Decarbonizing energy consumption in household sector:

Estimating demand for demand-side resources control

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1. Introduction

A demand-side resources control automatically manage part of the electricity consumption behavior and is expected to contribute to decarbonizing energy consumption in the household sector. However, it is unclear how much people are willing to pay for the service that necessitate lower flexibility in electricity service and requires provision of individual information to tailor the service design. By using a choice experiment survey, this study explores the consumers preference for the demand-side resources control services and estimate their valuation on various attributes that characterized the services.

2. Data and Methodology

We conduct a discrete choice experiment with an online panel of 2900 Japanese individuals in June 2024. Before answering the discrete choice questions, respondents read a description of the characteristics of a hypothetical demand-side resources control service. They also answered nine questions to elicit their understanding of the service. In addition, respondents were asked to indicate their level of concern about the risk of personal data leakage and their level of interest in new goods and services. Furthermore, they were asked to provide demographic information about themselves and their households.

This study employs Best Worst Scaling and estimate the marginal willingness to pay for the characteristics of electricity control services. The five characteristics of the external control service are defined as shown in Table1: annual energy savings rate, target equipment, availability of override, information provided by the consumer, and fee. 5^5 Orthogonal main effect plans are utilized to create 16 profiles, in which each attribute has a different level. In addition, this profile is assigned to 20 choice sets using balanced incomplete block

Table 1. Attributes and levels

Attributes	levels
Fee	5,000 yen, 10,000 yen, 15,000 yen, 20,000 yen
Annual energy savings rate	5%, 10%, 20%, 35%
Target equipment	Air conditioner, Water heater, Storage battery, EV charging
Availability of override	No override, Not available 6-10am, Not available 5-9pm, anytime
Information provided by the consumer	Location (post code), Household and residential information, Hourly electricity consumption, life style

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design. We utilize pre-test response data, and employ mixed logit and latent class models to estimate the model.

3. Main results

In the mixed logit model, as expected, the mean parameter of the annual fee and EV as the target equipment are statistically significant and positive. In addition, the parameter representing whether they can override at any time is statistically significant and negative. The coefficient of the annual energy savings rate is not statistically significant. The standard deviation parameter is, however, statistically significant, indicating heterogeneity regarding the preference for the attribute.

A latent class logit model is estimated to identify heterogenous segments among respondents. Three variables were used as membership parameters: whether the respondent lives in an all-electricity home, the number of household members, and household income. The respondents can be divided into three classes. Class 1 has the largest population (42.3%), more than half lives in all-electricity homes, and more than one-third of them has an income higher than 8 million JPY. The coefficients for Class 1 show that ASC, fee, energy savings rate and EV charging are negative and statistically significant. The coefficients for any time override, household and residential information are negative and significant, respectively. The remaining share of respondents can be divided into Classes 2 and 3. In Class 2, residents of all-electricity homes accounted for exactly half of the respondents, with families of four accounting for the largest proportion (35.7%) and one-third of households with annual income of less than 4 million JPY. For the class, ASC is positive and significant, fee is negative and significant, but other parameters are not statistically significant. Respondents in Class 3 are the highest proportion of both all-electric households (60%) and households with incomes of between 4 and 6 million JPY (39%). In this class, ASC and fee are negative and statistically significant, while the coefficients for annual energy savings rate, water heater, not available 6-10am, not available 5-9pm and anytime override are positive and significant. We find that the willingness to pay for the increase in the annual energy savings rate for Class 1 respondents is 374.8 JPY/% and for Class 2 is 20.7 JPY/%. Class 3 has a negative utility and its willingness to accept compensation is 259.2 JPY/%.

4. Conclusions

Obtained results indicate that people tend to highly evaluate the right to override at any time. In other words, respondents want relatively flexible external control. The results of the latent class model indicate that the classes with the highest proportions exhibit a relatively high preference for external control services and express an interest in enhancing their electricity saving rates. To expand the market for external control services, higher energy-saving and environmental performance, and more flexible control are required. Furthermore, it is necessary for respondents to have the option to override at certain times of the day in order to increase the respondents' intention to use the service.