Evaluating the Energy-Saving Effects of a Utility Demand-Side Management Program: A Difference-in-Difference Coarsened Exact Matching Approach

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Executive summary

In this projects, I estimate the energy-saving effects of a Demand-Side Management (DSM) program, specifically Gainesville Regional Utility's (GRU) high-efficiency central Air Conditioner (AC) rebate program, in which GRU offers incentives to its customers to replace their old low-efficiency AC unit with a high-efficiency model. This research combines a Coarsened Exact Matching (CEM) methodology with a Difference-in-Difference (DD) approach in order to reduce the bias from pre-treatment household and housing characteristics and to accurately disentangle the energy-saving effects of a DSM program from that of other confounding factors such as weather and household characteristics.

Most econometric evaluations of the effects of a DSM program use the classic difference-in-difference (DD) methodology or a variant of it where the impact of the DSM program is estimated as the difference in mean outcomes between all households participating in the program and those not participating. This approach leads to bias if there are unobserved characteristics that affect the probability of participating in the program that are also correlated with energy consumption. Further, the result might also be biased if program participants are very different from non-participants in terms of their pre-treatment characteristics.

The CEM methodology enables the construction of an accurate control group that can be employed to estimate the counterfactual energy consumption of comparable households in the treatment group. The DD CEM approach divides households into bins based on their pre-treatment characteristics and compares the outcomes of the treatment group and the control group in matched bins. The method compares the energy (electricity and natural gas) consumption of households in the same neighborhood, which allows me to control accurately for the effects of weather on energy consumption. Using the DD CEM method, I estimate the impact of GRU's 2009 high-efficiency AC program on annual energy consumption. Also, because the primary reason for a DSM program is to reduce peak period consumption, I disaggregate the energy-saving effects of the program into summer peak effects, winter peak effects, and non-peak effects. The results show substantial annual energy savings of the high-efficiency AC program. While the program has substantial effects on the summer peak, it has little or no statistically significant effects on winter peak energy usage. However, further analysis of the electricity consumption of the households that do not use natural gas reveals that the program had significant effects on electricity consumption even during the winter peak. I use the same methodology to estimate the size of the rebound effect by following the group of households who participated in the program for another year. The results indicate that there are no statistically significant rebound effects of the high-efficiency AC program.

This research contributes to the literature in part by employing the DD CEM methodology to reduce the imbalance between the treated and untreated observations and in part by matching on neighborhoods to control for the effects of weather on energy consumption. Such an estimation approach is novel to the evaluation of energy savings from demand-side management programs, and they are appropriate for dealing with selection bias when there are no valid instruments to allow for an instrumental variable approach. Further, the no rebound effects result indicates that the supply resources that the DSM program is designed to displace will indeed be avoided over the long run. This result helps to garner more stakeholder support for these programs.

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