Evaluating the Energy Savings Effect of Utility Demand- Side Management Programs using a Difference-in-Difference Coarsened Exact Matching Approach

Richard Boampong*

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overview

This paper seeks to estimate the energy savings effect 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. Most econometric evaluations of the effects of a DSM program use the classic difference-in-difference (DD) approach, 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 (e.g. (Godberg, 1986)). This approach leads to bias if there are unobserved characteristics that affect the probability of participation in the program that are also correlated with the outcome of interest. Even controlling for pre-program characteristics may not reduce the bias. It also ignores the problem of common support; the outcomes of non-participants whose characteristics are completely different from those of all participants are still used in the evaluation. This can be another source of bias. The common support problem with respect to neighborhoods greatly bias the estimated effects of DSM program on electricity consumption. This is because we cannot accurately disentangle the effects of weather from program effects when there are just one or just a few weather station in the area under study despite the fact that much of the variation in electricity consumption can be explained by changes in the weather (Reiss and White, 2003). [1] By including participants and non-participants from completely different neighborhoods and with no proxy for house-specific weather information, the estimated treatment effect is likely to be biased.

Method

In this paper, we use a DD approach in combination with the coarsened exact matching (CEM) approach described in Iacus et al. (2008) to reduce the imbalance of pre-treatment characteristics between treated and control households. The idea of CEM is to temporarily group each variable into meaningful strata and match observations based on the coarsened variables while retaining the original (uncoarsened) variables for analysis. However, some variables can be restricted from

*Department of Economics, University of Florida, PO Box 117140, Gainesville, FL 32611 USA, email: *rboampong@ufl.edu*. phone: 3523011306

[1] With more weather station in the area, we can follow Reiss and White (2003) by mapping each house to the nearest weather station based on proximity and elevation and imputing the weather information of the station to the house.

further coarsening. The main reason of using coarsened exact matching instead of exact matching is to circumvent the curse-of-dimensionality problem with exact matching (adding one continuous variable to an exact matching methodology effectively kills the matching, since we are unlikely to find two observations with similar values on a continuous scale). In this paper, we restricted neighborhoods from further coarsening so that, by comparing participants and non participants in the same neighborhood, we are able to disentangle the effects of weather from program effects since houses in the same neighborhood are more likely to experience the same weather. Also, since houses built in the same year or a few years apart and in the same neighborhood are likely to be built with the same building materials and have similar characteristics, by matching on neighborhoods and age of buildings, we are again able to control for the effects of building characteristics and materials on electricity consumption.

Matching is normally performed on cross-sectional data. However, since we have panel data, we do not employ the CEM approach in levels; instead, we combine the CEM with a DD approach in order to relax the selection-on-observables assumption and to control for any time-invariant, unobservable characteristics that affect electricity consumption for which we were not able to control.

Results

First, we estimate the effect of GRU's 2009 high efficiency AC program on annual electricity consumption. Second, since the main reason for DSM programs are to reduce peak-period consumption, we disaggregated the effects of the program into summer-peak effects, winter peak effects, and non-peak months effects. [2] Our preliminary results shows substantial annual energy savings of the high efficiency AC program. Also, while the program has high effects on summer-peak and non-peak months electricity consumption, it has no significant effect on winter-peak consumption. This is quite surprising, since most Floridians depend on their air conditioner to heat their homes during winter. To check the robustness of these results, we again evaluated the 2010 high efficiency AC program . The results are very similar to that of the 2009 program . Lastly, by following the group of people who participated in the rebate program in 2009 for two years after the program, we used a difference-in-difference-in-difference (DDD) methodology in combination with our matching approach to estimate the rebound effect. [3] We used a DDD approach instead of a DD approach to control for any confounding trends in energy usage overtime. The initial results suggest that there are no statistically significant rebound effects of the 2009 AC program.

References

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[2]Florida has two peak periods: the summer peak and the winter peak. These two peak periods are based on the distribution of heating degree days and cooling degree days in Florida.

[3]Rebound occurs when DSM program participation result in a decline in participants energy cost so that participants increase their thermostat setting or other energy use levels, thereby decreasing energy savings.