Power to the people
Electricity demand and household behavior

Mattias Vesterberg

Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för
avläggande av filosofie doktorsexamen framläggs till offentligt försvaret vid
Hörsal D, Samhällsvetarhuset, fredagen den 24 Februari, kl. 13:00.
Avhandlingen kommer att försvaras på engelska.

Fakultetsopponent: Professor Maximilian Auffhammer, University of California, Berkeley, USA.
Power to the people: Electricity demand and household behavior

Abstract

Paper [I] Using a unique and highly detailed data set on energy consumption at the appliance-level for 200 Swedish households, seemingly unrelated regression (SUR)-based end-use specific load curves are estimated. The estimated load curves are then used to explore possible restrictions on load shifting (e.g. the office hours schedule) as well as the cost implications of different load shift patterns. The cost implications of shifting load from "expensive" to "cheap" hours, using the Nord Pool spot prices as a proxy for a dynamic price, are computed to be very small; roughly 2-4% reduction in total daily costs from shifting load up to five hours ahead, indicating small incentives for households (and retailers) to adopt dynamic pricing of electricity.

Paper [II] Using a detailed data set on appliance-level electricity consumption at the hourly level, we provide the first estimates of hourly and end-use-specific income elasticities for electricity. Such estimates are informative about how consumption patterns in general, and peak demand in particular, will develop as households' income changes. We find that the income elasticities are highest during peak hours for kitchen and lighting, with point estimates of roughly 0.4, but insignificant for space heating.

Paper [III] In this paper, I estimate the price elasticity of electricity as a function of the choice between fixed-price and variable-price contracts. Further, assuming that households have imperfect information about electricity prices and usage, I explore how media coverage of electricity prices affects electricity demand, both by augmenting price responsiveness and as a direct effect of media coverage on electricity demand, independent of prices. I also address the endogeneity of the choice of electricity contract. The parameters in the model are estimated using unique and detailed Swedish panel data on monthly household-level electricity consumption. I find that price elasticities range between -0.025 and -0.07 at the mean level of media coverage, depending on contract choice, and that households with monthly variation in electricity prices respond more to prices when there is extensive media coverage of electricity prices. When media coverage is high, for example 840 news articles per month (which corresponds to the mean plus two standard deviations), the price elasticity is -0.12, or 1.7 times the elasticity at the mean media coverage. Similarly, media coverage is also found to have a direct effect on electricity demand.

Paper [IV] I explore how households switch between fixed-price and variable-price electricity contracts in response to variations in price and temperature, conditional on previous contract choice. Using panel data with roughly 54000 Swedish households, a dynamic probit model is estimated. The results suggest that the choice of contract exhibits substantial state dependence, with an estimated marginal effect of previous contract choice of 0.96, and that the effect of variation in prices and temperature on the choice of electricity contract is small. Further, the state dependence and price responsiveness are similar across housing types, income levels and other dimensions. A plausible explanation of these results is that transaction costs are larger than the relatively small cost savings from switching between contracts.

Keywords
electricity demand, real-time pricing, demand flexibility, elasticity, appliance-level data, end-use, media, contract choice, de-regulated market, household behavior, intermittent electricity production, efficiency, imperfect information

Language: English  ISBN: 978-91-7601-651-0  ISSN: 0348-1018  Number of pages: 25 + 4 papers