The Influence of Dynamic Pricing on Consumers' Electricity Saving Behaviors

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Overview

In 2008, a Northeast Regional Electric Company initiated the "Smart Energy Pricing (SEP)" pilot program to solicit consumers' demand responsiveness toward different pricing mechanisms. Two dynamic pricing mechanisms are tested: 1) the dynamic peak pricing (DPP), where the price is raised during the peak hours and lowered during the off-peak hours of a day, with the price further raised to almost eight times higher during the peak hours in critical days; 2) the peak time rebate (PTR), where consumer can earn a rebate *in peak hours on critical days if* they reduced their consumption below their typical usage during these hours, which including a relative low rebate treatment (PTRL) that sets the rebate at 9 times greater than the flat rate and a relative high rebate treatment (PTRH) that sets the rebate almost 13 times greater than the flat rate. BGE called 12 critical days during the summer of 2008. The hours between 2 pm through 7 pm on non-holiday weekdays were designated as the peak period and all the remaining hours were designated as the off-peak period. All the participants in the pilot experiments were notified the critical days in advance. Table 1 summarizes the electricity rates for different pricing mechanisms under both critical and non-critical days.

	DPP	PTRL (Rebate)	PTRH (Rebate)	Flat Rate
Critical-Peak	1.309	1.313 (1.16)	1.903 (1.75)	0.153
Critical-Off-Peak	0.099	0.153	0.153	0.153
Non-Critical-Peak	0.149	0.153	0.153	0.153
Non-Critical-Off-Peak	0.099	0.153	0.153	0.153

Table 1. Rates for Different Pricing Mechanisms; all numbers are in $/KWh.

In our study, we first compare the energy consumption of treatment groups relative to the control group on the critical days or event days. Households in the treatment groups were notified an event on the day before. While the households across all the treatment conditions on average consume significantly less energy than those in the control condition on the event days, the degree of demand reduction differs across DPP, PTRL and PTRH. We find that the average reduction in the PTRH group is the highest, DPP in the middle and PTRL the lowest. This is consistent with our theoretical predictions when we consider the real price by factoring into the unit price and the rebate. PTRH group faces a higher real price than others. Although the rebate rate of this group is the highest, the unit price is also the highest and it requires a deeper reduction in energy use to avoid excessive payment.

We further examine the consumption pattern the day after an event day. We find that while these is state-dependence in general, that is, energy saving behavior tends to continue on the second day, households that gain higher rebates tend to use more energy. This is partially driven by the "income effect". In addition, the empirical evidence suggests that the licensing effect is also present and it is a significant driver of increasing energy consumption. Taking the results together, we find that rebate along with well-designed pricing scheme is effective in reducing energy consumption on critical days. Meanwhile, it leads to consumption rebound due to both monetary and psychological reasons. Without considering the behaviours responses might lead to a biased estimate regarding the overall impact of rebates and thus undermine the ability of the social planner, or the utility company achieving the desired policy outcomes. Lack of full considerations on incentive issue may lead to perverse consequences.

Methods

We estimate the household energy saving in different treatment groups, using the first-difference estimator. Then we evaluate the magnitude of license effect for the rebate mechanism after controlling for the income and state dependence effect.

Results and Conclusion

We find peak-time high rebate (PTRH) is most effective in reducing the peak load consumption, then the dynamic peak-time pricing (DPP), with the peak-time low rebate (PTRL) being the least effective. This result is consistent with our theoretical prediction based on effective price rabte. Moreover, we identify the so-called "licensing effect" where the rebates could back fire in the short run. The relative magnitude of license effect versus income effect is roughly 28% in the PTRL group and 41% in the PTRH group.