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Towards understanding the role of price in residential electricity choices: Evidence from a natural experiment☆

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ABSTRACT

We examine a choice setting in which residential electricity consumers may respond to non-financial incentives in addition to prices. Using data from a natural field experiment that exposed some households to a change in their electricity rates, we find that households *reduced* electricity usage in response to a contemporaneous decrease in electricity prices. This provides clear evidence that other factors – potentially encompassing non-monetary and dynamic considerations – can influence consumer choice, and even dominate the static price response in some cases. A comprehensive understanding of household behavior in energy markets is essential for the effective implementation of market-based energy and environmental policies. The documentation of our result and others like it is a necessary step in achieving such an understanding.

1. Introduction

Most economists, including ourselves, favor market-based approaches to addressing energy and environmental issues. The theoretical attractiveness of such instruments relies partly on being able to predict how consumers will respond to prices. But a growing body of empirical evidence suggests that within the energy choice setting, consumer behavior can be affected by a number of non-pecuniary factors in addition to prices. Further, some consumer decisions today will affect energy requirements in subsequent months and years, implying that anticipated prices far into the future may also play a

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role. Understanding the full context in which consumer choices are made is crucial for designing market-based instruments that can achieve efficiency in energy markets and broader environmental goals cost-effectively.

In this paper, we document an instance in which households did not respond to a retail electricity price intervention as economists would generally predict. Specifically, the intervention *lowered* the price of electricity for a number of months, but we find that households responded to it by *decreasing* their electricity usage in those months. Our empirical setting offers a unique opportunity to test how consumers respond to contemporaneous prices when other considerations may also be important, and we find conclusively that in this instance the other drivers of behavior dominated. While we are left to speculate about the precise mechanisms that were at play, our results suggest that there may be risk in adhering too ideologically to price interventions in terms of missing policy goals or achieving them only imperfectly or inefficiently. An assertion that static price incentives always work can be disproven by the counter-example we provide.

Our findings may not be entirely surprising. The theory of "bounded rationality" has long predicted that it may be rational for consumers to be imperfectly informed or to not deploy full cognitive effort in the face of information acquisition or cognition costs (Simon, 1955), leading to outcomes that appear sub-optimal. More generally, people may be motivated by intrinsic forces in addition to extrinsic (e.g. financial) incentives. This concept, already widely accepted by psychologists and sociologists, has recently entered the economics domain in Benabou and Tirole (2003) and others. In the residential electricity choice setting, non-monetary incentives such as moral license or pressure to conform to social norms can dominate financial incentives. Voluntary enrollees in carbon offset and green electricity programs increase their electricity consumption despite also facing higher prices (Harding and Rapson, 2013; Jacobsen et al., 2012), and customers informed of their neighbors' electricity usage respond by using less themselves (Allcott, 2011). Altruism and green identity also play important roles, with environmental concerns becoming a relevant aspect of consumer decisions (as in Kotchen and Moore, 2007).

In addition to the significant potential for such non-financial motivations to influence electricity choices, consumers grapple with the complexity of the setting, which could reduce the effectiveness of price signals. Features such as multi-tiered pricing structures (as explored by Reiss and White, 2005) or noisy signals about consumption may limit customers' ability to respond to prices. Consumers facing an increasing-block electricity rate structure appear to respond more to average price than marginal price (Ito, 2014), and high frequency information about real-time consumption increases the price elasticity of electricity demand (Jessoe and Rapson, 2014). Interventions that make prices or expenditure more salient may meaningfully influence household electricity usage: for example, residential consumers have been shown to conserve electricity immediately after receiving their electricity bill (Gilbert and Graff-Zivin, 2013).

These results suggest that the price elasticity of residential electricity demand may depend on several very specific aspects of the various settings in which different consumers make their electricity choices. Unobserved variation in the presence of these factors within and across different populations may therefore partially explain the variety of estimated price elasticities that have been reported in the literature (e.g. Alberini et al., 2011; Fell et al., 2014; Reiss and White, 2005; Ito, 2014). A sensitivity of price responsiveness to unobserved factors may also make broad policy recommendations drawn from a limited number of program evaluations misleading. For example, Faruqui and Sergici (2010) provide a meta-analysis of a number of price interventions and conclude that price-based policies are an effective means to achieve desired reductions in usage. However, while their findings may indicate that prices often work, they do not imply that prices always work, and give regulators limited guidance on how future interventions can be designed most effectively.

In this paper, we present a case in which a price change did not work as expected, in the sense that the implied short-run price elasticity is large and of the wrong sign. This surprising result is well-identified by a natural experiment that we partnered with an electricity distribution company (EDC) to evaluate. The EDC, located in the northeast US, implemented a large-scale mandatory residential time-of-use (TOU) program that forced households to switch irrevocably from a flat rate tariff to a TOU tariff after breaching a monthly usage threshold.[2] The setting gives rise to a regression discontinuity framework in which we compare outcomes of households just above the usage threshold to those of households falling just below the cutoff. Due to customers' inability to perfectly control monthly usage, in the neighborhood of the usage threshold assignment to the TOU rate is as good as random. The large-scale deployment of the program exhibits a high density around the threshold, creating a large sample of treatment and control households on which we examine responses to the change in the price of electricity induced by the intervention.

In the first summer months of the program in 2008, TOU rates were low relative to the flat rate alternative. Whereas the standard formulation of TOU prices is for the on-peak rate to be substantially higher than the flat rate and the off-peak rate substantially lower, in our setting TOU households faced on-peak rates in June to September of 2008 that were either lower than the relevant flat rate, or only slightly higher.[3] Off-peak rates were correspondingly even lower. The static financial incentives for TOU households are clear: total electricity use in those months – regardless of substitution patterns across on-peak and off-peak hours – should increase.

[2] TOU electricity pricing divides electricity use into two blocks according to the time of day at which electricity is consumed, and applies a higher rate to the block corresponding to historically high-cost times. It is a small step towards aligning retail electricity prices with marginal production costs. It is also the most common corrective measure used by electricity regulators to achieve such an alignment, due largely to the crucial advantage of being easy for consumers to understand and, in principle, respond to.

[3] Customers may purchase the generation component of their electricity services from either our EDC partner or an alternate supplier. This choice affects the relative on-peak and off-peak prices (the "TOU gradient"). In the discussion below we demonstrate why this does not affect our conclusions.

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