Does Energy Information Really Help Energy Saving? An Empirical Study on the Relationship between Energy Information and Residential Energy Consumption

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Overview

Research Motivation

The emergence of Energy Management System (EMS), an inspiring digital infrastructure that meters real-time electricity flow and provides energy information via communication network [1,2], have drawn new market paradigm to the energy industry. This computerized information system may seem only beneficial at first glance, there is an aspect that needs a little more caution [3].The effect of energy information provided by EMS on consumers' demand sensitivity is, however, difficult to figure out because of to issues: 1) selection biases between consumers who have installed energy management system and who have not and 2) confounding effect between increased attention and information. The attentiveness in energy consumption is an important factor as energy consumption is fostered by inattentive energy behavior unless consumers receive interpretable energy information [4]. Few studies have clarified whether information or increased notices induce electricity conservation, controlling the attentiveness level of households. In the natural experiment setting, this study has been motivated to investigate the different energy behavior induced by provision of energy information in price varying situation. Controlling energy attentiveness level, these settings provided better condition to test the effect of energy information on residential energy consumption.

Research Context

The residential electricity charging system in Korea is based on the increasing-block tariff (IBF) and the pricing gap between tiers is much larger than that of other countries[5]. In the summer of 2016, the average temperature in July and September were higher than usual and the issue of electricity charging system was widely discussed. In the end of active discussion, the government decided to alleviate the price gap between tiers for the rest of summer. In this period, people's interests in electricity charging system increased drastically and people received more detailed information about this IBF system.

Methods

Variables

The total amount of electricity payment in an apartment complex is used as dependent variable, but this variable is significantly correlated with the number of households. To alleviate this problem, we divide the total amount of electricity payment by (1) total residential area in each apartment complex, (2) the number of households in each apartment complex, and (3) both (1) and (2) together. Independent variables are described in the Table.

Table 1 Independent Variable Description

Variable	***Description***
Interest	A binary variable of periods when interest in increasing-block tariff(IBF) increased (Period from July 2016: 1, Otherwise: 0)
EMS	A binary variable of the installation of EMS (Installed: 1, Not installed: 0)
CDD	Monthly cooling degree day
HDD	Monthly heating degree day
SmallHouseRatio	A ratio of small size houses (under $85m^2$) in an apartment complex
NumHouseholds	Number of households in an apartment complex
UsageType	A binary variable of apartment building usage type (Residential Usage: 1, Otherwise: 0)
HeatingSystemType	A binary variable of heating system (District heating: 1, Complex individual heating: 0)
ResidenceType	A binary variable of the residence type of an apartment complex (Private residence APT: 1, Public rent APT : 0)
CorridorType	A binary variable of the type of corridor (Closed corridor type : 1, Other types : 0)

Data

Dataset includes monthly amount of residential electricity consumption from January 2014 to December 2016. Data about residential electricity consumption in apartment complexes with apartment-specific characteristics is provided by the website for apartment management information system affiliated to the ministry of land, infrastructure and transport of Korea. Data about weather information is gathered from Korea Meteorological Administration.

Model Description

Difference-in-differences (DID) analysis is employed to test the research model. This study utilizes the research design with two distinctive group of apartment complexes:

(1) A “treatment” group that consists of apartment complexes that install the home energy management system

(2) A “control” group that comprises apartment complexes that do not install the home energy management system.

We put the period of increased interests in electricity charging systems as the criteria of time-difference.

$$\ln(\mathrm{ElectPerArea}_{ijt}) = \delta_{0j} + \delta_1 EMS_{ij} + \delta_2 Interest_t + \delta_3(EMS_{ij} \times Interest_t) + \Theta \mathrm{X}_t + \Phi\Omega_{ij} + \varepsilon_{ijt} \quad (1)$$

$$\ln(\mathrm{ElectPerHH}_{ijt}) = \delta_{0j} + \delta_1 EMS_{ij} + \delta_2 Interest_t + \delta_3(EMS_{ij} \times Interest_t) + \Theta \mathrm{X}_t + \Phi\Omega_{ij} + \varepsilon_{ijt} \quad (2)$$

$$\ln(\mathrm{ElectPerHHArea}_{ijt}) = \delta_{0j} + \delta_1 EMS_{ij} + \delta_2 Interest_t + \delta_3(EMS_{ij} \times Interest_t) + \Theta \mathrm{X}_t + \Phi\Omega_{ij} + \varepsilon_{ijt} \quad (3)$$

Results

To test the randomness of the electricity consumption pattern across treatment and control group, we compare the mean consumption of electricity in the period before the summer of year 2016. The result of randomness test allows us to use difference in difference method.

Table 2 Results of DID Model

	Model 1		***Model 2***		***Model 3***	
DV	*ln(ElectPerArea)*		*ln(ElectPerHH)*		*ln(ElectPerHHArea)*	
Variables	*Fixed*	*Random*	*Fixed*	*Random*	*Fixed*	*Random*
Interest	*-0.158*** (-10.84)*	*-0.157*** (-10.70)*	*0.158*** (-10.84)*	*-0.157*** (-10.76)*	*-0.158*** (-10.84)*	*-0.158*** (-10.78)*
EMS	*Omitted*	*-0.016 (-0.44)*	*Omitted*	*-0.017 (-0.33)*	*Omitted*	*-0.003 (-0.05)*
DID	*0.176*** (8.09)*	*0.169*** (7.8)*	*0.176*** (8.09)*	*0.172*** (7.92)*	*0.176*** (8.09)*	*0.173*** (7.97)*
CDD	*0.006*** (41.17)*	*0.006*** (41.09)*	*0.006*** (41.17)*	*0.006*** (41.12)*	*0.006*** (41.17)*	*0.006*** (41.14)*
HDD	*0.000*** (18.00)*	*0.000*** (17.97)*	*0.000*** (18.00)*	*0.000*** (17.98)*	*0.000*** (18.00)*	*0.000*** (17.99)*
APT-fixed Effect	*Omitted*	*Included*	*Omitted*	*Included*	*Omitted*	*Included*
Year-fixed Effect	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Constant	*6.471*** (762.81)*	*6.794*** (73.12)*	*10.873*** (1281.7)*	*10.88*** (81.5)*	*0.179*** (21.11)*	*1.616*** (10.91)*
Observations	*8429*	*8429*	*8429*	*8429*	*8429*	*8429*
Groups	*250*	*250*	*250*	*250*	*250*	*250*
R-Squared	*0.5115*	*0.2264*	*0.7108*	*0.358*	*0.8628*	*0.6676*

Conclusions

This study examines whether the installation of energy management system (EMS) really affects electricity saving in households when people’s interests in electric charges increase. An electric charging system in Korea is based on increasing-block tariff, where the price of electricity increase largely according to the used amount. The price gap between tiers is very higher in Korea compared to other countries adapting increasing-block pricing system. This issue has been argued widely in August 2016 when the average temperature was above usual year. With the empirical dataset from apartment complexes in Korea, we employ the difference-in-difference (DID) analysis and investi-gate how different the behavior of people with EMS is from the behavior of people without EMS.

Our major finding is that people in the EMS-installed apartment complexes were likely to con-sume electricity more than people in the apartment complexes without EMS. People without EMS showed electricity saving behavior when they got more interest in electric charging system. This finding implies that people with EMS may spend more electricity more efficiently compared to peo-ple without EMS because people with EMS can check how much electricity they used while people without EMS just guess their used amount and try to save energy recklessly.

References

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