Journal of Environmental Economics and Management 79 (2016) 114–134

Contents lists available at ScienceDirect

Journal of Environmental Economics and Management

journal homepage: www.elsevier.com/locate/jeem

Conservation policies: Who responds to price and who responds to prescription?☆

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ARTICLE INFO

Article history:
Received 30 August 2014
Available online 22 July 2016

JEL Classification:
Q25
D12
H42
L51
L95

Keywords:
Water demand
Nonprice policies
Price regulation
Conservation
Drought

ABSTRACT

The efficiency properties of price and nonprice instruments for conservation in environmental policy are well understood. However, there is little evidence comparing the effectiveness of these instruments, especially when considering water resource management. We exploit a rich panel of residential water consumption data to examine heterogeneous responses to both price and nonprice conservation policies during times of drought while controlling for unobservable household characteristics. Our empirical models suggest that among owners of detached, single-family homes in six North Carolina municipalities, relatively low-income households are more sensitive to price and relatively high-consumption households are less sensitive to price. However, prescriptive policies such as restrictions on outdoor water use result in uniform responses across income levels, while simultaneously targeting reductions from households with irrigation systems and historically high consumption.

Introduction

Although prescriptive policies are commonly employed by resource managers to encourage conservation, economists tend to advocate for pricing mechanisms on efficiency grounds. However, many environmental management contexts involve resources whose prices are regulated by utility commissions or federal oversight. As such, the use of pricing tools to encourage conservation is politically challenging. This is particularly true with water resource management. Efficiency would dictate that price should reflect long-run marginal cost of provision, including scarcity rents, which is typically greater than regulated market prices (Mansur and Olmstead, 2012). As such, nonprice strategies, also referred to as prescriptive policies, have become popular demand management tools for water conservation during periods of drought when the short-run reliability of water resource systems is at risk. These strategies can take the form of restrictions on outdoor

☆ Partial support for this research by the Center for Environmental and Resource Economic Policy (North Carolina State University) and the Environmental Finance Center (University of North Carolina, Chapel Hill) is gratefully acknowledged. The authors thank participants at the following workshops and conferences for helpful suggestions: Camp Resources, Appalachian State University, the Association of Public Policy Analysis and Management, the North Carolina Water Resources Research Institute, the Property and Environment Research Center, and the Agricultural and Applied Economics Association Annual Meetings. Two anonymous referees and the co-editor provided helpful comments.

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http://dx.doi.org/10.1016/j.jeem.2016.07.001
0095-0696/

water use (Castledine et al., 2014; Renwick and Green, 2000), information campaigns (Coleman, 2009), social comparisons (Ferraro and Price, 2013; Brent et al., 2015), or financial incentives for technology adoption (Bennear et al., 2013; Renwick and Archibald, 1998).[1] A noteworthy case where nonprice (and to a lesser degree, price) policies have been adopted to reduce water consumption is that of California, where Governor Jerry Brown recently issued an executive order that mandates a 25 percent reduction in urban potable water use to combat the ongoing statewide drought.[2]

Despite growing use of nonprice policies in environmental contexts, and a corresponding literature measuring their effectiveness, there is little evidence of the relative merits of pricing versus prescriptive restrictions using household-level data that allow consideration of both policy types simultaneously. Moreover, there is even less evidence about the heterogeneity in responsiveness to these conservation tools across households. This research aims to fill these gaps with an application to residential water demand management. These responses are important to understand because water utility managers and policymakers are concerned with the incidence of pricing policies on lower-income households. Further, an important goal of water utilities is to manage the use of high-consumption households to minimize the need to invest in additional water infrastructure. While efficient pricing—such as dynamic increasing block rates or lump-sum rebates to low-income households—could address some of these concerns, they are rarely used in practice.

In this research, we provide evidence on important observable household and housing characteristics that influence responsiveness to demand-side management policies while econometrically controlling for unobservable household attributes. Olmstead and Stavins (2009) lay out an exhaustive comparison of price and nonprice policies and conclude that neither prices nor prescriptive policies are superior in their distributional bona fides, despite prices being a more cost-effective management tool. Although we do not directly consider the incidence of price and nonprice policies in this research, we provide strong empirical evidence that prescriptive conservation interventions have more palatable impacts across socioeconomic groups (compared with pricing policies) and lead to reductions among high resource users.

Our analysis exploits a rich dataset of monthly water consumption for 1727 households residing in detached, single-family homes located in six North Carolina municipalities. The data cover a two-and-a-half-year period that includes one of the most severe droughts in North Carolina history, as well as normal weather conditions. Our data include variation in drought conditions, price, and nonprice policies across municipalities both spatially and temporally. Further, for each household we observe socioeconomic and housing characteristics, including the household's income, lot size, and whether an irrigation system is present. Our rich panel data allow us to improve on the econometric strategies of recent research on water conservation that uses either aggregate data (Renwick and Green, 2000; Klaiber et al., 2014; Halich and Stephenson, 2009), relatively short panel data (Olmstead, 2009; Mansur and Olmstead, 2012) or data without simultaneous variation in pricing and prescriptive policies (Nataraj and Hanemann, 2011; Ferraro and Price, 2013; Castledine et al., 2014; Wichman, 2014; Brent et al., 2015). Given the long panel and rich variation in key variables, we are able to identify price and nonprice policy responses that reflect short-run responses within a household while controlling for time-invariant unobservable household characteristics that might confound results.

Our results suggest that voluntary and mandatory prescriptive policies focused on outdoor watering restrictions achieve approximately an 8.5 and 13 percent reduction in aggregate consumption, respectively. Interestingly, there is a notable lack of heterogeneity among households in their responsiveness to voluntary and mandatory prescriptive policies, with the very important exception of households with irrigation systems or those that are large-volume consumers. Households with irrigation systems and households in the upper 20th percentile of average consumption in their municipality are found to be almost twice as responsive to mandatory policies relative to other households. These results are robust to alternative model specifications, controls for the irrigation season, and definitions of key variables.

With respect to price responsiveness, we find short-run price elasticities ranging from -0.15 to -0.30 in our preferred models, which is consistent with the existing literature. Moreover, results from our empirical models suggest that there is important heterogeneity in how households respond to price: relatively low-income households are more responsive to price, whereas households with irrigation systems are essentially unresponsive to the price changes that occurred during our sample period. However, our estimated price coefficients are sensitive to whether we include the average or marginal price of water in the model, where the former generates robust and plausible demand responses but the latter does not. As we describe in the empirical strategy and results section, there are behavioral reasons why households may respond to average, rather than marginal, prices (e.g., Ito, 2014; Wichman, 2014). Alternatively, the sensitivity of our marginal price coefficients may be driven by limited price variation. We find this explanation somewhat less likely since our robust and plausible average price results are identified with *less* price variation than the inconsistent marginal price results (see the empirical strategy and results section). Regardless, it is interesting to note that our elasticity estimates suggest that an average price increase of more than 50 percent would be required to achieve the same 13 percent reduction in water use that the prescriptive policies achieved. This price increase would raise annual expenditures on water by $330 for the average household in our sample.[3] Of course, this calculation is only suggestive since it is based on a large, non-marginal change in price that is outside the range of our observed data.

[1] Select examples of these tools being used in the energy sector to manage household demand include social comparisons (Allcott, 2011) and financial incentives for technology adoption (Alberini et al., 2013).

[2] https://www.gov.ca.gov/docs/4.1.15_Executive_Order.pdf, (accessed 08.10.15).

[3] All dollar values reported are real and have been deflated to 2006$.