Water Pricing in the West: What is Fair?

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Residential water prices exhibit considerable variation through time and space. Understanding the origins of this variation and how it affects consumers with varying levels of financial resources can help us design better water pricing schemes. In this short essay, I first clarify the economic arguments for price regulation and what they imply in terms of pricing structure. I then review the literature that highlights the need for fairness considerations in water pricing, and propose three equity criteria adapted from the philosophy of justice literature. Finally, I provide new evidence on the pricing of water in California among urban retail water suppliers, discuss how their pricing schemes perform in terms of equity, and compare the prices of utilities receiving water from the Colorado River with the rest of the state.

1 The economic rationale for price regulation

The most important result in economic theory is called the *First Fundamental Theorem of Welfare Economics*. It can be stated in one sentence: If markets are *perfect*, then they deliver *efficient* allocations of resources. The notion of efficiency is relatively straightforward. Simply put, it means that markets provide the greatest good for the greatest number of people.[1] The concept of a "perfect" market, on the other hand, is slightly more complex. In fact, undergraduate students spend four years defining what are "perfect" markets and studying their desirable properties. Among the list of characteristics that a market has to satisfy to be considered "perfect" are i) a large number of firms that compete with one another, and ii) the absence of economies of scale in production.

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[1]There are some subtleties to the notion of economic efficiency. In particular, economics often implicitly refer to "Pareto Efficiency", which means a situation where the welfare of any individual cannot be increased unless we decrease the welfare of another individual. Pareto Efficiency is very restrictive (it's hard to please everybody), and economists prefer to view as desirable a policy that *could* lead to improved outcomes for at least one individual, without making anyone worse off, *if* the relevant transfers between individuals are performed. This second notion of efficiency is called "Pareto improvement with potential compensation" (and is one of the greatest scam in the economics literature, as recently discussed in Sallee (2019)).

When a market is not perfect, economists view it as a great cause for excitement since it means that *regulation* could increase efficiency. And, sure enough, water markets (and in particular residential water distribution) suffer from market imperfections. In particular, providing water to consumers entails very large *fixed costs* (water supply costs, distribution infrastructures, etc). As a result, water distribution exhibits economies of scale: it is very expensive for a utility to provide water to a few residents, but once the utility is in place, it becomes much cheaper to provide water to additional residents. This implies that it is in general less costly to have only one utility providing water in any given area (intuitively, having two water systems and two complete sets of pipes operated by distinct utilities would be a complete waste of resources). Unfortunately, having only one utility means that there is no competition between firms. Without price regulation, the only utility in town would charge a *monopolist* price, which would be too high.

This quick discussion illustrates that from a purely economic efficiency perspective, water prices need to be regulated. We can further show (as in Levinson and Silva (2019) for instance) that in the presence of large fixed cost, the efficient way to price water is to have a fixed charge, or **service charge**, that does not depend on the amount of water consumed by individuals, and a variable charge, or **commodity charge**, that increases with water consumption. Virtually all large utilities in the United States (and in the West in particular) have this two-parts pricing structure.

2 Equity considerations in water pricing

If a two-parts pricing structure is economically efficient, it does not automatically lead to a *fair* pricing scheme. The need for equity considerations in water pricing been acknowledged for a long time in the literature (see for instance Rogers et al. (2002) for a review). Different concepts of equity lead to different policy recommendations in terms of water pricing.

2.1 Sustainability

Due to its vague definition, the concept of sustainability can be viewed as both an efficiency concept and an equity concept. This leads Bakker (2001) to argue that that "the false paradox between efficiency and equity requires deconstruction". For instance, Rogers et al. (2002) argue that water pricing should be based on the *full* cost of water, not just the economic cost. For Rogers et al. (2002), the economic cost includes operation and management costs, capital costs, pumping costs and opportunity costs, whereas the full cost need to further include the "net impact to the environment", in order to achieve sustainability. While this breakdown is correct from an accounting perspective, these separations of costs do not arise in economic theory. For economists, the "impacts to the environment" are intrinsically part of the "economic costs", and hence should be taken into account to set efficient prices. What is regularly omitted from economic models, however, is the welfare of future generations. When economists derive the set of "efficient prices", they often mean efficiency from the point of view of the current generation only. Some economists have long recognized that issue. Mathematician and economist Graciela Chichilnisky was among the first to provide a mathematically consistent definition of sustainability, and derived a set of results to include the welfare of future generations in models of optimal growth (Chichilnisky, 1996).

The issue of sustainability in water pricing mostly arises in irrigation agriculture (see for instance Tsur and Dinar (1995), Abu-Zeid (2001) and Massarutto (2003) for reviews of efficiency and equity in irrigation water pricing). This is because agriculture is one of the largest sector consuming water (especially in the American West), and is a sector that tends to pay a highly subsidized price (especially in the American West, where ground water had until very recently an implicit price of ...zero). Low prices lead to over consumption, and over consumption of groundwater can lead to an irreversible loss of groundwater storage: for instance, Smith et al. (2017) estimates that at least 5% of groundwater storage capacity has already been lost in the San Joaquin Valley due to subsidence and permanent compaction caused by intense pumping.

2.2 Interpersonal equity

Until the end of the twentieth century, philosophers of justice used to think of the role of equity as to simply "correct for bad luck". For instance John Rawls, one of the most prominent members of the justice John club,[2] described the famous thought experiment of the "Veil of Ignorance" (Rawls, 1971): in this experiment, the "fair" amount of inequality is the one that you would choose to see in the world *before* you know where you will be born and what will be your lot. Because of this uncertainty, and the potential for bad luck, most people playing this experiment would tend to avoid choosing extreme levels of inequality.

At the end of the twentieth century, the philosopher Elizabeth Anderson (one of John Rawls' students) wrote a groundbreaking paper called "What is the Point of Equality" (Anderson, 1999) that amounted to a little bomb in the philosophy of justice circles. In this paper, she argues that the role of equality is not to correct for some "cosmic injustice", but is instead intrinsically political. In her view, the goal of equality is to end oppression.

Adapting this view to the case of water pricing, we can argue that a fair scheme should not impose a higher price of water on poorer individuals than it does on wealthier individuals. Unfortunately, this is exactly what a standard, efficient two-part pricing scheme does, since richer individuals tend to consume much more water than poorer individuals. The service charge means that poorer individuals pay their water at a relatively higher price. To see this, assume that the service charge is \$10/month, that a poor household consumes one unit of water per month, that a

[2]A John club is a boys' club where most people are called John. The other famous thinkers of justice in the club are John Locke and John Stuart Mill. For a recent and prominent John club, see the Fortune 500: `https://www.nytimes.com/interactive/2018/04/24/upshot/women-and-men-named-john.html`

wealthy household consumes two units per month, and that the commodity charge on water is $1 per unit. In this scenario, the poor household pays $11 for one unit of water, whereas the wealthier household pays $12 for two units.

One tweak to the standard two-part pricing schedule can fix this issue: the use of **increasing block rates**, or tiers. With tiers, low volumes of water consumption have a lower price than high volumes. For instance, in a system with two tiers, water can cost $1 per unit from 0 to 10 units, then $2 per unit above 10 units. This is for instance argued by Savenije and van der Zaag (2002), and Bithas (2008) argues that increasing block rates is a "clear example of societies having decided that neoclassical economics do not apply to the provision of domestic water services".[3]

Increasing block rates further have the additional benefit of promoting water conservation, and hence sustainability.[4] In this regard, the more tiers, the merrier. For an early study of the equity potential of increasing block rates applied to the context of Tucscon (AZ) see Agthe and Billings (1987).

2.3 The capability approach

Finally, philosopher Martha Nussbaum and economist Amartya Sen jointly developed a framework which highlights that the freedom to achieve well-being should itself be pursued, and is a requisite to human dignity (Nussbaum and Sen, 1993; Sen, 2005). The ability to achieve well-being is then described as arising from a set of *capabilities*, which are an individual's actual opportunities of achieving certain *functionings*, understood as states and activities.[5]. This all sounds very theoretical (it is, after all, a theory), but also has very concrete consequences. In particular, we can interpret Nussbaum and Sen's approach to argue that an equitable water pricing scheme should provide some amount of water *free of charge* to allow individuals to achieve their basic needs. For instance, we could decide to calculate how much water is needed for basic cooking, drinking and bathing, and provide this amount of water for free each month (Barberán and Arbués (2009) discuss the thorny question of household size). Water spent in excess of this amount would then be charged at a relatively high price to make up for the lost money on the low consumption tiers. That way, people who wish to take thirty-minutes showers and sprinkle their front loan would implicitly subsidize the basic water needs of everyone else.

Summing up, the equity criteria that we have discussed call for clear pricing adjustments:

- Sustainability and interpersonal equity both call for higher prices charged on the highest consumers: this implies the use of increasing block pricing instead of uniform pricing

[3]This partly reflects an abuse of language. Most of neoclassical economics is not concerned with equity (above potential Pareto compensation). As such, the use of equity considerations is merely an *extension* of the neoclassical framework.

[4]If prices are high enough

[5]Their framework is hard to summarize in a paragraph, but the Stanford Encyclopedia of Philosophy as a great introductory article: `https://plato.stanford.edu/entries/capability-approach/`

- Interpersonal equity and the capability approach call for a reduction of the service charge
- The capability approach call for a service charge near zero, with a certain amount of water offered for free

3 Residential water pricing in California and the valuation of the Colorado River's water

I use a novel data set of consolidated water prices charged by public utilities in California called the Open Water Rates Specification (OWRS) dataset.[6] I focus on large California utilities, both public and private, that serve at least 8,000 individuals.[7]

I would ideally like to compare how the water from the Colorado River is priced relative to the water from other sources. This exercise is unfortunately hard to perform, as utilities usually get their water from a variety of sources that I don't directly observe. However, a large portion of the Colorado River water is distributed by the Metropolitan Water District (MWD) in Southern California, and MWD mostly provide water to utilities located in six counties. I represented these utilities in red on Figure (1).

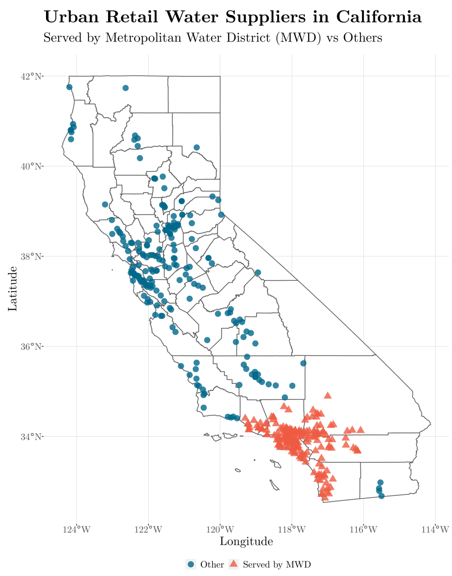

Figure 1: Largest water utilities in California

[6]These data were cleaned during the California Water Open Data Challenge 2019 by Lauren Adams, Ben Dawson, Ian Morelan, Kyle Onda, Wai Yan Siu and myself. All data are publicly available here: `https://github.com/JoakimWeill/ca_owrs`

[7]I removed utilities using a Budget-Based approach to water pricing. While this approach is promising from an equity stand-point, it is only implemented by a miniority of utilities in the State and would take an extra page to describe properly.

3.1 Service charge

The service charges are very heterogeneous within the state, with some utilities having completely removed the service charge, while others charge more than USD$60 per month (see Figure (2))[8].

When we compare the service charges in counties served by the MWD versus other counties, the distributions look very similar (see figure 3). This is further confirmed by a Kolmogorov-Smirnov test: the distributions are not significantly different.[9]

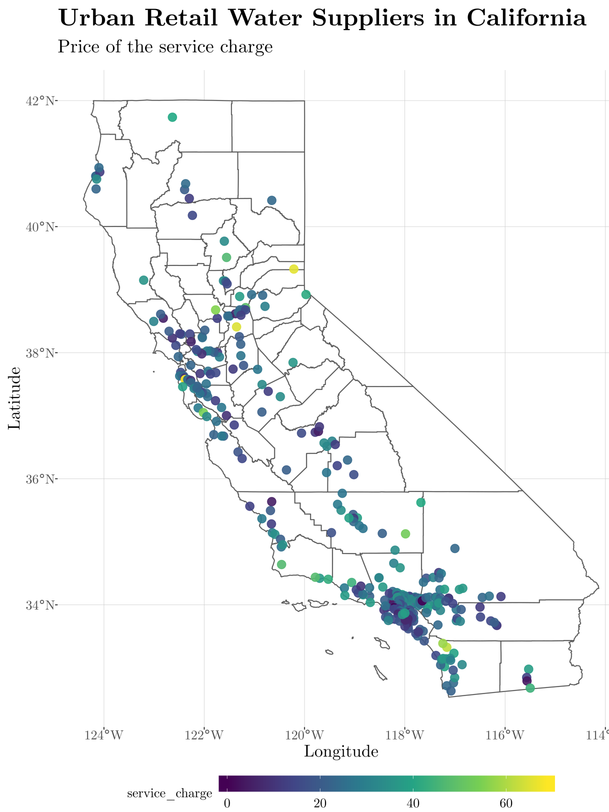

Figure 2: Service charges are very heterogeneous in California

[8]The astute reader might notice that some utilities appear in Figure 1, but not in Figure 2. This is due to the incompleteness of the price data. I am working on updating these data for a different project.

[9]MWD partially subsidized the ECOGEO trip, so the cynical reader might rightfully enquire about conflicts of interests. I can only say that I produced these figures before MWD started to contribute to ECOGEO; you don't have to take my word for it, as the data is available online if anyone wants to do a re-analysis.

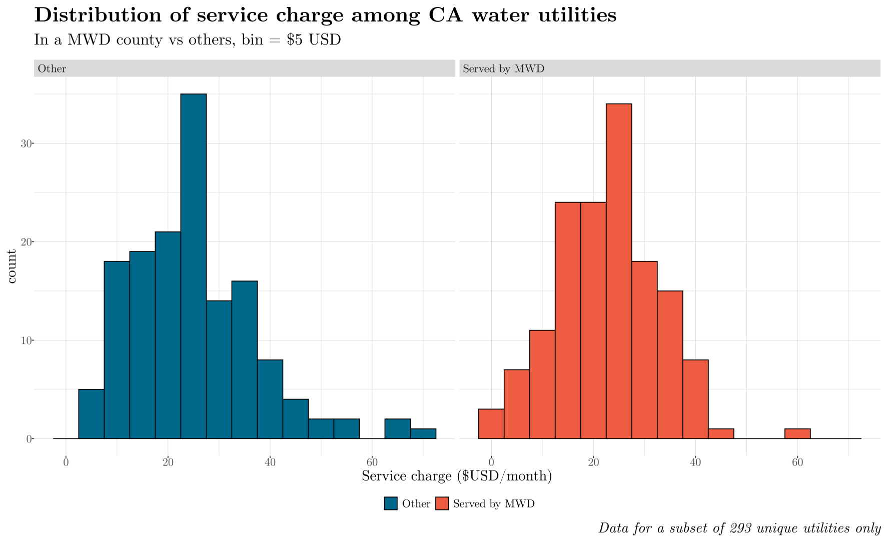

Figure 3: Are "MWD-served counties" less equitable? At first glance, no difference

3.2 Uniform vs Increasing block pricing

Most utilities in California are using increasing block pricing (in yellow on Figure (4)), which everything else equal is pretty good from an equity stand-point.

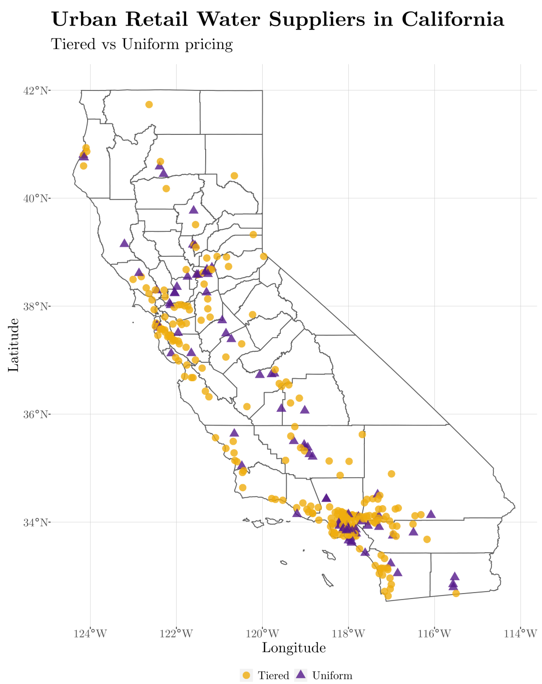

Figure 4: Tiered vs Uniform pricing

3.3 Increasing block pricing and minimum prices

Finally, among the utilities that have increasing block pricing, we can look at the price within each tier to assess how these utilities perform on our equity criteria. Figure (5) shows the distribution of the prices charged at each tier.[10] The capability approach criteria calls for free consumption up to a certain volume, so equitable prices from this perspective would lead to a mass at $0/kgal, which we do not observe. Sustainability calls for high prices on higher tiers: while some utilities tend to charge more than $10/kgal on the highest tiers, many utilities charge less than $5/kgal on their biggest consumers.

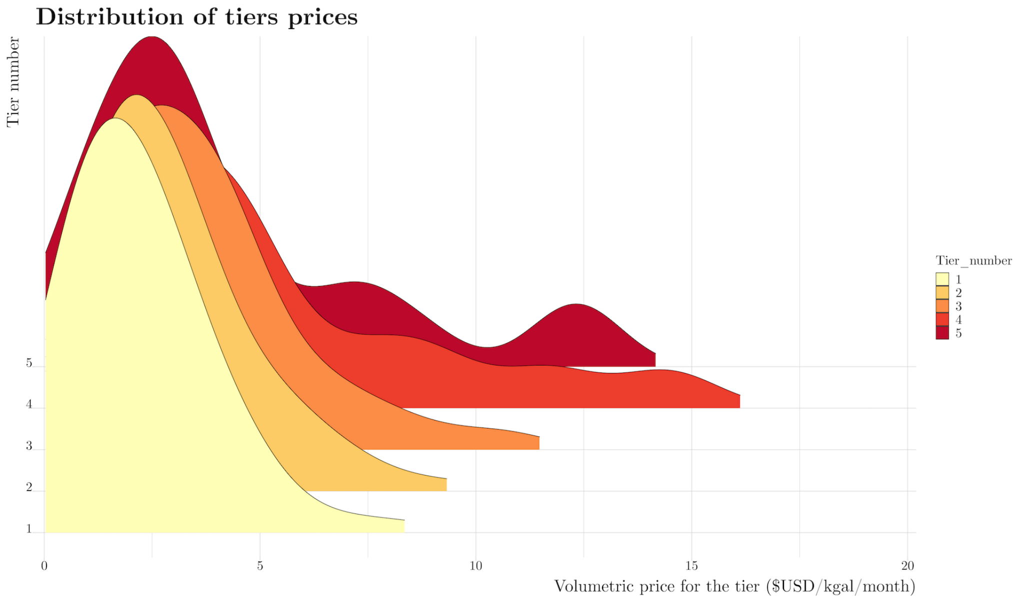

Figure 5: Tiered vs Uniform pricing

4 Conclusion

Pricing water is a complex issue that needs to account for both cost-recovery and equity concerns. Several equity criteria imply to provide water for free up to a certain volume, but the highest consumers need to face higher prices to ensure that water is not wasted on swimming pools and golf course looking front yards.[11] Increasing block pricing achieves this middle-ground, and most of the large water utilities in California are using this structure. However, to comply with the equity considerations that we presented, many utilities need to reduce prices on the lowest tiers (with the tier-limiting volume potentially adjusted), while prices on the highest tiers need to be increased.

[10] The tiers are defined differently by different utilities. A more complete analysis would redefine tiers to compute how different utilities charge the first kgal, 5 kgals, etc.

[11] If anyone can explain to me why most of the US (and the water-scarce South West in particular) waste so much water on front yards, I'd love to hear it.

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