URBAN WATER RATE DESIGN BASED ON MARGINAL COST

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ABSTRACT

Tucson passed marginal cost rates in 1976 and the City Council was voted out of office one year later. This was interpreted as a manifestation of the political infeasibility of applying marginal cost rate design to water (Martin, Ingram, Laney, and Griffin 1984). Yet Los Angeles passed marginal cost rates in 1992 with a Democratic mayor, and reaffirmed the decision in 1995 with a Republican mayor. This chapter presents the author's observations as participants in the process of designing and adopting the Los Angeles rate structure.

INTRODUCTION

When resources are not allocated in a manner that is economically efficient, gains from reallocation can be made sufficient to compensate losers, with a surplus left over. Economic efficiency is hampered by issues of compensation, who gains the surplus, and the transactions costs (including legal and political disputes). A Paretian improvement occurs when resource reallocation makes some better off without making anyone else worse off. In practice, increases in economic efficiency

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often do make some individuals worse off. A potential Paretian improvement (the Kaldor-Hicks criterion) is when the gains from resource reallocation are sufficient to compensate all losers, even if the compensation is not paid. Most economists support institutions (such as private property) and policies (such as marginal cost pricing) that meet the Kaldor-Hicks criterion (Tisdell 1991). When changes to institutions or policies cause harm without compensation, economists usually ignore the obvious political ramifications of rent seeking behavior that can dissipate the surplus to attorney's fees or the political process. When a potential Paretian improvement is prohibited by the prospect of wealth redistribution, economists usually ignore or erroneously identify basic political concerns. We describe and document the process by which such political concerns were addressed when Los Angeles adopted marginal cost water rates, enabling Paretian improvement to occur.

As a general rule, it takes more policy instruments to simultaneously solve more problems. Ramsey (1927) pricing is an example of a second-best pricing strategy with a single policy instrument to meet two goals: efficiency and zero monopoly profit. The Ramsey solution is to set the price equal to marginal cost for customers with elastic demand, and meet the revenue constraint by adjusting the price charged to customers with inelastic demand, resulting in output close to the economically efficient amount. In a review of rate design, Russell and Shin (this volume) credit Boland with the observation that two-part tariffs (Coase 1946) make Ramsey pricing obsolete. Set the tail block rate equal to the marginal cost and set a head tax (customer charge) or subsidy (customer credit) to meet the revenue constraint. In essence, a two-part tariff increases the number of policy instruments to achieve the two policy objectives of economic efficiency and zero monopoly profit.

The Coase solution has a number of problems. In the case where marginal cost is greater than historic average cost, the Coase solution assumes that a customer credit is politically acceptable. It assumes homogeneous customers and no droughts. It assumes no difficulties in adjusting the rates when the revenue requirement is not met. It assumes no concern for low income customers. It assumes that the losers are compensated, or at least enough are compensated so that marginal cost pricing is politically feasible. The solutions to these problems require increasing the number of policy instruments. Before presenting our solutions to these problems, we provide some institutional background on the circumstances facing Los Angeles.

By April 1991, the customary end of the rainy season in California, it became evident that the fifth year of a drought ensured severe disruption of the California water system and that urban users in Southern California would face cutbacks in their water supply. In Los Angeles, the Department of Water and Power (DWP) called for a voluntary 15% reduction in water use. Citizens responded eagerly and water use fell by over 20%. So did water revenues, which created a severe financial problem. DWP had to return to its customers and announce a rate increase. This created a political furor since those who conserved at the behest of DWP would be penalized by a rate increase.

Mayor Bradley responded in the summer of 1991 by appointing a Blue Ribbon Committee on Water Rates (BRC) with sixteen members representing all geographic areas and major constituencies in one of the most racially diverse cities in the United States. Fifteen of the members were civic leaders with substantially divergent interests and no special knowledge of utilities or water. The other was an economist.[1] Mayor Bradley's BRC conducted extensive investigations and issued a report (Mayor's Blue Ribbon Committee on Water Rates 1992) in June recommending a series of changes that would create a two-tier increasing-block rate structure based on marginal cost. In December 1992, the City Council adopted this proposal with minor modifications, and it went into effect in February 1993.

In June 1993, mayoral elections were held in Los Angeles. Mayor Bradley had decided not to run for another term and the Democratic candidate whom he had endorsed was defeated by the Republican candidate, Richard Riordan. Mayor Riordan took office in July 1993.

July and August were somewhat cool months by local standards, but September was a relatively warm month and many customers found their water bills rising as their usage entered the higher block range. This was especially true for residents of the San Fernando Valley, a warmer part of the DWP service area, and a bastion of support for Mayor Riordan. In response to citizen protests, Mayor Riordan reconstituted and reconvened the BRC, adding three new members from the San Fernando Valley. Mayor Riordan's BRC held hearings throughout the city and conducted further analysis. Its work was delayed by the Northridge earthquake in January 1994, which damaged part of the DWP distribution system. In August, Mayor Riordan's BRC issued a report (Mayor's Blue Ribbon Committee 1994) recommending refinements to the rate design but retaining the two-tier, increasing block rates. In March 1995, the City Council adopted this proposal with some minor changes, and it went into effect in April 1995, reaffirming marginal cost rates for Los Angeles.

The present authors were involved in these events. Hall was appointed in the summer of 1991 as a citizen member of Mayor Bradley's BRC. He subsequently became chair of the BRC's Finance Subcommittee, a member of the BRC Executive Committee, and a member of the Technical Advisory Panel. He was reappointed to Mayor Riordan's BRC. Hanemann served on the Technical Advisory Panel to Mayor Bradley's BRC, and continued as a technical advisor to Mayor Riordan's BRC.[2] In the next section we describe the context in which Mayor Bradley's BRC began its deliberations. Section 3 describes the work of Mayor Bradleys BRC and the rationale for the rate structure that it recommended. Section 4 deals with Mayor Riordan's BRC and describes the problems it faced and how these were resolved. Section 5 presents our conclusions.

BACKGROUND TO MAYOR BRADLEY'S BLUE RIBBON COMMITTEE

When he established the BRC in 1991, Mayor Bradley was actually following his own precedent. In November 1975, he had appointed a Blue Ribbon Committee of citizens to review both the water and the electricity rate structures used by DWP. The backdrop to that committee was controversy over a 16% increase in DWP water rates in June 1975, coming on the heels of two other rate increases during the previous three years, as well as growing public debate about the need to reform electricity pricing. That committee's tenure coincided with the 1976–1977 drought in California, which had caused severe concern during the spring of 1977, leading to significant voluntary water conservation by DWP's customers.

The committee's report on water rates, issued in October 1977, called for DWP to abandon its current practice of using declining-block commodity charges in favor of a uniform flat commodity charge set essentially at somewhat less than the current average cost. Demand and customer charges were retained in the rate design, for a three-part tariff. A demand charge varied with the size of the pipe connection to the customer, essentially retaining one aspect of declining block rates. The customer charge varied among customer classes, retaining another aspect of declining block rates. The committee considered but rejected seasonally differentiated rates, and rates based on long-run marginal cost (Mayor's Blue Ribbon Committee 1977). The recommendation of a "relatively" flat rate structure (excepting the demand and customer charges) for water was accepted by the City Council and implemented soon thereafter.

This structure of water rates remained until 1985, when it was modified with seasonally differentiated flat commodity charges, retaining the demand and customer charges, for a four-part tariff. The summer flat commodity charge was set about 15% higher than the winter flat charge. By 1991, the differential between the summer and winter commodity charges had risen to about 25%.

There had been several other changes in the water situation by 1991. Between 1970 and 1990, the population of the City of Los Angeles had grown from 2.83 million to 3.46 million, an increase of 22%. The total amount of water delivered by DWP also grew by about 22%, from 570,000 acre feet (AF) in 1971 to 695,000 AF in 1990. Thus, per capita consumption stayed roughly constant over the period, although it dipped by about 20% between 1975 and 1977 due to voluntary conservation induced by the drought. The main change during this period was a decline in the number of single-family residential accounts and an increase in the number of multi-family residential accounts. During the same time that demand increased, supply from DWP's three major sources declined.

Local surface and groundwater basins were the City's original source of water, but by 1971, these were only a minor source, providing about 13% of DWP's supply. One major source of supply is from the eastern Sierra Nevadas via the Los Angeles Aqueduct (LAA). Two other major sources are via the Metropolitan Water District of Southern California (MWD) which takes water from the Colorado River and from the great Central Valley of California. Water from the Central Valley is delivered to MWD by the State Water Project.

Since 1913, Los Angeles has taken surface and groundwater from the Owens Valley on the eastern slopes of the Sierra Nevadas and conveyed it to the City via the 223-mile long LAA. In 1934, DWP initiated a 115-mile extension of the aqueduct north to the Mono basin. It obtained a permit in 1940 to appropriate the full flows of four tributary streams of Mono Lake, beginning diversions in 1941. In 1963, it initiated construction of a second aqueduct that would nearly double the capacity of LAA; this came into operation in 1970. By 1971, 78% of DWP's supply came from the LAA. Since that time, there have been significant reductions in both sources, Mono Lake and Owens Valley.

Between 1941 and 1970, the surface elevation at Mono Lake fell from 6,417 feet above sea level to 6,391 feet. In the 1970s, DWP was receiving about 470,000 AF/yr from the LAA, consisting of about 370,000 AF/yr from the Owens Valley and about 100,000 AF/yr from the Mono basin. By 1982 it had fallen to 6,377 feet. In 1979, the National Audubon Society and several other environmental groups filed a suit with the State Water Resources Control Board (SWRCB) asking it to reduce DWP's diversions from the Mono basin because of their adverse environmental consequences. In 1983, the California Supreme Court ruled that the SWRCB could legally override DWP's rights to water in the Mono basin in order to protect environmental resources because there was a public trust interest in those resources. The SWRCB was also ordered to make a determination of how much protection the public trust interests should be afforded. A decade of vigorous legal activity between DWP and its critics followed. In 1984 California Trout and other environmental groups filed suit against DWP when it sought to resume normal diversions following heavy precipitation during the winter which had caused it to release flows into the normally dry channel of one of the tributary streams, thereby (re-) creating a fishery in that channel. California Trout argued that extinguishing this fishery would violate both the State Fish and Game Code and the public trust doctrine. It sought and received a temporary restraining order for a minimum release into the stream. In 1986 it filed a similar suit under similar circumstances on another Mono Lake tributary and received a temporary restraining order for a minimum release on that stream. In 1989 an appellate court ruled that DWP's water right was subordinate to the relevant provision of the Fish and Game Code as well as the public trust doctrine. In 1990 the appellate court rejected the SWRCB's request to delay enforcing compliance with the Fish and Game Code until after it had completed a comprehensive review of Mono basin diversions. The result was an immediate cessation of DWP's diversions from the Mono basin pending return of the lake level to 6,377 feet.[3]

In 1972, DWP announced that, because of the expanded capacity in the LAA, it would increase its groundwater pumping in the Owens Valley. This provoked a lawsuit by Inyo County seeking to limit the groundwater pumping. Following a series of rulings in 1973, 1977, 1981, and 1984, DWP entered into an interim agreement with Inyo County to restrict its groundwater pumping, especially in drought years. Together with the shutting down of diversions from the Mono basin, this reduced deliveries along the LAA to about 200,000 AF in 1990 and 1992, well under half the deliveries in the 1970s.

DWP's second and third main sources of supply are delivered by the Metropolitan Water District of Southern California (MWD). MWD was formed in 1928 by Los Angeles and some neighboring cities to obtain water for Southern California from the Colorado River. In 1960 MWD helped create the State Water Project (SWP) which transports water from the west slope of the Sierras via the Sacramento-San Joaquin Delta to Kern County in the San Joaquin Valley and to Southern California. MWD alone contracted for almost half the SWP supply. With water from the Colorado River and the Delta, MWD was providing about two-thirds of Southern California's water supply. In 1971, DWP received 9% of its supply, 52,000 AF, from MWD. DWP actually has an entitlement to more than 500,000 AF of MWD water, but in the 1970s it was taking only about a tenth of its entitlement because it had an adequate supply from other sources; it relied on MWD water primarily for unanticipated shortages and emergencies, as well as to meet future growth in demand. When LAA supplies declined after 1987, DWP compensated by drastically increasing its deliveries from MWD.

MWD was itself facing some serious problems. In its 1963 ruling in *Arizona v. California*, the U.S. Supreme Court upheld Arizona's claim for a larger share of Colorado River water. With the Central Arizona Project finally coming on-line in 1988, MWD expected that it would soon have to reduce diversions along its Colorado River Aqueduct (CRA) from its capacity of 1.2 million AF/yr to as little as 620,000 AF/yr.[4] It also saw looming shortages in the State Water Project. The SWP had a planned capacity of 4.2 million AF/yr, of which MWD contracted for about 2 million AF/yr, but as built in the 1960s it could deliver only about 2,400,000 AF/yr on a sustained basis. The shortfall was at first relatively unimportant to MWD, since the CRA supply was adequate to meet its needs. This changed at the end of the 1980s. From 1972 to 1987, MWD never took more than 650,000 AF/year of SWP water. In 1988, MWD took 800,000 AF of SWP water, and in 1990 it took 1.3 million AF. One reason for the change was the sudden increase in DWP's need for MWD water. Population growth in Southern California, which had accelerated during the mid-1980s, was another reason. Given the failure to complete the SWP, the structural imbalance in California water supply was finally becoming evident: California was now entering a situation of excess demand given current prices, institutions, and water rights allocations. This was a long-run phenomenon and not just an artifact of a drought that began in 1987.

On top of this, MWD was facing the prospect of a permanent reduction in its supply from SWP because of actions by the State Water Resources Control Board to protect the aquatic environment of the Sacramento-San Joaquin Delta. The U.S. Bureau of Reclamation's Central Valley Project (CVP) and the SWP together divert almost 8 million AF/yr from the Delta. The diversions affect the balance of freshwater and saltwater in the estuary, create reverse flows in the southern part of the Delta that disrupt fish migration, and kill fish through entrapment in the pumps. In 1978, the SWRCB had completed its review of the CVP's and SWP's permits for Delta diversions and had set conditions to protect beneficial uses within the Delta. These were challenged by both water users and environmental groups. The case was decided in 1986 in favor of the environmental groups. The SWRCB was then directed to adopt a global perspective and consider all water rights within the Sacramento-San Joaquin basin. In July 1987, the SWRCB began a process to revise its delta water quality standards. It issued a Draft Water Quality Control Plan in November 1988 that proposed stringent restrictions on Delta diversions, including limiting them to their 1985 level. Water users protested loudly, and the SWRCB was pressured to withdraw this plan in January 1989, leaving its decision process in some chaos.[5] In May 1991, it issued a new Water Quality Control Plan that omitted requirements for Delta inflows. Environmental groups immediately challenged this in a lawsuit and in September 1991, the Environmental Protection Agency announced that it would not approve the Water Quality Control Plan. Moreover, in 1991 the U.S. Fish and Wildlife Service issued a decision listing the winter run of the Sacramento River king salmon under the Endangered Species Act, and later initiated a process to consider listing the Delta smelt. Approaching the winter of 1991–1992, SWP water contractors were not sanguine about prospects for sustained exports of Delta water to Southern California.

To summarize, although it was a drought unprecedented in this century that occasioned Mayor Bradley's creation of the BRC, potential savings from rate reform resulted from the rising marginal cost of water. Environmental costs of water are now reflected in restrictions on the amounts taken from Mono Lake (Wegge, Hanemann and Loomis, this volume) and from the Sacramento Valley (Fisher, Hanemann and Keeler 1991). Growing demand in Arizona, Nevada and Colorado has restricted the share of Colorado River water available to MWD. MWD forecasts that its wholesale rates will rise rapidly. The marginal cost to DWP is from reclamation projects in increasing order of cost, and eventually from desalination. These marginal costs rise rapidly. The difference between the low historic average cost rates and the marginal cost represents potential savings to ratepayers from rate reform. Marginal cost rate design could increase economic efficiency, slowing the frequency of increases in water rates.

DECISION MAKING BY MAYOR BRADLEY'S BLUE RIBBON COMMITTEE

The BRC's fundamental finding was that DWP's revenue requirement would continue to rise for reasons beyond its control, but these increases could be minimized by redesigning rates and basing them upon marginal cost (Mayor's Blue Ribbon Committee 1992). Increased economic efficiency would create benefits that could be shared among the ratepayers. The problem facing the BRC was how to reform rates so that the benefits could be shared in a politically feasible fashion.

Mayor Bradley's BRC solved five problems of marginal cost rate design, two of which are usually considered fatal flaws. The first is avoiding monopoly profit. The second is incorrectly titled "revenue stability." The third, identified by Russell and Shin (this volume), is the heterogeneity of customer demand; this problem was solved for commercial and industrial customers but not for residential customers. Fourth is variation in demand and supply caused by drought. Fifth are additional issues of fairness, concern for low income customers, for example. The details of these solutions are presented in this section, immediately following discussions about embedded cost rate design and the Technical Advisory Panel.

The first decision of the BRC was whom to trust. The BRC decided that issue by limiting voting to citizen members, excluding representatives from the DWP or its consultants, the City Council, the other departments within city government, the Board of Commissioners of DWP, and the Mayor's office.

The second decision was whether to consider marginal cost as a basis for rate design, in addition to embedded cost pricing. The BRC extended the list of consultant firms contacted by the DWP and hired a consulting firm with an economist subcontractor. The BRC then proceeded to educate itself about alternative philosophies of rate design, the links between water supply and the environment, utility finance and operations, demand-side management, water reclamation, and specifics related to DWP. After almost 6 months, the BRC rejected embedded cost rate design. Instead, the BRC decided to divide its remaining resources and time into two phases: a first phase aimed at investigating the cost structure for DWP and determining marginal cost, and a second phase considering alternative rate designs.

Embedded Cost Rate Design

The standard approach to water rate design in the water utility industry is based upon historical costs. There are scores of embedded cost rate designs. The most popular are the Demand/Commodity method and the Base Capacity/Extra Capacity method. All of the methods share a common framework around these deceptively appealing steps (Mitchell and Hanemann 1994).

The first step is based on accounting methods to determine the revenue requirement. Required revenue equals operating costs, plus the depreciation of capital accounts for investments and interest during construction, plus interest payment on debt. For a municipal utility, there is an additional amount to meet financial ratios such as debt-service, interest coverage or debt-equity (Hall and Thomas 1984). For investor-owned utilities, there is an additional amount to cover a normal return on investment (Kahn 1988).

The second step is to allocate costs to categories that can be converted into commodity charges, capacity charges and customer charges. For example, operating costs might be calculated per unit of water and allocated for collection via commodity charges. Capital costs for plant and equipment might be allocated for collection through capacity charges. Sometimes referred to as a "demand" charge, the capacity charge can be levied on the size of the customer's pipe connection to the utility delivery system. Billing costs are typically allocated as a customer charge, a monthly (or bi-monthly, depending on the billing period) charge per customer.

Third, customer usage patterns are used to allocate the costs among customer classes: residential, commercial, etc. For example, customer classes with larger temporal variation in demand might be allocated a larger portion of the capacity costs. Another example, large industrial customers, can be served from main lines. Smaller residential customers require additions to the distribution network, the costs of which can be allocated to that customer class.

Fourth, the rates are adjusted to ensure that projected revenue equals required revenue.

One motivation for embedded cost rate design is a sense of fairness, expressed as follows. "Customers *should* pay a customer charge that reflects the cost they impose on the system for handling customer accounts. The utility has an obligation to serve, and therefore *must* build to the capacity adequate to serve at the pressure necessary if all customers were to simultaneously open their spigots to the maximum. The size of a customer's pipe connection to the system "causes" the utility to build a distribution system of the size constructed, so the customer *should* pay in accordance with the size of the pipe connection. Customers who use more water impose higher operating costs on the system, so they *should* pay their portion of that cost in accordance with the amount they use."

A second motivation for embedded cost rate design is that the revenue collected exactly equals the required revenue, avoiding monopoly profit.

A third motivation for embedded cost rate design, widely espoused by engineers, is revenue stability in the face of rising operating costs or droughts. The customer charge and the capacity charge are fixed charges; they do not vary with the amount of water sold. The amount of revenue will therefore not be greatly affected during droughts when there is less water to be sold; sufficient revenue will still be collected to cover fixed costs. When operating costs increase, the commodity charge can be adjusted without greatly affecting the quantity demanded, avoiding repeated changes in the rates that might be required to meet the revenue requirement if all the revenue were collected with a commodity charge.

Economists take issue with four aspects of embedded cost rate design. The first rationale is social engineering, since the motivation for embedded cost rate design is normative. *Should* connotes value judgments. Second, embedded cost allocation for joint costs is economically meaningless (Brown and Sibley 1986). For example, it is nonsense to allocate a larger portion of the capacity costs to customer classes with larger temporal variation in demand, particularly since the use could fall during the shoulder or off-peak period. Third, the capital costs are historic, backward-looking, rather than based on future potentially avoidable costs; they are based upon accounting depreciation rather than the current market value of the assets. Fourth, customer and capacity charges are fixed charges, rather than charges that vary with the amount of the water consumed. Consequently, customers do not have the incentive to invest in water efficiency (xeriscaping, drip irrigation, low flush toilets) even if the cost per unit of water saved is substantially below the per unit cost for the utility to supply additional water.

We add a fifth objection. Engineers believe that embedded cost rate design will reduce the frequency, and the political difficulty, of getting approval for changes in the rates. To the contrary, embedded cost rate design encourages inefficient water use, leads to construction of increasingly expensive projects before they are necessary, and subsequently leads to large increases in required revenue and repeated requests for rate increases. Embedded cost rate design adds to the problem of political instability.

Technical Advisory Panel

To assist the consultant with the calculation of marginal cost, the Executive Committee of the BRC appointed a Technical Advisory Panel (TAP). The most important decision facing the TAP was whether to use long- or short-run marginal cost. Hall (this volume) examines alternative models of marginal cost and points out that the argument for short-run marginal cost pricing is based on models where only the utility can make investments. Since conservation investments by consumers are critical allocations of resources, and economic efficiency requires that all resource allocations be considered, the basis for selecting short-run over long-run marginal cost pricing is not economic efficiency. This is particularly true since excess capacity is a feature of the optimal system design for system reliability in response to weather and climate related fluctuations in demand and supply (Rodrigo, Blair and Thomas, this volume). In addition to the dispute over short- and long-run marginal cost, the TAP resolved a number of other difficulties for calculating marginal cost, most of which are presented in Hall (this volume) and a few of which are mentioned here.

The marginal cost of additional supply has these components: obtaining the water, treating the water, transporting the water, and serving the customer (Hall, this volume). These costs typically are computed in separate units of measure: annual dollars per capacity for fixed costs of pipes and treatment plants, dollars per unit of water for variable costs of treating and pumping water, and annual dollars per customer for serving customers. Hall (this volume) presents the details of which of these costs should be converted into dollars per unit of water in order to obtain the marginal cost.

One common error results from the temptation to design marginal cost-based rates with the three traditional components: a commodity charge in dollars per unit of water, a "capacity charge" in dollars per size of pipe hook-up, and a customer charge in dollars per customer. The basis for this error has three sources. One is that embedded cost rate design has all three components, and when utilities change to marginal cost rate design, retaining these three components can raise the psychological comfort level of those accustomed to embedded cost rate design.

The second source of this error stems from confusion over the concepts of option demand and costs that vary with the system peak demand. A connected customer that is not using water, if faced with a standby charge, has an incentive to terminate service if the connection has no value, thereby reducing the cost born by the utility to monitor and bill the customer. Such a standby charge would be zero for a customer using water since the charge does not provide the customer with an incentive to do anything. Consequently, a minimum charge, not a customer charge, is consistent with the concept of marginal cost.

Similarly, a capacity charge dependent on the size of the customer's pipe connection has nothing to do with peak system demand since the customer does not have an incentive to alter behavior as a result of the charge. The concept of marginal cost requires a direct link between the charge and behavior to achieve efficiency.

A potential error is to calculate the annual marginal capital cost based upon normal years rather than all years. The argument made to the Technical Advisory Panel of the BRC was that because during drought years the marginal cost is the curtailment price to equate demand and supply, the capital costs should be allocated to normal years only. This error stems from embedded cost procedures for cost allocation.

Marginal Cost Rate Design and Monopoly Profit

Figure 1 shows the revenue generated from a typical customer with a demand curve given by *d* and a single-part tariff set equal to marginal cost. The revenue from the customer equals the rectangle. If, in adding up the revenue from all customers, too much revenue is generated, there are three solutions to equate actual to required revenue. One solution is to use the excess revenue for a revenue stabilization fund which is drawn down and used to avoid rate hikes during droughts. A second solution is credits. A third solution is to develop increasing block rates, charging a low rate for a minimal amount of water, and a higher rate for amounts beyond the minimal amount. The second and third solutions are variants of the two-part tariff proposed by Coase (1946).

One option, abandoned by the BRC, is a rate stabilization fund to stabilize rates during droughts. For this option, during droughts the customer would guarantee not to use more than the amount allotted, or face a large penalty. During periods of plenty, extra revenue collected would accrue to a rate stabilization (sunny day) fund. During periods of drought, the fund would be drawn down to pay the costs of the utility while water sales are low. One problem with a rate stabilization fund is that the degree of geophysical uncertainty is unknown. For example, the MWD's rate

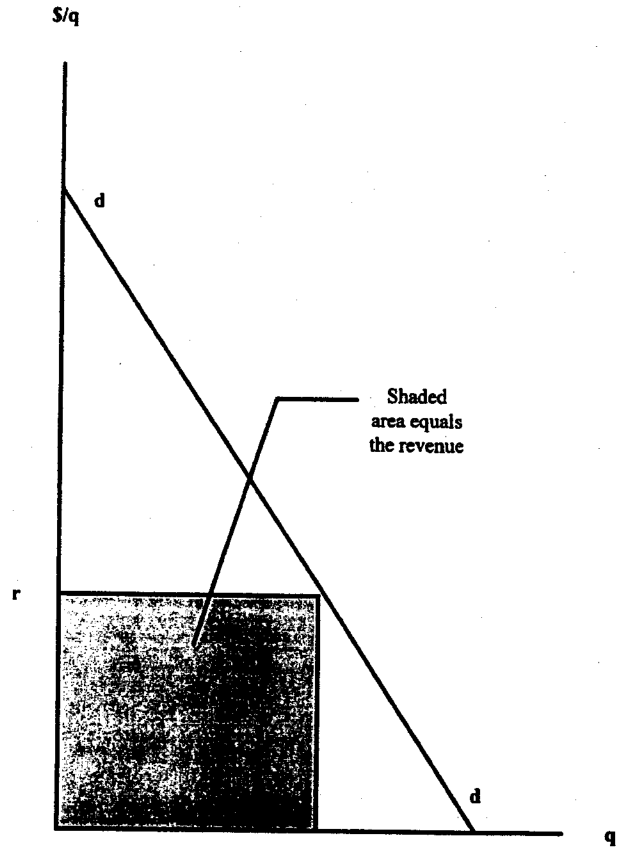

Figure 1. Revenue from Single Part

stabilization fund was exhausted long before the drought ended. One consequence of geophysical uncertainty is that water deliveries cannot be guaranteed by the utility, even when the customer has paid in advance for the guarantee. Another result is that the rates have to be adjusted when the rate stabilization fund is exhausted, so some unspecified risk is still borne by the customer even though the customer has paid to shift that risk to the utility. A second problem is that a rate stabilization fund is both a political target and a potential political plum to pick.

Credits can either be in the form of cash, or can be confined solely to help pay the water bill. For some percentage of water customers, the credit may be larger than the bill. For those customers, in order to maintain the incentive to conserve, the credit could be carried forward for some limited period of time (some number of billing periods). Alternatively, the maximum credit could be set equal to the bill.

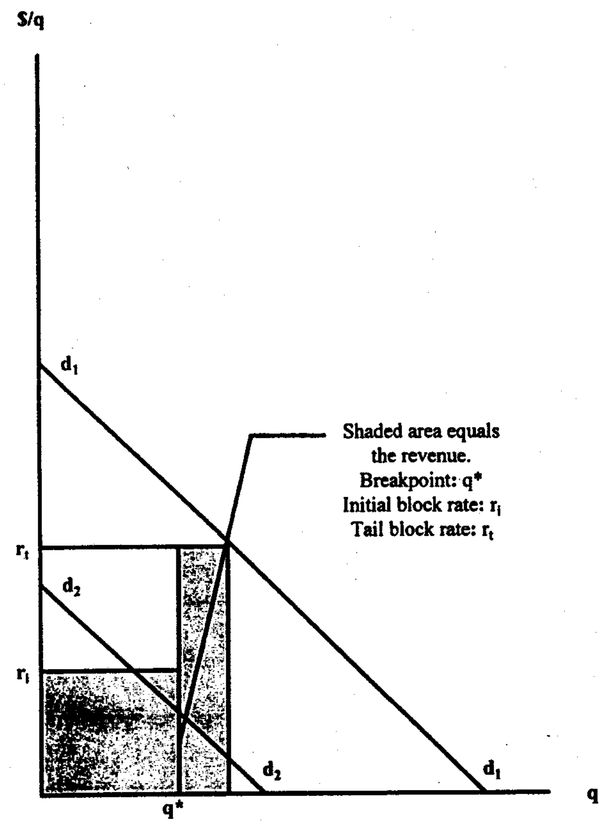

Figure 2. Revenue from Two-Part Tariff

Increasing block rates can also constrain revenue to avoid monopoly profit. Figure 2 shows the revenue generated by increasing block rates from a customer with demand curve d_1. The per unit charge equals r_i for the initial block of water — consumption up to the breakpoint, q^*. The per unit rate increases to the tail block rate of r_t for all units of consumption greater than q^*. The tail block rate is set equal to the marginal cost, and the initial block rate is adjusted so that actual revenue equals required revenue, thereby avoiding monopoly profit.

Credits are more efficient than increasing block rates because a larger percentage of customers actually experience the marginal cost as the price for another unit of water. For example, with increasing block rates, Figure 2 shows that a customer with demand curve d_2 would not face the marginal cost incentive to invest in conservation.

Table 1. Normal Year Water Rates

Customer Class	*Low Block*	*Breakpoint*	*High Block*
Residential Single Family	$1.71	21 Billing Units (175% of Median)	$2.92 Summer $2.27 Winter
Multi-Family	$1.71	125% of Winter Average	$2.92 Summer $1.71 Winter
Commercial/Industrial	$1.78	125% of Winter Average	$2.92 Summer $1.78 Winter

Source: Mayor's Blue Ribbon Committee on Water Rates, 1992.

The rate design recommended in 1992 by the BRC for DWP included both increasing block rates as shown in Tables 1 and 2, and a credit to subsidize low income customers. During normal years, residential customers have a tail block rate equal to the marginal cost of $2.92 in summer and $2.27 in winter. The BRC recommended an initial block equal to 21 billing units per month, which was 175% of consumption by the median residential customer. To an economist, this breakpoint seems high and likely to only provide the efficient price signal to a small fraction of customers, but the BRC reasoned that customers in the hotter San

Table 2. Shortage Year Water Rates

	Low Block	*Breakpoint*	*High Block*
10% Shortage			
Residential Single Family	$1.71	19 Billing Units	$3.70
Multi-Family	$1.71	115% of Winter Average	$3.70
Commercial/Industrial	$1.78	115% of Winter Average	$3.70
15% Shortage			
Residential Single Family	$1.71	18 Billing Units	$4.44
Multi-Family	$1.71	115% of Winter Average	$4.44
Commercial/Industrial	$1.78	115% of Winter Average	$4.44
20% Shortage			
Residential Single Family	$1.71	17 Billing Units	$5.18
Multi-Family	$1.71	110% of Winter Average	$5.18
Commercial/Industrial	$1.78	110% of Winter Average	$5.18
25% Shortage			
Residential Single Family	$1.71	16 Billing Units	$6.05
Multi-Family	$1.71	110% of Winter Average	$6.05
Commercial/Industrial	$1.78	110% of Winter Average	$6.05

Source: Mayor's Blue Ribbon Committee on Water Rates, 1992.

Fernando Valley with larger lots would be more inclined to accept such a rate design. In fact, in order to pass the City Council, the breakpoint was raised by setting seasonal breakpoints and by increasing the percentage to 200% of median use in the winter and 200% of median use in the summer, discussed further below.

Revenue Stability versus Political Stability

The best solution to a problem can only be found if the problem is correctly identified. Rate design manuals and the literature on rate design incorrectly identify revenue stability as a problem for rate design to solve. The real problem is political instability of the rate approval process.

The rate approval process is political. Municipal utilities are typically governed by an appointed (or sometimes elected) board that recommends rates to be approved by a city council (or the board has the authority to approve rates). Investor-owned utilities are governed by state utility commissions. The rate approval process is affected by the interests of elected and appointed officials, ratepayers, and the utility managers.

Two identifiable tensions permeate the rate approval process. One is tension among the varied interests of the ratepayers. This tension is played out through divisions among customer classes, cost allocation and subsidies for special groups of ratepayers. A second tension is between the interests of the elected officials and the interests of the utility management. This is made manifest when elected officials refuse rate increases and blame utility management for higher costs that may well be outside the control of management. Motivation for disapproval ranges from the cynical (capturing the political spotlight) to the desire to achieve legitimate goals of interest groups in the electorate. Examples of legitimate goals include eliminating disparate water quality across electoral districts, protecting the environment, and promoting economic growth and equality in low income areas.

The consequence of the political tension between politicians and utility management is that utility engineers strive to design rates to achieve revenue stability. Utility management's underlying objective is to reduce the frequency of rate increase requests to avoid being bashed by politicians in rate hearings. This is a critical reason why utility management prefers embedded cost rate design, with high fixed charges, over marginal cost rate design that could cause fluctuations in sales and require more frequent rate hearings.

The embedded cost solution to the problem of "revenue stability" doesn't work in two instances. As noted above, when the long-run marginal cost is higher than the historic average cost, the economic inefficiency of embedded cost rate design results in over-construction and the need to raise rates even higher than if marginal cost rate design moderates demand, delaying construction until it is economically efficient to proceed. Another instance when embedded cost rate design fails to solve the problem of "revenue instability" is when the operating and capital costs of the utility vary substantially. When costs vary, revenue stability is not even desirable.

The problem then shifts from that of maintaining "revenue stability" to one of approving changes to rates so as to match actual revenue with required revenue. This occurred with the electric utility industry in the mid-1970s after the first OPEC oil embargo, when energy costs rapidly rose and then fluctuated wildly. Operating and capital costs are rapidly changing for water because of changing water quality requirements established by the EPA and state agencies. In the arid West, capital costs are rising because water is becoming increasingly scarce, for reasons given in section 2.

The real problem is that the rate approval process takes time and has a volatile political component. In private industry, when weather or costs change supply conditions, or when demand shifts, then prices change without awaiting a political process for approval and without reference to cost components. The rate approval process does not account for rapid changes in required revenue. The solution to the problem is to include formulae in the Rate Ordinance, formulae that automatically adjust the actual revenue to the required revenue as conditions change. This solution works for electric utilities and has various names, such as "energy cost adjustment." Some water utilities have automatic adjustment formulae for increases in the purchase price of wholesale water, and for increases in the cost of energy to pump water.

The BRC perceived that utility management had a legitimate desire to avoid constant bashing by elected officials when cost conditions outside management control required changes in rates. The BRC recommended a water revenue adjustment in the rate ordinance. The initial block rate is adjusted quarterly to maintain required revenue equal to actual revenue and account for variation in water sales due to the high tail block rate. This adjustment was approved by the City Council with three limitations. One limitation restricted the maximum amount of the adjustment to 10% of the average sales price without additional approval of the council. A second limitation was the maximum adjustment each quarter of approximately 3 percent. A third limitation allowed the Council to reconsider the decision to adjust the rates with a 2/3rd vote within five working days of a rate adjustment. Thus, the Council delegated the authority to adjust rates, within the limits of some safeguards, a politically feasible way to solve the problem of "revenue stability" without resorting to embedded cost rate design. During 1993 residential customers actually paid an initial block rate that varied from $1.52 to $1.79 (Mayor's Blue Ribbon Committee 1994), compared to the $1.71 shown in Table 1. This solution removed objections to marginal cost rate design by the DWP management, and provided the basis for utility management to trust the motivation of the members of the BRC.

Heterogeneity of Customer Demand

The main choices for increasing block rate designs are how many customer classes to define, how to define them, how many blocks to define, and where to

delineate the blocks. All of these choices relate to the equity problem of cross-subsidy with heterogeneous customers, a problem that exists with any rate design except a simple average cost commodity charge. These choices also determine how much economic efficiency is achieved by an increasing block rate design. Discussion of the efficiency of an increasing block rate design with heterogeneous residential customers is in the next section of this chapter.

To see the equity problem of cross subsidy with heterogeneity, consider two customer classes, say, residential customers, all with demand curves d_r in Figure 3 and commercial customers, all with demand curves d_c. With a two-part tariff that is identical for both customer classes, the revenue collected from residential customers equals $R_r = r_i q^* + (q_r - q^*)r_t$, and the revenue collected from commercial customers equals $R_c = r_i q^* + (q_c - q^*)r_t$. The average charge per unit of water for

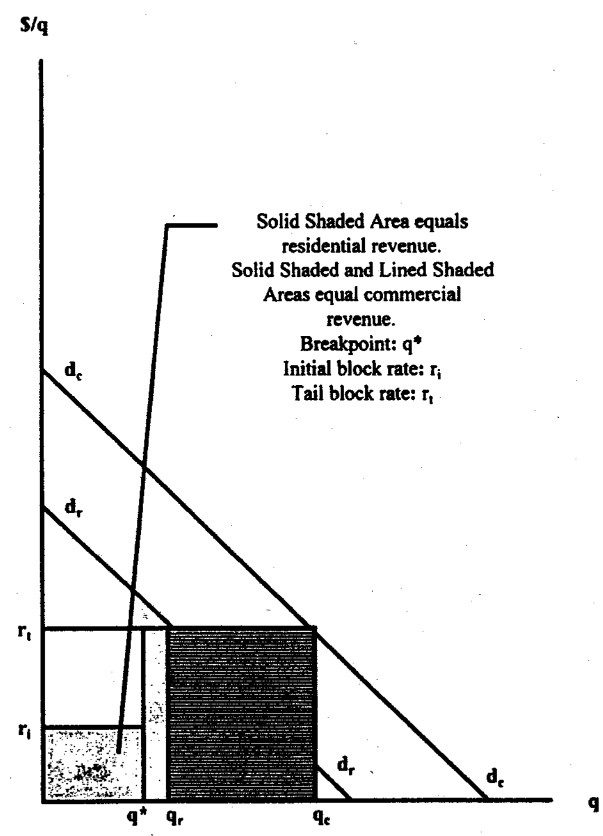

Figure 3. Cross Subsidy

the commercial customers, $AC_c = R_c/q_c$, is significantly higher than the average for the residential customers, $AC_r = R_r/q_r$.

Cross subsidy is a potentially divisive issue, the type that can pit commercial and industrial customers against marginal cost rates. The BRC considered allocating costs among customer classes using three alternative methods. One method included variants of the embedded cost approach. As discussed above, that approach allocates costs based on the philosophy that customer classes should pay for the portion of historical costs that can be somehow ascribed to each class. Another method is the "Equal Percentage of Marginal Costs," which allocates marginal costs among customer classes based upon the philosophy that customer classes should pay for the portion of future costs the system will bear that can somehow be ascribed to each class. The simplest method is to allocate costs to classes on the basis of units of consumption, the "average cost method." All three of these methods were compared, and the resulting differences were minor. The BRC used the average cost method. The result was that the BRC's initial block rates varied among customer classes.

More important than subsidies across classes is the subsidy within classes. Commercial and industrial customers are considerably more heterogeneous than residential customers. Similarly, multi-family dwellings come in all sizes, from high rises to duplexes. In order to avoid the perception of cross subsidy between smaller and larger commercial and industrial customers, one option is to define a large number of customer classes, perhaps by the size of the pipe connection to the system. Then the size of the first block could be adjusted within each customer class to determine the proportion of total cost collected from each customer class.

A better solution was identified. The BRC determined the breakpoint between the initial block rate and the tail block rate to be calculated separately for each customer. In winter, there is a uniform rate design, as shown in Table 1. In summer, the breakpoint for each customer equals some percentage of the previous winter's average use for that individual customer.[6]

Table 1 shows that for normal years the breakpoint recommended by the BRC was 125% of the previous winter's average. In the sense that winter usage largely reflects indoor usage, the tail block rate is a "penalty" on what is perceived to be more discretionary outdoor use, so the rate design is perceived as "fair."[7] While 33.9% of the commercial and industrial customers are expected to pay the tail block rate at least once during the year, only 4.8% of all water purchased by this customer class will be billed at the higher tail block rate (Mayor's Blue Ribbon Committee 1992). Consequently, a large percentage of customers (one third) faced the efficiency incentive of marginal cost based rates, but only a small percentage might find the rate reform politically unacceptable. Compared to the previous rate design, the BRC's design results in 61% of commercial and 65% of industrial customers with lower annual bills.

Drought Rates

At the onset of the drought, citizens were urged to conserve. After conserving, customers were told that less water had been sold, so the rates had to be increased to cover the fixed costs. In essence, it was perceived that a penalty was levied because customers conserved. Table 2 shows the solution recommended in 1992 by the BRC. The tail block rate is set to the market clearing price. The breakpoint between the initial block rate and the tail block rate is reduced by an amount that depends on the size of the shortage. Through the revenue stability adjustment, the initial block rate is adjusted quarterly to collect the required revenue. With this rate design, any customer that reduces water use below the breakpoint does not experience the tail block rate.

Other Equity Issues

Two separate equity issues are discussed below: the cost that new development imposes on existing customers and low income subsidies. Because fairness is a value judgment, these are normative issues that economists typically leave to others. Yet it is critical that various options be presented to elected officials to achieve political acceptability, while preserving the features of rate design that achieve efficiency.

In general, because they are not related to water use, fixed charges against new development are contrary to efficient rate design and encourage water use. When more revenue is collected through fixed charges, less revenue is collected through commodity charges, lowering the incentive to conserve. One exception is the concept of an offset policy, proposed by the BRC but not adopted.

An offset works like this. For each unit of water required by a proposed new development, the developer is required to pay for water conservation investments that reduce the amount of water used by existing customers. Such a policy effectively requires developers to offset the increased water demand created by their projects. Demand can be offset by installing conservation devices, including ultra-low flush toilets and low-flow shower heads, in public facilities such as schools and hospitals that do not have the financial resources to improve their efficiency. An alternative to direct offsets is for the developer to contribute to a fund used to finance other conservation programs or water recycling projects.

The water offset policy is connected to water use in two ways. First, the amount of the charge assessed on developers is directly dependent on calculations of potential water use, based on the size of the connection and the amount of landscape to be served. Second, the revenue collected goes into a fund that is used to finance water conservation and reclamation investments.

In the case of DWP, many low income customers reside in multiple family dwellings without individual meters for water. These apartment buildings have master water meters, and the cost of water is passed through in rent on the apartment.

As an additional subsidy for low income customers, an increasing block rate design or a credit for a master metered building poses two problems. One is that the subsidy might not be passed through to the customer. Another is the complexity of the application process for the subsidy.

Because electricity is more expensive than water, relative to the cost of installing separate hook-ups and meters, renters in these apartments typically have separate electric meters. DWP provides both water and power, so the BRC's solution was to provide a credit to the electric bill. This solution adds a policy instrument to meet an additional policy objective, without sacrificing some of the economic efficiency, and is superior to the Feldstein[8] (1972) solution. The Feldstein solution, like Ramsey pricing, artificially limits the rate design to fewer policy instruments, in this case to a two-part tariff, and sacrifices efficiency to gain another objective, in this case equity.

MAYOR RIORDAN'S BLUE RIBBON COMMITTEE

When public furor arose from San Fernando Valley residents over higher water bills, what was overlooked by the popular media was the broad support for the rate design. The Chamber of Commerce, industrial and commercial customers, owners of multifamily dwellings, and residential customers in all of the other areas of the City were silently satisfied. In fact, the votes in City Council were not sufficient to alter the rate design.

Mayor Riordan reconvened and substantially altered the composition of the BRC, adding four new members from the San Fernando Valley and retaining 10 of the 16 members from Mayor Bradley's BRC. The interests and inclinations of a majority of the reconstituted BRC initially favored no change to the rate design. As seen from the vantage of a zero sum game, rate relief to the San Fernando Valley could only come at the expense of all the other customers. A convincing argument was made, however, that carried the day. The rate design could be refined in a manner to capture additional economic efficiencies. The BRC recognized that more than the additional surplus would go to rate relief for the Valley. This meant that members of the BRC ultimately voted in favor of refinements that were on net less favorable to their constituencies, but did so in the spirit of cooperation for the gain of the City as a whole. Our concluding remarks return to this outcome.

The key issue facing Mayor Riordan's BRC was how to expose as many users as possible to the marginal cost incentive, doing so in a manner that would encourage additional economic efficiency yet provide rate relief for the San Fernando Valley residential customers. Mayor Bradley's BRC had solved the problem of heterogeneity among commercial and industrial customers, but Mayor Riordan's BRC did not consider that particular solution applicable to residential customers. In its consideration of other solutions, the BRC recognized that charging different rates to different residential customers would be perceived as unfair and would complicate the rate structure. A three- or four-tier rate design would obscure the price signal to the customers.

For marginal cost rate design, the real difficulties are how to determine the breakpoint for increasing block rates and how many blocks to include in the design. The breakpoint determines the extent to which large water users subsidize small water users. Placement of the breakpoint and the number of blocks determine how many customers are consuming an amount in the tail block and receiving the price signal that reflects the marginal cost. Before presenting the solution of Mayor Riordan's BRC, we review the process that determined the breakpoint in the 1993 Rate Ordinance.

Breakpoint from Mayor Bradley's BRC

In order to send a clear price signal, to include more customers in the tail block, and to avoid a confusing array of charges, Mayor Bradley's BRC recommended two blocks in 1992. During the last year of the drought the median residential customer in the DWP service territory consumed 12 BU/month on an annual basis. (A Billing Unit (BU) is 750 gallons.) As a matter of fairness, Mayor Bradley's BRC recommended that the breakpoint equal 175% of the median, or 21 BU/month. This recommended breakpoint was determined after extensive numerical analysis and consideration of the following issues. A low breakpoint increases the number of customers that experience the marginal cost price signal. A breakpoint near but above the median does not "penalize" with excessive frequency, given variation in weather and characteristics of variation in home usage.

Compared to the pre-existing design, Mayor Bradley's BRC forecast that its proposed rate design would have reduced annual bills for 3/4ths of the residential customers, and reduced annual bills for 2/3rds of the residential customers in every region served (Mayor's Blue Ribbon Committee 1992). The actual rate design approved in 1993 reduced bills for about 70% of the customers (Mayor's Blue Ribbon Committee 1994).

The heterogeneity of demand results in extremely large bills for some customers while other customers never face the marginal cost. The most difficult test of Mayor Bradley's BRC's recommendations was the perceived unfairness of the residential breakpoint. Residents in the San Fernando Valley complained that because of the higher temperatures there, relative to the coastal areas, and relatively larger lots in the Valley, the breakpoint should be higher. In the ordinance passed in February of 1993, the City Council increased the BRC's recommended breakpoint to 200% of the winter median and 200% of the summer median, for breakpoints of 22 BU in winter and 28 BU in summer. That was the most significant change to the recommendations of Mayor Bradley's BRC made by the City Council.

Even with this increase in the breakpoint, middle to upper middle class customers continued to complain bitterly. Table 3 shows the bill impact analysis that compares the previous rate design with the marginal cost rate design proposed by Mayor Bradley's BRC in 1992. Table 3 shows that of the four districts, the San Fernando Valley had the largest percentage (33.9%) of customers with a bill increase.

Table 3. Residential Bill Impact Analysis of 1992 Proposed Marginal Cost Rate Design

Residential District	Percentages of Customers with Increases or Decreases in Bills by Ranges			
	% Decrease	*% Customers*	*% Increase*	*% Customers*
District 1	0 to –10%	41.3%	0 to +10%	5.1%
Metro	–11 to –20%	28.6%	+11 to +20%	3.5%
Los Angeles	–21 to –30%	11.9%	+21 to +30%	2.4%
# Customers	–31 to –40%	0.2%	+31 to +40%	1.2%
129,384	–41 to –50%	2.5%	+41 to +50%	0.3%
	Over –50%	3.0%	Over +50%	0.0%
Total		87.5%		12.5%
District 2	0 to –10%	46.7%	0 to +10%	4.1%
Harbor	–11 to –20%	30.5%	+11 to +20%	2.2%
San Pedro	–21 to –30%	10.4%	+21 to +30%	0.9%
# Customers	–31 to –40%	0.1%	+31 to +40%	0.3%
17,787	–41 to –50%	2.1%	+41 to +50%	0.0%
	Over –50%	2.7%	Over +50%	0.0%
Total		92.4%		7.6%
District 3	0 to –10%	46.9%	0 to +10%	11.6%
San Fernando	–11 to –20%	13.4%	+11 to +20%	10.2%
Valley	–21 to –30%	3.9%	+21 to +30%	7.8%
# Customers	–31 to –40%	0.2%	+31 to +40%	3.6%
215,263	–41 to –50%	0.8%	+41 to +50%	0.7%
	Over –50%	1.0%	Over +50%	0.0%
Total		66.1%		33.9%
District 4	0 to –10%	42.6%	0 to +10%	7.7%
West	–11 to –20%	22.2%	+11 to +20%	6.4%
Los Angeles	–21 to –30%	8.1%	+21 to +30%	5.1%
# Customers	–31 to –40%	0.2%	+31 to +40%	2.9%
60,160	–41 to –50%	1.6%	+41 to +50%	1.0%
	Over –50%	2.0%	Over +50%	0.1%
Total		76.7%		23.3%
All Districts	0 to –10%	44.6%	0 to +10%	8.8%
	–11 to –20%	20.0%	+11 to +20%	7.3%
	–21 to –30%	7.2%	+21 to +30%	5.5%
# Customers	–31 to –40%	0.2%	+31 to +40%	2.6%
422,594	–41 to –50%	1.5%	+41 to +50%	0.6%
	Over –50%	1.8%	Over +50%	0.0%
Total		75.3%		24.7%

Source: Mayor's Blue Ribbon Committee on Water Rates, 1992.

Moreover, about 12% of the Valley customers had bill increases exceeding 20%. While this may seem small, keep in mind that these are annual figures that shroud the sticker shock of the summer bills. Note that over one half of the residential customers are in this district. Those who complained were the constituents of newly elected Mayor Riordan.

Mayor Riordan's BRC Recommendations

In fall of 1993, Mayor Riordan reconvened and reconstituted the BRC to consider refinements to the rate design. The BRC held a series of hearings and distilled the major complaints to identify alternative refinements that would reallocate costs among residential customers while maintaining or improving the efficiency message of the marginal cost rate design.

The key to achieving greater efficiency with increasing block rates is to partition the residential customers into subgroups, each of which have more homogeneous usage patterns than the group as a whole. It is politically feasible to set the breakpoint for each subgroup closer to the subgroup median because those consuming in the tail block have fewer units charged at the tail block rate. Thus, the percentage of customers who share in the benefits of increased economic efficiency is larger.

Table 4. 1994 BRC Recommended Temperature and Lot Size Breakpoints

Lot Size (sq. ft.)	Summer Average Daily High	Number of Billing Units Charged at Low Initial Block Rate	
		Winter	*Summer*
	<75°	13	16
<7,500	75–85°	13	17
	>85°	13	17
	<75°	16	23
7,500–10,999	75–85°	16	25
	>85°	16	26
	<75°	23	36
11,000–17,499	75–85°	24	39
	>85°	24	40
	<75°	29	45
>17,499	75–85°	30	48
	>85°	30	49
	1993 Rate Design Breakpoint		
all lots	all temperatures	22	28

Source: Mayor's Blue Ribbon Committee on Water Rates, 1994.

The BRC divided residential customers into four lot sizes and three temperature zones (Table 4). The lot sizes and temperature zones were selected based upon these criteria: improvements to homogeneity of use, historical lot size zoning patterns, available data matching zip codes with temperature zones, and administrative practicality. For family size, the BRC recommended that the initial block be augmented as household size increases from 6 to 13 people. An extra 2 billing units per person each month for household size of 7–8, 1.5 BU/person in the 9–10 range, and 1 BU/person in the 11–13 range (see Table 5). Customers could apply for initial block adjustments based on household size.

Because each subclass is more homogeneous, the breakpoint recommended by the BRC in 1994 was 120% of the subclass median. Compare this to the 1992 recommendation where all residential customers were treated as one customer class. After modification by the City Council in 1993, the breakpoint was 200% of the median use. The 1994 refinement increased the number of customers actually facing the marginal cost incentive to conserve.

By adding lot size, temperature zones and population density as variables for defining the breakpoint, the benefits from rate reform can be more evenly distributed among all the customers. Table 6 shows the bill impact analysis that compares the 1993 rate design with the design proposed by the BRC in 1994. Over 12% of the Valley customers received a bill decrease greater than 6 percent. These were the same customers that received the largest bill increases from the 1993 rate design. The refinements in the 1995 rate design ameliorated the impact of marginal cost rates on a politically significant customer class, thereby more equitably sharing the benefits of increased economic efficiency from marginal cost pricing.

The DWP Board of Commissioners altered the 1994 recommendations by adding another category for extremely large lots to reduce bills paid by that group, and increased the allocation for higher temperature zones (Table 7). This adjustment by the Board of Commissioners was primarily of benefit to customers in the hotter San Fernando Valley, and also to upper middle class and upper class customers with lot

Table 5. Monthly Household Size Billing Unit Augmentation for Initial Block

Household Size	Mayor's BRC Recommendation	Ordinance Passed by City Council
6 or less	0	0
7*	2	2*
8	4	4
9	5.5	6
10	7	7
11	8	8
12	9	9
13 or more	10	10

*automatic for 24 zip codes

Source: Mayor's Blue Ribbon Committee on Water Rates, 1994.

Table 6. Residential Bill Impact Analysis of 1994 Proposed Refinements

Residential District	Percentages of Customers with Increases or Decreases in Bills by Ranges				
	% Decrease	% Customers	% Increase	% Customers	No Change
District 1	0 to –5%	65.8%	0 to + 5%	13.3%	
Metro	–6 to –10%	1.7%	+6 to +10%	7.4%	
Los Angeles	–11 to –15%	0.5%	+11 to +15%	5.9%	
# Customers	–16 to –20%	0.0%	+16 to +20%	1.2%	
120,822	–21 to –25%	0.0%	+21 to +25%	0.0%	
	Over –26%	0.0%	Over +26%	0.0%	
Total		68.0%		27.8%	4.2%
District 2	0 to –5%	70.3%	0 to + 5%	12.2%	
Harbor	–6 to –10%	0.3%	+6 to +10%	6.8%	
San Pedro	–11 to –15%	0.1%	+11 to +15%	4.5%	
# Customers	–16 to –20%	0.0%	+16 to +20%	1.5%	
13,654	–21 to –25%	0.0%	+21 to +25%	0.0%	
	Over –26%	0.0%	Over +26%	0.0%	
Total		70.7%		25.0%	4.3%
District 3	0 to –5%	45.9%	0 to + 5%	20.0%	
San Fernando	–6 to –10%	8.2%	+6 to +10%	7.2%	
Valley	–11 to –15%	3.6%	+11 to +15%	7.5%	
# Customers	–16 to –20%	0.4%	+16 to +20%	1.8%	
201,711	–21 to –25%	0.0%	+21 to +25%	0.0%	
	Over –26%	0.0%	Over +26%	0.0%	
Total		58.1%		36.5%	5.4%
District 4	0 to –5%	57.9%	0 to +5%	14.3%	
West	–6 to –10%	6.5%	+6 to +10%	7.4%	
Los Angeles	–11 to –15%	2.7%	+11 to +15%	5.0%	
# Customers	–16 to –20%	0.1%	+16 to +20%	1.9%	
52,278	–21 to –25%	0.0%	+21 to +25%	0.0%	
	Over –26%	0.0%	Over +26%	0.0%	
Total		67.2%		28.6%	4.2%
All Districts	0 to –5%	54.6%	0 to + 5%	16.9%	
	–6 to –10%	5.7%	+6 to +10%	7.3%	
	–11 to –15%	2.4%	+11 to +15%	6.5%	
# Customers	–16 to –20%	0.2%	+16 to +20%	1.6%	
388,465	–21 to –25%	0.0%	+21 to +25%	0.0%	
	Over –26%	0.0%	Over +26%	0.0%	
Total		62.9%		32.3%	4.8%

Source: Mayor's Blue Ribbon Committee on Water Rates, 1994.

Table 7. Breakpoint as Altered by Board of Commissioners

		Monthly Billing Units Billed at Low Initial Block Rate	
Lot Size (square feet)	*Temperature Zone*	*Winter*	*Summer*
	Cool	13	16
less than 7,500	Moderate	14	18
	Hot	14	19
	Cool	16	23
7,500–10,999	Moderate	17	26
	Hot	17	27
	Cool	24	36
11,000–17,499	Moderate	25	40
	Hot	25	42
	Cool	28	45
17,500–43,559	Moderate	29	51
	Hot	29	53
	Cool	36	55
> 1 Acre	Moderate	38	62
	Hot	38	65

Source: Mayor's Blue Ribbon Committee on Water Rates, 1994.

sizes over one acre. The proposal by the Board of Commissioners enjoyed the support of Council members from the Valley, but by themselves they were not enough votes to pass the ordinance.

The City Council required a further adjustment to benefit the lower income class (Table 5). Customers in densely populated zones automatically received an augmentation to the initial block for indoor use by large families. Based upon the 1990 Census, zip codes were identified that had ten % or more of their customers eligible for a large household adjustment. All customers in those zip codes are granted a conditional classification of eight persons per household until verified by a change in service (until they move). The estimate is that 16% of the customers in those zip codes will benefit from the adjustment. The customers in these zip codes have little landscaping.

The finer partitioning of the residential customer class into subclasses improved the economic efficiency of increasing block rates by lowering the breakpoint for more customers, also allowing for the benefits from rate reform to be more equitably allocated. Winners could actually compensate a greater number of losers. Moreover, the two-tiered design allowed the politicians to focus on where the breakpoint would occur, giving them something to change without destroying the signal for economic efficiency. Marginal cost rate design can meet the political test of compensating losers.

CONCLUDING REMARKS

In 1992 the recommendations of the BRC were unanimous. In 1994, except for one member, the recommendations of the reconstituted BRC were again unanimous. The 1992 recommendations enjoyed widespread support from environmental groups, low income groups, and the Los Angeles Chamber of Commerce. The 1994 recommended refinements were strongly supported by residents who complained about the 1992 ordinance. Both recommendations (1992 and 1994) were adopted, except for a few modifications, by the Board of Commissioners and the City Council.

We have an empirical proof of the theorem that it is politically feasible to design marginal cost water rates in four steps. One, set the tail block rates in normal and drought years equal to the marginal costs for those years. Two, design the initial block rate and allow it to automatically adjust to avoid monopoly profit. Three, divide customers into homogeneous groups. Four, vary the breakpoint between normal and drought years, and set the breakpoint slightly above the median of each homogeneous group of customers. Our empirical proof of this theorem is that the City of Los Angeles did it under two mayors, one a Democrat and the other a Republican. Marginal cost rate design based solely on the Kaldor-Hicks compensation criterion, where compensation is possible but may not occur, is not politically feasible.

The process for rate reform in Los Angeles started with a citizen committee of civic leaders with a genuine desire to improve the City as a whole, and a willingness to compromise on behalf of narrower interest groups to achieve the social good. The cost was the resources and time to educate the BRC about technical matters, and the time to build trust among the members of the BRC. This stands in contrast to the political model of appointing to positions of regulatory authority those who have gained technical knowledge through rent seeking behavior.

NOTES

1. The economist was one of the authors, Darwin C. Hall.
2. The work of the BRCs was assisted by extensive support from DWP staff under the direction of Gerald Gewe, DWP Project Director, including Richard West, Water Rates Manager and Samuel Hernandez. The BRC also was assisted by consultants from David M. Griffith & Associates, including Michael Mount and Robert Reed, and from Richard M. Hairston. Professor Shmuel Oren from U.C. Berkeley served on the Technical Advisory Panel from March to May, 1992. Dr. Hethie S. Parmesano of NERA served as a consultant to DWP during the first BRC and as a member of the Technical Advisory Panel from March to June, 1992.
3. In September 1994, the SWRCB completed its review of Mono basin diversions, called for by the 1983 ruling in the National Audubon case. The SWRCB imposed conditions similar to those adopted after the 1990 appellate court ruling. It limited DWP's diversions to 4,500 AF/yr until the lake level reaches 6,380 feet, then to 16,000 AF/yr until the lake reaches 6,391 feet, and then to 31,000 AF/yr until the lake reaches 6,410 feet. The SWRCB's decision was based on extensive hearings and an Environ-

mental Impact Report (EIR) of which Hanemann was one of the authors. The economic analysis in the EIR is described in the chapter in this book by Wegge, Hanemann and Loomis (this volume).

4. See State Water Contractors (1992). MWD abandoned this position in October 1993, announcing that it now expects to be able to keep the CRA filled to capacity through water market purchases in the Colorado River system.

5. Hanemann served as the SWRCB's economic staff for the Delta decision process from 1987 to 1989, and was a co-author of the 1988 Plan.

6. A potential problem is that customers could waste water in the winter to increase the amount of water in the summer charged at the initial block rate. The sewer charge is ideally dependent on indoor use, and winter use can be a proxy for indoor use. Therefore, when the sewer charge is based on winter use, there is little worry that commercial customers will waste water in winter in order to extend the breakpoint during the summer.

7. For two or three customers, like a baseball stadium, this rate design was modified. The allowance for exceptional cases was accounted for in the Rate Ordinance, but each case required special action by the Board of Commissioners of DWP.

8. See Russell and Shin (this volume) for a description.

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