Journal of Environmental Economics and Management 74 (2015) 94–106

Contents lists available at ScienceDirect

Journal of Environmental Economics and Management

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

Do energy prices influence investment in energy efficiency? Evidence from energy star appliances

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ARTICLE INFO

Article history:
Received 4 November 2014
Available online 8 October 2015

JEL:
Q3
Q4
D1

Keywords:
Energy efficiency
Energy Star
Appliances
Electricity prices
Energy efficiency gap
Energy efficiency paradox

ABSTRACT

I examine whether electricity prices influence the likelihood that consumers purchase high efficiency appliances by using state-year panel data on electricity prices and the proportion of sales of new appliances that involve high efficiency "Energy Star" models. I find no evidence that electricity prices affect the propensity for consumers to choose high efficiency appliances. Point estimates are extremely small and precisely estimated. The findings suggest that price-based energy policies may be limited in the extent to which they increase investment in residential energy efficiency, which has been considered one of the lowest cost opportunities for reducing carbon emissions.

Introduction

The negative externalities that are associated with energy consumption, often in the form of emissions of greenhouse gases and other pollutants, provide the basis of numerous policies aimed at reducing energy consumption. Price-based policies, such as an emissions tax or cap-and-trade program, provide an appealing avenue by which to induce conservation because the increase in energy prices provides incentives for a broad set of economic actors to find ways to reduce their consumption. For example, a substantial literature on the price elasticity of demand for electricity has found that households reduce consumption in the face of elevated prices.[2]

The way in which households reduce consumption is likely to have important implications for the welfare effects of price-based policies. A large body of literature on the "energy efficiency gap" (sometimes called "energy efficiency paradox") has presented evidence that consumers substantially under-invest in energy efficiency and that many investment opportunities exist that offer high rates of return in the form of reduced energy bills.[3] In the presence of unexploited opportunities for high-return investments in energy efficiency, the loss in consumer surplus from a price-based policy may be very low or even negative if consumers respond to policy-induced increases in prices by purchasing high efficiency appliances and

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[2] See Espey and Espey (2004) for a meta-analysis of the price elasticity of demand for residential electricity. Kahn et al. (2014) present related evidence on the importance of energy costs in the commercial sector.

[3] Gillingham and Palmer (2014) and Allcott and Greenstone (2012) provide recent surveys on the energy efficiency gap. Both papers suggest that the energy efficiency gap has likely been overstated in many studies (especially in consulting reports from McKinsey and Co.), but that the gap is also not zero.

http://dx.doi.org/10.1016/j.jeem.2015.09.004
0095-0696/

equipment. In contrast, if consumers respond by changing their consumption of energy services, for example by adjusting the thermostat, then consumers are likely to experience a more significant loss in surplus (albeit one that may be justified based on the simultaneous reduction in social damages).

While the relationship between energy prices and investment in energy-using durables has important implications for policy, research in this area is surprisingly sparse, especially within the context of electricity consumption. Of the studies that exist, most have been based on cross-sectional datasets. The earliest notable studies followed the energy crises of the 1970s and early 1980s. Hausman (1979) provides a discrete-model of consumer choice across types of air-conditioners based on 65 observations and Dubin and McFadden (1984) provides a similar analysis of consumer choice of heating systems. Both studies, as well as Gately (1980), find that households value but substantially discount future energy costs when purchasing appliances.

Perhaps prompted by heightened concerns related to climate change, there has been renewed interest among researchers regarding consumer adoption of electricity-using durables in recent years.[4] Rapson (2014) develops a structural model of demand for air-conditioners and finds evidence that consumers value the stream of future savings provided by high efficiency units. Houde (2014) develops a structural model of the U.S. refrigerator market and finds that consumers respond to both energy costs and efficiency labels, though substantial heterogeneity in the nature of the response exists across households. The key distinction of the present study is that it is based on panel data, whereas the earlier studies are both based primarily on cross-sectional variation in prices. Rapson (2014) analyzes cross-sectional variation in the prices faced by households observed in the Residential Energy Consumption survey, where average prices are computed based on a household's total electricity consumption and expenditures. Houde (2014) links sales data from a major retailer to average electricity price data (at both the state and county level) based on the zip code of the store where the purchase was made.

In this paper, I employ an advantageous yet underexploited dataset to provide new evidence on the relationship between energy prices and investment in energy efficiency. In particular, I evaluate the relationship between state electricity prices and the percentage of sales of new appliances that involve high efficiency "Energy Star" models using state-year level panel data on electricity prices and appliance sales patterns for the period from 2000 to 2009. The advantage of exploiting panel variation is that I can control for time-invariant differences across regions, such as differences in demographics, economics, and consumer preferences, which are difficult to fully control for in a cross-sectional setting. I find little evidence of a relationship between electricity prices and the market share of Energy Star appliances. The point-estimates are very small in magnitude and are precisely estimated. The finding is consistent across different types of appliances and robust to both fixed effects and first-difference specifications, as well as specifications that allow for lagged instead of contemporaneous price effects and specifications that instrument for electricity price changes using variation in natural gas prices.

While the finding that consumers do not respond to energy prices when choosing appliances seems inconsistent with simple models of utility maximization, other studies have documented results in various settings that foreshadow such a finding. Allcott and Taubinskly (2013) implement a field experiment to study the effect of presenting retail shoppers with information about the energy costs associated with different types of light bulbs.[5] They find that the availability of information on energy costs does not have a statistically significant effect on purchase patterns. Kahn and Kok (2014) conduct a hedonic study of the price premium for green homes, which typically have high levels of energy efficiency. They find little evidence that the price premium for a green home increases when there are elevated energy prices.[6]

In addition to being hinted at by earlier empirical studies, the lack of a response is also consistent with more nuanced theoretical models of consumer behavior in the context of energy efficiency. Using theory and evidence, Sallee (2014) shows that it is rational for consumers to ignore energy efficiency in many settings because assessing the value of energy efficiency often requires time and effort and because energy efficiency is unlikely to be a pivotal feature when consumers have strong preferences about other product attributes. Similar arguments can be applied in the context of this study. Given the complexities of electricity usage and billing, most consumers are likely to find it difficult to evaluate how energy prices influence the returns to energy efficiency and such knowledge, even if acquired, may be unlikely to influence their choice of product given the many different features of appliances.

Finally, while the finding that appliance sales patterns do not respond to state energy prices deviates from previous studies on energy prices and appliance choice, it is perhaps what one might predict in light of the labeling scheme used for appliances. In particular, yellow "EnergyGuide" labels are federally required for major appliances in the United States and provide information to consumers on the estimated yearly energy costs associated with different models of appliances. The

[4] There has also been renewed interest in the effectiveness of policies designed to promote efficiency. For example, Jacobsen and Kotchen (2013) show that energy efficiency standards for new buildings ("energy codes") are effective at reducing energy consumption and Jacobsen (2016) shows how energy codes could be designed to prioritize reduced consumption of energy types with large social damages.

[5] Note that Allcott and Taubinskly (2013) differs from the present study because their focus is primarily on information. In particular, they examine how information on the expected energy costs of each model (which varies by model due to the differing levels of energy efficiency) has an effect on consumer decision-making, as opposed to how changes in energy prices affect consumer decisions.

[6] More generally, there are numerous examples of unconventional consumer behavior within the residential electricity setting. Jessoe et al. (2014) find that households decreased their energy consumption in response to a shift to time-of-use pricing that represented a price *decrease*. Jessoe and Rapson (2014) present strong evidence of habit formation in residential energy consumption. Jacobsen et al. (2012) find evidence of moral licensing in the context of residential electricity consumption and green electricity programs. Gromet et al. (2013) presents laboratory-based evidence that prominent energy labels can lead to perverse outcomes for consumers with conservative ideologies. Fowlie et al. (2015) present experimental evidence that households have very low take-up rates of "weatherization" retrofits even when the expected benefits are sizable and the monetary benefits are zero.