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Olmstead, Sheila, W. Michael Hanemann, and Robert N. Stavins. 2007. "Water Demand under Alternative Price Structures." *Journal of Environmental Economics and Management* 54 (2): 181–98.
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Comment Erin T. Mansur

From one point of view, climate adaptation can be thought of as a series of responses to supply and demand shocks. From this perspective, a well-functioning economy determines the socially optimal response. In other words, if markets are perfectly competitive—whereby all market failures of externalities, market power, imperfect information, and so on have been addressed—then the economy will adapt to market shocks in an efficient manner. Thus, the role of government is not to impose the outcome (for example, by subsidizing farmers to use more heat-tolerant crops or requiring power companies to construct more dams for hydropower capacity) but rather to facilitate well-functioning markets.

Thus, correcting failures in those markets most sensitive to climatic change becomes the focus of market-based adaptation policy. In particular, Smith looks at consumer pricing of two goods that are especially likely to become increasingly scarce, water and power, due to supply and demand shocks, respectively. These goods are expensive to store and have volatile supply and demand, respectively. Dynamic, or real-time, pricing of such goods would be a possible response. We observe this type of pricing in other markets with similar characteristics, such as hotels and airplane flights. However, utilities have been restricted (in part, because of regulation but also, at least historically for electricity, because of technological limitations). Thus, a single price, or price schedule, has been used without correcting for volatile supply and demand. Climate change is expected to increase the importance of peak load pricing in both water and power.

Smith begins by modifying a model on peak load pricing from Carlton (1977). Carlton and others noted the importance of allocation rules when prices do not clear the market. In some cases, there will be excess demand and, without variable prices in the short run, the good may still be allocated

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to those willing to pay the most for it (i.e., efficient), or it may be randomly assigned.

The main focus of Smith's chapter is on how climate change will affect these optimal decisions. In particular, climate change will affect the supply of water and the demand for electricity in a stochastic manner. This additional source of variation complicates the objective function and needs to be taken into account when thinking about optimal pricing and capacity decisions. The chapter does this by adding natural supply to this discussion of capacity: $\phi = \phi(s, n)$.

This is a useful modification for water and also for power if we think of demand shocks as negawatts. Note that much of the discussion of demand side management programs also includes demand as part of the "supply" function. Nonetheless, a more direct treatment of this uncertainty may be to include it in demand, u. However, climate change may have a direct effect on supply in regions with a significant amount of hydropower.

The chapter discusses two important features: ϕ may be nonlinear; and shocks to natural supply could be correlated with with demand shocks, u. For water, less precipitation will likely increase people's willingness to pay for utility-provided water (for watering lawns) and also decrease the utility's ability to supply water as its reservoirs will likely have less in them. This negative correlation will exacerbate the welfare loss from incomplete pricing (namely the loss that would be avoided by real-time pricing). While this correlation has not yet been included in the model, I think that this would be an interesting extension of the current chapter.

Smith suggests that this correlation may be an important characteristic of actual water demand. In particular, Klaiber et al. (2010) estimate water demand using data from households in Phoenix. For each census block and month, they calculate the quantity consumed at the 10th, 25th, 50th, 75th, and 90th percentiles. They then look at the change in consumption for that calendar-month, census block percentile group from the base year (2000) to another year (2002 or 2003). Averaging across census blocks and summer/winter months, they find several results that are consistent with those found in Mansur and Olmstead (2010): larger consumers are less elastic (Mansur and Olmstead find consumers with greater income are less elastic and purchase more water); and summer elasticity is greater than that in the winter (Mansur and Olmstead find outdoor demand is more elastic than indoor demand and makes up a larger share of total demand in the summer). Klaiber et al. (2010) then compare price changes from a normal to a normal year versus prices changes from a normal to a dry year. They find that summer demand is less elastic in the dry year. However, somewhat surprisingly, they then find that winter demand is more elastic in the dry year.

On identification, Klaiber et al. (2010) argue that ordinary least squares (OLS) is unbiased. In general, OLS estimates of a cross section of households facing increasing block pricing will result in biased, possibly positive, estimates of demand elasticity (e.g., Olmstead 2009). However, Klaiber et al. (2010) are mostly identifying demand response from changes in prices over time. They argue that OLS will be consistent as none of their consumer groups changed from the low price block to the high price block, or vice versa, when prices changed over time. However, Olmstead, Hanemann, and Stavins (2007) note that *all* prices enter into a household's demand function given uncertainty. This suggests that more complicated estimation strategies that account for nonlinear pricing may result in different estimates. In particular, demand elasticity estimates for those households near the block pricing kink point may be the most biased. Olmstead (2009) finds that the structural model of water demand and two stage least squares result in similar estimates for her sample, so the bias in Klaiber et al. (2010) may be small.

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