the specific problem of measuring the benefits and costs of water meter installation. Then we apply it to the case of Perth, Australia, for the fiscal year 1976–1977.

The real marginal costs of water are increasing in most parts of the world. As a result, water conservation policies have become important issues and frequent media topics.[1] Water metering, an important conservation measure, has received attention but only ersatz economic analysis.[2] We overcome this problem by adapting Turvey's benefit-cost model and applying it to the metering decision in Perth.

Our problem is first to adapt the model presented by Turvey so that it can be used to evaluate the benefits and costs of water meter installation. When meters are installed, the price per m^3 increases from zero (P_0) to a positive level (P_1) and the quantity of water used is reduced from Q_0 to Q_1. This reduction in water use represents a loss or cost to consumers, and its value is given by:

$$\left(-\frac{P_0 + P_1}{2}\right)(Q_0 - Q_1). \qquad [1]$$

The logic that supports this measure of consumers' losses is straightforward. We assume that the value of water consumption is reflected by consumers' willingness to pay. Prior to meter installation, consumers could have used one more m^3 of water at a cost of P_0 (zero) or they could have used one less m^3 at a savings of P_0. Hence, if there are no administrative restrictions on water use, the fact that consumers used what they did (Q_0), rather than one m^3 more or less, implies that the average value of an additional

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[1] For examples from the business press, see Marcial (March 9, 1980); *The Economist*, October 25, 1980; and Vitullo-Martin, February 23, 1981).

[2] The metering decision is important in countries such as Great Britain and most of the third world, where domestic water use is not metered and priced on a volumetric basis. It is also important in many cities throughout the world, where only a fraction of the total domestic customers are metered. For accounts of the debates and the ersatz analyses of water meter installation decisions in Latin America, Canada, New York City, and Great Britain, respectively, see (Bartone (1976); Gysi and Lamb (1977); Hirschleifer, DeHaven, and Milliman (1960); and National Water Council (1980).

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TABLE 1

ANNUAL BENEFITS AND COSTS OF WATER METERS

Season	$-\frac{P_0^i + P_1^i}{2}$	$+ M^i$[2]	$\left(-\frac{P_0^i + P_1^i}{2} + M^i\right)$[3]	$(Q_0^i - Q_1^i)$[3]	Net Benefits Before Metering and Billing Costs	Metering and[4] Billing Costs	Total Net Benefits
Summer	− \$0.053/m³	+ \$0.176/m³	+ \$0.123m²	5,600,000 m³	+ \$688,800		
Winter	− \$0.053/m³	+ \$0.096/m³	+ \$0.043/m³	2,200,000 m³	+ \$ 94,600		
Total				7,800,000 m³	+ \$783,400	− \$241,342	+ \$542,058

[1] P_0^i = \$0/m³ and P_1^i = \$0.106/m³.

[2] For the method used to determine marginal costs, see Hanke (1977), and for the marginal cost calculations, see (Binnie International (Australia) Pt. Ltd., et al. 1977).

[3] Estimates of reduced use are based on data contained in (Hanke 1970).

[4] This figure is based on the assumption that 17,968 meters were purchased and installed in the fiscal year 1976–1977 at \$55.65/meter. Annuitized at 10% interest over seven years, the initial investment of \$1,000,000 equals \$205,406 per year. To this we add the annual, extra meter reading and billing costs of \$35,936, for a total annual cost of \$241,342.

and sacrificed m³ is P_0 or zero. After meters are installed and the price becomes positive (P_1), we can apply the same argument, and conclude that the average value of one more or less m³ of water consumption is P_1. Hence, the average value per m³ to consumers of their reduced water consumption must lie between P_0 and P_1. We follow Turvey and use the midpoint "as a convenient best guess" (Turvey 1974, p. 826) of this value.[3] Then, to compute the value (cost) to consumers of their reduced consumption, we simply multiply the average of the sum of the two prices times the change in consumption.

We now turn to an evaluation of the benefits or savings generated by metering. If M represents the marginal cost of supply, then the resource savings or benefits associated with reduced use are equal to:

$$(M)(Q_0 - Q_1). \qquad [2]$$

If we let the superscript i stand for different commodities (summer and winter water), whose price changes when meters are installed, we have an expression that can be used to evaluate the annual net benefits of meter installation, exclusive of extra metering and billing costs:

$$\sum_i \left(-\frac{P_0^i + P_1^i}{2} + M^i\right)(Q_0^i - Q_1^i). \qquad [3]$$

To determine the annual, total net benefits of meter installation, we must set against any annual gain revealed by [3] the annuitized capital and installation

[3] For a discussion and justification of this approach, see (Renshaw 1957).

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cost of meters and the extra, annual meter reading and billing cost.

With this formulation of the benefit-cost problem, we are ready to analyze the metering decision in Perth. Perth is located on Australia's west coast at a latitude of 32°S. Its climate is seasonal, with cool, wet winters and hot, dry summers. In the fiscal year 1976–1977, 185.2 $\times$ 10^6 m^3 of water were produced, with 73% of the total being distributed in the summer season (November-April). The total water produced was distributed to the following uses: (1) metered, residential in-house use (20%), (2) metered, residential outdoor use (36%), (3) metered, nonresidential use (15%), (4) unmetered use (14%), and (5) leakage (15%). Therefore, 25.9 $\times$ 10^6 m^3 were used by 17,968 unmetered water connections. Commercial establishments and single-family residences accounted for this unmetered, nonpriced use.

A summary of the application of our benefit-cost procedure for Perth is presented in Table 1. In addition to demonstrating that universal metering in the fiscal year 1976–1977 would have been economic in Perth, we illustrate the economy of using Turvey's benefit-cost formulation. We suggest that it be adopted by water authorities when they consider the installation of meters. Moreover, we suggest that Turvey's "shortcut" has the potential to assist benefit-cost analysts, when they evaluate policies and programs that involve changes in prices and resource use.

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