

Handout-Price and Rate Structure

EEP 162: Water Resource Economics

We do not have time in section to go over all of the issues involved in price and rate structures. This handout provides a brief overview of issues involved in pricing water delivered to municipal water users by public water supply systems. Refer either to Hanemann's article in the reader (p182) or the lecture notes associated with the topic for more detailed information. If you find any of these issues particularly confusing, please send me an email and depending on the number of responses I get I will either revisit some of these ideas in section or set up a time to go over them during office hours.

1. Components of a Water Rate Structure

- Flat charges vs. charges that vary with quantity
- Uniform vs. Block rate variable charges:
 - Uniform-amount paid per unit of consumption is the same over all units consumed.
 - Block rate-unit charge varies, either decreasing with the amount consumed (decreasing-block rate) or increasing with the amount consumed (increasing-block rate).
- Rates that charge different prices in different time periods versus those that change the same price in all time periods
- Additional charges (e.g. connection charge), special rates for particular classes of users (e.g. low income).

2. Criteria for designing water rates

- Generate revenue—rates generate revenue that permits a utility to cover its costs.

- Allocate costs—rates serve to allocate costs among different types of users.
- Provide incentives—rates provide price signals to customers which may serve as incentives for them to use water efficiently, encouraging them to modify their behavior in particular directions.

3. Difficult to apply these criteria in practice:

- Some of the criteria may conflict (e.g. revenue stability and economic efficiency).
- More than one party involved in determining rate-setting process (utility, customer, society), thus inherently a political process.
- Complicated nature of water utility costs. The very nature of water utility costs tends to create conflicts between the criteria of raising adequate revenues, allocating costs fairly, and providing incentives for efficiency and conservation. Embedded costs (historical average cost) vs. marginal cost (replacement cost).

4. Goals in price setting:

- Raise revenue
- Redistribution of cost burden among users
- Promote efficiency in water use and water supply (marginal cost pricing)
- Change consumer behavior

5. Marginal Cost Pricing

- Focus on economic efficiency. The criterion for economic efficiency is to maximize the sum of Consumer Surplus and Producer Surplus, the total net benefit from water supply to consumers plus producers. This happens when $price = marginalcost$.
- Basic idea here is that commodities should be produced and allocated to the point where their marginal benefit equals their marginal cost. That is, the benefit gained from consuming one more unit of a good is equal to the cost to produce it. This is when marginal benefit equals marginal cost.

6. Choice of time frame for Marginal Cost Pricing: Long Run vs Short Run

- Marginal cost of fixed costs, by definition, is zero. The quantity of output changes, but there is no change in the quantity of these inputs, and so there is no change in this component of total cost.
- In the short run, the capital stock is fixed, and the marginal cost arises mainly from operating and management (O&M) costs. In the long run, the capital stock can be replaced and expanded, and the marginal cost includes not only O&M costs but also capital costs. So, by definition the short-run marginal cost is always less than the long-run marginal cost.
- This gap is especially huge in the water industry because of its unusually high capital intensity. Thus, it matters a lot whether prices are set on the basis of short- or long-run marginal cost.
- Everyone agrees that price should never be set below short-run marginal cost, but should it be set any higher?
- Argument for short-run marginal cost pricing can be illustrated with airplanes. No airplane should take off with empty seats as long as there exist some potential travelers willing to pay the almost negligible short run marginal cost associated with the additional passenger.
- However, prices may be volatile, thus short-run marginal cost may vary a lot. May want to abandon SRMC pricing to smooth prices. Also, need to think about long run investment issues.
- Central Valley Project has charged prices below long run marginal costs while making investment decisions for new reservoirs. Building new reservoirs and aqueducts that would not have been considered worthwhile if those who used the additional supply actually had to bear the cost.
- Possible solution: Charge based on incremental variable costs of additional unit plus the estimated additional capital costs per unit for the additional capacity that will have to be constructed if sales at that price are expected to continue over time or to grow.
- If capacity is freely variable, then the standard argument would be to set price equal to long-run marginal cost. If capacity is fixed,

there is an argument for both. Economic efficiency with respect to production from a given capital stock calls for setting price equal to short run marginal cost; economic efficiency with respect to investment and the determination of long-run capacity calls for setting price equal to long run marginal cost.

- If the producer will need to replace or expand capital in foreseeable future, should set price equal to long run marginal cost to give the right signal and avoid inefficient investment decisions. This is important because (i) capital is non-malleable and (ii) demand may be partly or fully irreversible (vintage capital model where current demand function of price of water at the time of construction).

7. Meeting Revenue Requirements with Marginal Cost Pricing

- When prices are set to marginal costs, total revenue may not cover total cost.
- Industries with decreasing average costs would not cover their total cost if they set prices equal to marginal cost. Two solutions:
 - (a) Two-part tariff: utility combines a commodity charge based on marginal cost with a fixed charge, for example, a service charge or connection charge. The idea is that the fixed charge raises the additional revenue needed to cover total cost, but does not interfere with economic efficiency.
 - (b) Ramsey pricing: derived a complex formula for how one should adjust prices away from marginal costs in inverse proportion to the elasticity of demand. One imposes the most price adjustments to consumers whose quantity demanded is least sensitive to price, and the smallest adjustments to the costumers whose demand is most sensitive to price. Clearly, it is hard to have enough information to do this in practice. Also, cross-subsidization may be politically unfeasible.

8. Marginal Cost vs Average Cost Pricing Summary

- Rate structures based on marginal cost pricing are intended to provide price signals that result in a more efficient allocation and use of a scarce supply of water

- Marginal-cost pricing reflects the cost of producing an additional unit, while average-cost pricing reflects the unit cost of producing all units. If costs are increasing as output increases, average costs will be below marginal costs. Price based on average costs will not result in efficient consumption choices because consumers will not be matching marginal benefit with marginal cost
- Marginal-cost prices are more difficult to calculate than average cost prices. To calculate average cost, a utility needs some understanding of its total costs and production. To calculate marginal cost, one needs detailed information on costs for a variety of plants and equipment.
- Marginal-cost pricing can result in over- or undercollection of revenue. Can use two-part tariffs, multiple block rates and Ramsey pricing.

9. Seasonal Rates (Peak Load Pricing)

- The idea of marginal-cost pricing requires that all customers purchasing a good should be charged the same price, but suppose that it costs more to provide a good during certain periods.
- Suppose that a water agency has several sources of supply, and that its most expensive sources are required only when demand is high, whereas its cheaper sources are sufficient when demand is low, what do you do?
- Peak-load pricing—the service is priced higher during the peak demand period, when cost is high, then during the off-peak period, when cost is low. For water, main variation is summer versus winter.
- Idea here is that the utility requires an excess capacity above the average level of demand it can expect due to variation in demand. Essentially, a customer holds an option to utilize this reserve capacity, and can exercise this option at any time. The cost of the option to the utility is the cost of providing the extra capacity necessary to meet the maximum expected demand. Efficiency requires that the customer's willingness to pay for the option equals the cost of the option. If the variation in demand is systematic, then the price for service during the peak periods should include

the cost of capacity that makes consumption at the peak level possible.

- In the off peak period you set price equal to short-run marginal cost. On peak, you set price above long-run marginal cost, $p = b + \frac{B}{\theta}$ where b is SRMC, B are additional long run costs and θ is the percentage of time we are in peak demand. This means that the peak users essentially pay for the capacity costs. See Hanemann's lecture notes for more on this.
- Example: Suppose LRMC equals 60% of costs, and SRMC =40% of costs. Also, $\theta = .5$, that is peak and off peak are of equal duration. What is the price during the peak period?

$$p_{peak} = b + \frac{B}{\theta} = b + \frac{1.5b}{.5} = 4b, p_{offpeak} = b \quad (1)$$

which says that there should be a 400% premium during the peak period.

10. Lumpy investments

- In this case capital is indivisible and can only be expanded in lumpy investments.
 - Two questions: (i) should you expand capacity and (ii) what price should you set?
 - Price serves to ration demand and also as a signal for investment. Price is set to short-run marginal cost if capacity underutilized, price is set to long-run marginal cost if capacity if fully utilized and freely adjustable. Price is set above short run marginal cost if capacity if overutilized and not freely adjustable
 - See Hanemann's lecture notes for graphical illustration.
11. Read Hanemann's article entitled "**Designing New Water Rates for Los Angeles**" as a good look at how some of these issues play out in practice. There are also lecture notes on this article on the website.