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A Field Experiment on the Choice of Power Tariffs Before and After Japanese Retail Electricity Liberalization

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Abstract

We consider the case of choosing an electricity fee plan and examine differences in attitudes toward each plan by providing information on electricity bills, which is either based on test participants' past electricity consumption or not. We conducted randomized control trial stated preference (SP) and revealed preference (RP) experiments on the choice of electricity rates before and after liberalization. In the SP experiment, we found that providing information that informs the participant of their benefit or loss from switching corrects the tendency toward overconfidence and the evaluation value attached to the potential benefit of switching declines. By analyzing the benefit and loss separately, we further clarified that this drop exemplifies the loss aversion tendency. The evaluation value drops greatly when information about a loss is provided; however, this drop is not proportionate to the magnitude of the loss. The RP experiment differ from the SP experiment results. We found that that the selection was not boosted in both gain and loss cases.

JEL classification: C93, D91, Q49.

Keywords: Randomized controlled trial (RCT), Stated preference, Revealed preference, Information provision, Power tariff, Overconfidence.

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1. Introduction

In Japan, the total liberalization of electricity retailing began in April 2016, making it possible for residential consumers to freely select an electricity tariff plan and a power company according to their preferences. In addition, it became possible for consumers to consider switching based on their power consumption by comparing prices on power rate comparison sites. However, as of March 2017, approximately one year after the liberalization, the switching rate was approximately 8.8% (or 5.53 million households), of which the rate of switching to a new power company was approximately 4.7% (Agency for Natural Resources and Energy, 2017). In addition, the conversion rate from a regulated tariff plan to a free tariff plan within the major power companies was approximately 4.1%. Furthermore, as of February 2018, the switching rate was 15.5% (approximately 9.7 million households), of which approximately 9.5% switched to a new power company, and the rate of switching from a regulated tariff plan to a free tariff plan within major power companies was approximately 6.0% (Agency for Natural Resources and Energy, 2018). Thus, switching to new power companies and new rate plans is still uncommon despite liberalization.

The reason for this is “inertia” (Hartman et al., 1991); that is, consumers do not look for alternative tariff plans or utilities (Hortaçsu et al., 2017). Consumers do not want to exert energy to search for another plan or power company, so even if it costs them more, they may choose to retain their current plan. In such situations, it is possible to promote consumer choice by providing information to consumers (Bertrand and Morse, 2011; Giné and Mazer, 2016).

Regarding consumers' perception of electricity prices, Borenstein (2009) and Ito (2014) show that consumers respond to the average price, not the marginal price. Therefore, there is a possibility that they do not respond to the electricity price, even after correctly recognizing their own consumption patterns. Chetty et al. (2009), Finkelstein (2009), and Sexton (2015) have also shown that, in the context of tax and power saving, the reaction to tax becomes weak when the salience of price is low. Furthermore, those who switch may believe that they can reduce their monthly electricity bill payments by the Time-of-Use (TOU) tariff, and may have made the switch regardless of their actual consumption patterns. This tendency is called “overconfidence” and it has been observed in the attitudes towards investment (Barber and Odean, 2001), people’s expectations about their own abilities (Clark and Friesen, 2008; Eil and Rao, 2011; Ertac, 2011), and future preference (Thunström, Nordström and Shogren, 2015). It is also known that the overconfidence correlated with the optimism positively (Heger and Papageorge, 2018). Therefore, even if they try to change the power plan and the company, there is a possibility that the consumer cannot select the plan and the company properly, because they do not understand their own consumption patterns well enough.

The RECAP (Read, Evaluate, and Compare Alternative Prices) approach to providing information is known for its effectiveness (Thaler and Sunstein, 2009). In the case of information asymmetry,

whereby the enterprise has more information about the consumer than the consumer themselves, giving the consumer information about their own consumption and payments will make it possible for them to identify which plan will benefit them (or not), improving consumer welfare (Kamenica et al., 2010). Kling et al. (2011) empirically verified changes in consumer choice by providing such RECAP-type information. They found that approximately 11% of people will change their decision appropriately if provided with information on the current plan and the cheapest plan in the context of health plans for the elderly in the insurance market.

This paper presents an experiment that investigates whether consumers will properly select a rate plan if they are provided RECAP-type information. Stated preference (SP) and revealed preference (RP) regarding the choice of power plan before and after power liberalization are considered. A randomized controlled trial (RCT) is conducted to verify the effect of information provision. In RCT, subjects are randomly assigned to control groups that do not receive intervention and treatment groups that receive intervention. Because the assignment is random, the covariates in the treatment and control groups are considered homogeneous on average and the difference in average outcome can be interpreted as the difference due to the intervention. Therefore, the internal validity of the average treatment effect is secured by performing RCT. The intervention we performed detailed 30 minutes of electric power usage data for each subject in the summer of 2015 as RECAP-type information provision. For each subject in the treatment group, monthly electricity rates calculated by each tariff plan are provided using a flat plan that does not change the tariff rate, and a TOU plan, in which the daytime and night rate fluctuate. We also provided the price differences. It is found that the tendency toward overconfidence is corrected and the overall evaluation value decreases when consumers are given information about gaining or losing by changing their electricity rate plan in the SP experiment. In particular, we found that, when consumers know they will lose money by switching, loss aversion is evident and the evaluation value is greatly reduced. In addition, there was no response to the information purely on the basis of a potential gain; the evaluation value was determined according to the increase in the gain amount. Furthermore, it was found that the results of the RP were somewhat different from those of the SP, and the selection was conservative, even in the case of a gain.

The structure of this paper is as follows. Section 2 explains the conceptual framework. Section 3 outlines the experimental design of the study. Section 4 focuses on the experimental design of the SP experiment, then provides the hypothesis in the experiment, and explains the estimation method. Section 5 provides the same information for the RP experiment. Section 6 discusses the results, and section 7 concludes the paper.

2. Conceptual framework

In this section, based on Kamenica et al. (2011), we consider the following model for the situation in

which the consumer considers the selection of an electricity rate plan. In this market, it is assumed that there are two types of consumers, with each constituting 50% of the sample. One type, ($s_i = W$), exhibits high power consumption at off-peak time ($t = 0$) and the other type, ($s_i = L$), exhibits high power consumption at peak time (t = 1). Consumer i is assumed to use power only monthly for $x_i^{s_i}$. In addition, consumers with high power consumption during off-peak hours have low power consumption during peak hours, and consumers with low power consumption during off-peak hours have high power consumption during peak hours[3]. The power used by each type of consumer is

$$x_i^{s_i=W} = \begin{cases} h & if \quad t = 0 \\ l & if \quad t = 1 \end{cases} \qquad x_i^{s_i=L} = \begin{cases} l & if \quad t = 0 \\ h & if \quad t = 1' \end{cases}$$

where $h > l > 0$.

In this market, we further assumed that all consumers are contracted to a flat plan (FLAT) at the beginning. It is assumed that the TOU plan is newly introduced to the market, and the consumers have the opportunity to change plans. In FLAT, the unit price of the electricity tariff does not change depending on the time. Let this price be p. In TOU, the unit price of power fluctuates between off-peak and peak times, and we set the off-peak price as q_l and the peak price as q_h. Also, we set $q_h > q_l > 0$. Here, we assume revenue neutrality for TOU and let $p = \frac{1}{2}(q_h + q_l)$ hold.

Under these tariff plans, if consumers choose FLAT, the monthly payments for both types of consumers are equal; $e^{FLAT} = p(h + l)$. When they select TOU, consumer's payment of $s_i = W$ is $e_h{}^{TOU} = q_l h + q_h l$ and the consumer payment of $s_i = L$ is $e_l{}^{TOU} = q_l l + q_h h$. For consumers of $s_i = W$, because $e^{FLAT} - e_h{}^{TOU} > 0$ holds[4], TOU is cheaper than FLAT. Therefore, consumers of $s_i = W$ are expected to switch to TOU to benefit from lower monthly payments. For consumers of $s_i = L$, FLAT is cheaper than TOU because $e^{FLAT} - e_l{}^{TOU} < 0$. Therefore, it is expected that consumers of $s_i = L$ will not switch from FLAT because their monthly payment would increase if they choose TOU.

Next, we consider the case in which information asymmetry exists. In this case, consumers do not

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[3] For example, type $s_i = W$ represents night type consumption, and type $s_i = L$ represents day type consumption. The peak consumption of large industrial and commercial customers occurs in the daytime, so the framework of this paper represents reality.

[4] The following relationship holds for the payment of FLAT (e^{FLAT}) and the consumer's payment of $s_i = W$ ($e_h{}^{TOU}$).

$$\begin{aligned} & e^{FLAT} - e_h{}^{TOU} = p(h + l) - (q_l h + q_h l) \\ & = \frac{1}{2}(q_h + q_l)(h + l) - (q_l h + q_h l) \\ & = \frac{1}{2}(q_h - q_l)(h - l) > 0 \end{aligned}$$

The first equation is derived from the definition of each payment. The second equation is derived from the assumption of revenue neutrality. For the last inequality, $h > l > 0$ and $q_h > q_l > 0$.

know their own consumption pattern, but the company has this knowledge. In the stage of considering switching plans, the consumer i receives information $\theta_i = \{W, L\}$ about their power usage pattern. The probability that consumer i relies on this information (λ) is

$$\Pr\left(x_i^{s_i} \middle| \theta_i\right) = \begin{cases} \lambda & if \quad x_i^{s_i} = \theta_i \\ 1-\lambda & if \quad x_i^{s_i} \neq \theta_i \end{cases},$$

where $\lambda \in [1/2, 1]$.

The conditional expected value of $x_i^{s_i}$ when consumer i receives the information $\theta_i = W$ is

$$E\left[x_i^{s_i} \middle| \theta_i = W\right] = \begin{cases} (h-l)\lambda + l & if \quad t = 0 \\ -(h-l)\lambda + h & if \quad t = 1 \end{cases}.$$

The conditional expected value of $x_i^{s_i}$ when consumer i receives the information $\theta_i = L$ is

$$E\left[x_i^{s_i} \middle| \theta_i = L\right] = \begin{cases} -(h-l)\lambda + h & if \quad t = 0 \\ (h-l)\lambda + l & if \quad t = 1 \end{cases}.$$

When consumer i receives the information $\theta_i = W$, she is expected to change to the TOU because TOU is cheaper than FLAT when $\lambda \in (1/2, 1]$. Also, if consumer i receives the information $\theta_i = L$, she is expected to stay with FLAT because FLAT is cheaper than TOU when $\lambda \in (1/2, 1]$. Furthermore, when $\lambda = 1/2$, consumer i is indifferent between the two plans[5].

In sum, when consumption information is provided, in the case of $\lambda \in (1/2, 1]$, consumers who receive the information $\theta_i = W$ choose TOU, and consumers who receive $\theta_i = L$ choose FLAT. In the case of $\lambda = 1/2$, consumers are indifferent between the two plans.

3. Experiment design

We conducted an SP and an RP experiment on electricity tariff plans before and after the power retail liberalization in April 2016. The participants in this experiment were residents living along the Tokyu Railway Line in Aoba Ward, Yokohama City, Kanagawa Prefecture, who participated in the "large-scale HEMS information platform provision business" of the Tokyu Corporation. In the target households of the experiment, a Home Energy Management System (HEMS) was installed and power consumption per 30 minutes was acquired during the summer of 2015 (June to September). Due to the

[5] If no information is given, then consumer i considers her type as random, so we treat this case as $\lambda = 1/2$.

requirements for the protection of personal information, power consumption could not be obtained outside the survey period.

First, we explain the flow of the experiment using Figure 1. A total of 1,063 households participated in the experiment[6]. We randomly divided the participants into two groups. The first group is the control group without intervention (N = 531), and the other is the treatment group (N = 532), which received intervention. Following the reform of the power industry in Japan, which liberalized power retailing for all consumers, an SP survey experiment was conducted from February to March 2016, just before the liberalization. 983 participants were contacted in the experiment, but 80 did not respond. In November 2016, after liberalization, we conducted an RP survey experiment. At that time, there were 306 non-responders, leaving a total sample size of 677 people participating in the experiment.

＜Figure 1: The flow of the experiments＞

The information provision occurred as follows. For the 531 participants in the treatment group, we enclosed the text shown in Figure 2 in a questionnaire. In this intervention text, (1) we provided the electricity bill payment per month calculated with the general electricity tariff plan (25 yen per kWh ($ 0.23 per kWh); FLAT) based on the electricity consumption measured in summer 2015. In addition, (2) we presented the electricity bill payment per month calculated using the time-of-use (TOU) tariff plan. Furthermore, (3) we presented information on how much lower or higher the electricity cost per month would be after switching from the general electricity tariff plan to the TOU plan.

＜Figure 2: Intervention flyer＞

Here, the daytime power unit price (9:00 am to 9:00 pm) of the TOU plan is 40 yen per kWh ($ 0.36 per kWh), and the nighttime power unit price (9:00 pm to 9:00 am) is 8 yen per kWh ($ 0.07 per kWh). We assume revenue neutrality for the unit price of this TOU plan. Specifically, first, we set the unit price of daytime electricity to be 40 yen per kWh. After that, we set the nighttime electricity unit price so that the monthly electricity rate payment among the participants is equal on average irrespective of whether the FLAT plan or TOU plan is selected.

Table 1 and Figure 3 show that revenue neutrality holds. In Table 1, for each participant, we use the HEMS data for the summer of 2015 to calculate the payments for the FLAT plan and the TOU plan, and calculate the average price per month. Here, we calculate the electricity rate assuming that price elasticity is zero. In addition, we also calculate the average difference per month between the FLAT and the TOU plans. The monthly average electricity rate was 9, 428.82 yen ($85.72) using the FLAT

[6] Note that among the participants in the experiment, 33 had defects in HEMS data because of technical errors.

plan and 9,428.80 yen ($85.72) using the TOU plan. The difference between them is about 0.02 yen, and it can be seen that the electricity rate per month is ± 0 as a whole on average when switching from a FLAT plan to a TOU plan.

＜Table 1: Monthly rate difference according to the tariff plan＞

Figure 3 shows the distribution of the difference between the FLAT plan and the TOU plan for each subject. The difference between plans are arranged from low to high for customers who switch on the horizontal axis. The vertical axis represents the difference. It is clear that, when switching from the FLAT plan to the TOU plan, 50% of people would benefit and 50% would suffer.

＜Figure 3: The distribution of monthly payment difference＞

In order to check the success or failure of randomization for the above-mentioned control and treatment groups, we did the balance check by t test for average power consumption per day (kWh), average power consumption (kWh) during the day (9:00 am to 9:00 pm) and average power consumption (kWh) at night (9:00 pm to 9:00 am) (Table 2), based on power consumption in the summer of 2015 (July to September)[7]. The average daily power consumption was approximately 12.92 kWh for the control group and approximately 13.02 kWh for the treatment group. The difference is -0.10, which is not statistically significant (t value = -0.29). The average daytime power consumption was approximately 6.87 kWh in the control group and approximately 6.97 kWh in the treatment group. The difference is -0.10, which is not statistically significant (t value = -0.53). Finally, the average power consumption at night was approximately 6.05 kWh for the control group and approximately 6.05 kWh for the treatment group. The difference is approximately 0.001 kWh, which is not statistically significant (t value = 0.0008). From the above, there is no significant difference in the averages for daily, or daytime and nighttime only, power consumption and it can be considered that the two groups are well balanced.

＜Table 2: Balance check of average power consumption＞

4. Stated preference experiment

In this section, we describe the experimental design and analysis results of the stated preference experiment conducted in February and March 2016, prior to liberalization.

[7] We confirm the balance check on other respondent attributes in Appendix 1.

4.1 Design

We conducted experiments from February to March 2016 before retail liberalization in the home sector. We provided a 1,000 yen ($9.09) Quo voucher to those who participated in the experiment. 983 participated in the experiment, while 80 potential participants did not respond.

In this experiment, for the control group and the treatment group, we asked eight questions using the stated preference method questionnaire to select the most desirable plan from three virtual power plans (Figure 4).

＜Figure 4: Stated preference method question attribute value＞

The stated preference method is a type of conjoint analysis, whereby good service is considered to be composed of several attributes. The experimenter presented a plurality of virtual options to the subject for which the property levels of the options are gradually changed, and the subjects selected an option. As a result, it is possible to analyze which attribute is emphasized to what extent based on the subject's selected option. As shown in Figure 4, the options for each plan in the question were "rate plan by new electric power company," "new rate plan by electric power company currently under contract," and "existing charge plan by electric power company currently under contract."

In Plan 1, the attribute of the power company is fixed by "new power company." The attributes of the rate plan are "time-of-use plan" or "Flat rate plan." Furthermore, "renewable energy ratio" and "nuclear power ratio" are 0%, 20%, or 40%. Finally, "Monthly electricity charges" are either "the same as the present," 10% lower, or 20% lower.

For Plan 2, the attribute of the power company is fixed in "the power company under contract," and the other attribute items are set the same as Plan 1.

Finally, for Plan 3, all the attribute values are fixed, assuming that, "Power company currently under contract," "Flat rate plan," 10% renewable energy ratio, 10% nuclear power ratio, and "monthly electricity charges" are "the same as the present."

4.2 Hypotheses

In this study, we set pricing such that revenue neutrality is established between the TOU rate plan and the FLAT rate plan. Therefore, the ratio of those who gain and those who lose by changing the rate plan is exactly half. First, how do people in the control group who do not receive RECAP information for rate plan transfers evaluate the TOU plan? Under the assumption of revenue neutrality, if the experiment participants correctly evaluate the TOU plan, the overall rating of the TOU plan will be zero. However, if people believe that they can use the TOU plan to reduce their monthly electricity

bill, because humans tend to have “overconfidence,” the rating of the rate plan may be positive on average.

Second, in the treatment group receiving RECAP information, the experiment participants can understand which rate plan should be selected after accurately understanding the gain and loss of the rate plan. For those who are informed that they can benefit from switching, it is expected that they will respond positively to the information and the evaluation value will be high. People who receive information that they will lose money by switching are expected to have a low evaluation of the TOU plan.

Thus, when viewed across the treatment group, if the ratings of gainers and losers are symmetrical, the ratings are expected to be zero on average. However, the evaluations of people who gain or lose from switching are not necessarily symmetrical. Because humans have a tendency of “loss aversion,” if the negative evaluation of the TOU plan by people who would experience a loss exceeds the positive rating of the people experiencing a gain, the evaluation of the TOU plan may be negative on average.

4.3 Estimation

Based on the response data obtained by the SP experiment, we assume a random utility model and estimate the evaluation for each attribute of the respondent by the maximum likelihood method. We assume the following random utility model:

$$U_{ni} = \beta_n x_{nit} + \gamma m_{nit} + \delta I_{nit} + \varepsilon_{ni}. \quad (1)$$

Here, the subscript n represents each individual, i represents the plan ($i \in (1,2,3)$) in each question, and t represents a question number ($t \in (1,2,\cdots,8)$).

U_{ni} is a function that represents the utility when individual n selects rate plan i, and x_{it} is a variable that represents each attribute level of the rate plan i presented in each question t. m_{it} represents the attribute level of monthly electricity rates, and I_{it} is an indicator function that takes 1 when the responder selects the status quo (plan 3), and 0 otherwise. Additionally, β_n represents the marginal utility for the change of one attribute level of each attribute of the respondent. Here, β_n is assumed to be a random parameter that follows a normal distribution. Next, γ represents the marginal utility associated with the decrease in monthly electricity charges. δ represents the basic utility for the current rate plan. Finally, ε_{ni} is an error term and follows the type 1 extreme value distribution. Assuming that an individual n selects option i to maximize (1) above, the probability that an individual n selects option i is expressed as follows for any j($\neq$ i):

$$P_{ni} = \Pr\left(U_{ni} > U_{nj}\right). \tag{2}$$

Additionally, the log likelihood function of the above selection probability is

$$L(\beta, \gamma, \delta) = \sum_n \sum_j I_{nj} \, ln \, P_{ni}. \tag{3}$$

Here, $I_{ni} = I\left(U_{ni} > U_{nj}\right)$ is an indicator function that takes 1 if an individual n selects option i, and 0 otherwise.

We assume a mixed logit model for individual selection probabilities. In this case, we can rewrite the selection probability in (2) as

$$P_{ni} = \int \frac{exp(V_{ni})}{\sum_j exp(V_{nj})} f(\beta) d\beta. \tag{4}$$

Here, $V_{ni} = \beta_n x_{nit} + \gamma m_{nit} + \delta I_{nit}$. Since the selection probability by the above mixed logit model cannot be solved algebraically, it is necessary to obtain the parameter by approximate calculation by simulation such as in the Halton sequence method. Furthermore, since the parameters obtained from the above simulation are difficult to intuitively interpret, we calculate Marginal Willingness to Pay (MWTP) from each random parameter (Train, 2009). Since each parameter in the random utility model represents the marginal utility of each attribute, MWTP can be obtained by dividing them by the marginal utility of money per yen. However, we cannot estimate the marginal utility of money directly from our question attributes. Therefore, we calculate the marginal utility per yen by dividing γ, which represents the marginal utility associated with the decrease in monthly electricity bill, by the monthly electricity bill calculated for each individual's FLAT payment[8].

Moreover, although the parameter obtained by the above calculation is an average parameter, it is possible to calculate the conditional distribution of the parameter according to the respondent by the Bayesian theorem in the mixed logit model. By the above method, we calculate MWTP for each respondent by dividing the random parameters of each participant by the marginal utility per yen.

4.4 Estimation result: Marginal willingness to pay

Table 3 shows the analysis results by treatment group and control group using the above-mentioned stated preference method. First, we look at fixed parameters. With regard to the parameters of the

[8] Therefore, in estimating the selection probability, we replace the attribute value of "Monthly electricity charges" with 1 if it is "the same as the present," 0.9 if it is "10% decrease," and 0.8 if it is "20% decrease."

electricity bill payment ratio, the coefficient is approximately -23.91 in the control group and approximately -23.15 in the treatment group, both of which are significant at the 1% level. In addition, the status quo parameter is 0.014 in the control group, and is insignificant. In the treatment group, it is 0.36, which is significant at the 1% level.

Next, we look at the random parameters. The parameters of the new company are -0.60 in the control group and -0.58 in the treatment group, and are significant at the 1% level. The TOU parameters are 0.25 in the control group and significant at the 5% level. For the treatment group, the coefficient is -0.14, but no significant results are found. The parameters of the renewable energy ratio are 0.053 for the control group and 0.051 for the treatment group, both of which are significant at the 1% level. Regarding the parameters of the nuclear power ratio, -0.12 in the control group and -0.14 in the treatment group, significant differences are observed at 1% level for both.

Finally, we look at the standard deviation of random parameters. First, for the new company parameters, the standard deviation is 1.61 in the control group and 1.80 in the treatment group. Both groups are statistically significant at the 1% level and have sufficient variation. Next, the TOU parameters are 1.80 in the control group and 1.84 in the treatment group, both of which are significant at the 1% level. Subsequently, the ratio of renewable energy is also 0.08 in the control group and 0.09 in the treatment group, and both are statistically significant at the 1% level. Finally, the ratio of nuclear power is 0.13 in the control group and 0.14 in the treatment group, which is also statistically significant at the 1% level.

From the above, it can be seen that for each attribute, both the fixed parameters and the random parameters show significance, excluding the status quo parameter of the control group and the TOU parameter of the treatment group. Additionally, the standard deviations of the random parameters are all significant, indicating that the parameters vary within each group.

＜Table 3: Estimated result by stated preference method＞

Table 4 shows the marginal utility of money and estimated values of the willingness to pay for each attribute based on the results in Table 3. First, we calculate the marginal utility of money by dividing the estimation result of the electricity bill payment ratio parameter by the monthly electricity bill calculated by the FLAT plan for each subject. The marginal utility of money is -0.0034 in the control group and statistically significant at the 1% level (t value = -12.27). In the treatment group, the mean is -0.0032, which is also significant at the 1% level (t value = -11.48). There is no significant difference in these differences (t value = -0.42).

Furthermore, using the marginal utility of money and the estimation results of each random parameter, we calculate the MWTP for each attribute. We divide the estimated results of each random parameter by the marginal utility of money, multiply it by -1 and obtain the MWTP. For new companies,

the MWTP of -238.04 yen ($-2.16; t value = -8.85) in the control group and -252.98 yen ($-2.30; t value = -8.78) in the treatment group, both have statistical significance at the 1% level. No significant difference is found in the difference in MWTP between the two groups (t value = 0.34). Regarding TOU, the MWTP is 125.93 yen ($1.14; t value = 4.75) in the control group, and this is significant at the 1% level. This value is -9.04 yen ($-0.08; t value = -0.34) in the treatment group but this result is not significant. However, there is a statistically significant difference at the 1% level (t value = 3.59). The renewable energy ratio is 22.40 yen for the control group ($0.20; t value = 18.35) and 23.72 yen for the treatment group ($0.22; t value = 15.59), and both groups show statistical significance at the 1% level. There is no significant difference in these differences (t value = -0.69). Finally, the nuclear energy ratio is -49.07 yen for the control group ($-0.45; t value= -22.18), and it is -56.40 yen for the treatment group ($-0.51; t value= -22.00). Both results are statistically significant at the 1% level. Focusing on the difference between the two groups, it is statistically significant at the 5% level (t value = 2.17).

＜Table 4: Marginal willingness to pay＞

4.5 Estimation results: Average treatment effect

In this section, we will estimate the treatment effects based on the MWTP. The basic estimation equation is

$$MWTP_n = \alpha + \beta \cdot Recap_n + \varepsilon_n. \quad (5)$$

Here, $MWTP_n$, which is the dependent variable, is the marginal willingness to pay for TOU of individual n. The explanatory variable $Recap_n$ is a dummy variable that takes 1 if the individual n is in the treatment group and 0 if in the control group. Since the control and treatment groups are randomly assigned, the coefficient β is the average treatment effect (ATE) for receiving information. α is a constant term and can be interpreted as the average MWTP of the control group. Finally, ε_n is an error term and follows a normal distribution with zero mean.

In the following, first, only the effects of intervention are estimated using the above formula. We then estimate the effects of each intervention for those who gain and those who suffer losses by switching from the FLAT to the TOU plan. Finally, we estimate the degree of gain or loss for the case of changing to the TOU plan and the case of not changing the plan.

Table 5 shows the estimation results of the effect of information treatment on MWTP for TOU. Here, we estimate only the presence or absence of the effect of the intervention. The effect of the intervention is approximately -135 yen ($-1.23) and statistically significant at the 1% level. The constant is

approximately 126 yen ($1.15), which is statistically significant at the 1% level.

＜Table 5: OLS estimation results-Overall treatment effect (SP)＞

From this, we found that the estimated value (MWTP) for TOU is higher than 0 yen when RECAP information is not given. However, this tendency is eliminated by giving RECAP information regarding changing plans, and the evaluation value approaches 0. In fact, when testing the sum of the constant term and the coefficient of the RECAP dummy, no statistical significance is found (t value = 0.12).

Next, in the result (2) of Table 6, we analyze the cases divided into the loss cases / gain cases. The Winner part of Table 6 shows the estimation result for the person who gains by switching, and the Loser part shows the estimation result for the person who loses by switching. Also, each constant term part (cons) represents the average MWTP of the corresponding control group. First, for Winner, the average WTP in the control group is 181 yen ($1.65), which is statistically significant at the 1% level. However, the treatment effect by RECAP information on Winner is not statistically significant. On the other hand, for Loser, the average MWTP of the control group is 76 yen ($0.69), which is statistically significant at the 5% level. The intervention effect by the RECAP information of Loser is minus 188 yen ($1.71) and statistically significant at the 1% level.

＜Table 6: OLS estimation result-Treatment effect (SP) on loss / gain＞

In result (1) of Table 5, the evaluation value for changing to the TOU plan decreased to nearly 0 yen by receiving the treatment. However, by analyzing the gains and losses in Model 2 of Table 6, we found that the evaluation value differs depending on whether the person is in the gain or loss region. For those in the gain area, even if it is found that they will earn by switching, we found that the evaluation value for the TOU plan does not change between receiving and not receiving information, maintaining the tendency for not receiving information. For people in the loss area, the evaluation value is significantly lower at 76 yen ($0.69) compared to the case of gaining (significant at 5%, t value = 1.96) when information is not received. By informing a participant that they will lose money, the evaluation value is further reduced. In the end, the evaluation value of changing to the TOU plan is -112 yen ($-1.02). In fact, the sum of the Loser's constant and Loser's RECAP dummy coefficient is statistically significant at 1% level (F value = 9.91).

Result (3) in Table 6 includes the amount of savings on electricity payments per month obtained when changing from the FLAT rate plan to the TOU rate plan. For people in the gain area, the constant term of the control group is 116 yen ($1.05), which is statistically significant at the 1% level. In addition, each time the amount of gain increases by 1 yen, the evaluation increases by 0.1 yen ($0.001),

and statistical significance is observed at the 5% level. However, the effect of the RECAP information is not significant in terms of the information about the gain or the increase of the gain amount. For those in the loss area, the constant term of the control group is 26 yen ($0.24), but no statistical significance is found. Also, no significance is found for the amount of the gain. The effect of information provision is also not significant.

From the above, by including the difference between the electricity payments of the two rate plans, we found differences in how people evaluate each plan in the loss or gain area and in response to information. A person in the loss area responds to the label that she loses by switching, and greatly reduces the evaluation amount. However, there is no effect on the amount of loss. For people in the gain area, there is no difference in response between receiving and not receiving information, but it is clear that the evaluation amount is determined by the amount of gain even if there is no information.

5. Revealed preference experiment

In this section, we investigate whether the same tendency as the preferences obtained in the SP experiment appears in the actual choice of the electricity tariff plan after liberalization.

5.1 Experiment design

In November 2016, after liberalization, we surveyed the actual conditions of electricity tariff plan contracts for the 983 people who participated in the SP experiment. In this questionnaire, participants are asked about the electricity tariff plan they are contracted to at the time of the survey. In the same way as the SP experiment, we provided vouchers worth 1,000 yen to those who responded. The final number of respondents was 677 overall, 306 people did not answer. The control group had 328 people and the treatment group had 349 people.

5.2 Estimation method

Based on the data obtained from the survey, we investigate the relationship with the presence of the RECAP information given prior to the SP experiment. Here, we use a binary variable that takes 1 when the TOU rate plan is actually contracted, and 0 otherwise. As with the stated preference experiment, we use the RECAP dummy, which indicates the presence or absence of intervention, as an explanatory variable. We also use the Winner dummy, which takes 1 when obtaining gain by a transition to the TOU plan, and the Loser dummy, which takes 1 when making a loss. Furthermore, we use the variable Gain, which indicates benefit from switching. In the estimation, we consider a linear probability model

and analyze it by OLS[9].

5.3 Estimation results

Table 7 shows the estimation results on the relationship between the intervention by providing RECAP information and the choice of TOU rate plan after liberalization. First, in result (1), we estimate only the relation between the intervention and the choice of the TOU rate plan. The intervention coefficient is -2.6% and is not statistically significant. The constant term representing the choice probability of TOU of the control group is 14.6%, which is statistically significant at the 1% level. From this, it can be seen that the probability of actually selecting a TOU plan does not change depending on whether information is given.

＜Table 7: Estimation result by OLS-Overall (RP)＞

Next, in result (2) of Table 8, we analyze results divided into whether a gain or loss results from changing to the TOU plan. For Winners, the probability of choosing TOU in the control group is 20.3%, which is statistically significant at the 1% level. From here, a statistically significant effect of RECAP information in the treatment group is not found. In addition, for Losers, the average choice probability of the control group is 9.7%, which is statistically significant at the 1% level. The effect of information provision is not found for Losers in the treatment group.

＜Table 8: OLS estimation result-Treatment effect (RP) on loss or gain＞

As in result (1), even when we analyze by gain or loss in result (2), it is clear that the choice probability does not change depending on whether the person receiving the information is in the gain or loss region. The probability of switching to TOU for a loss is significantly lower at the 1% level compared to the probability of switching for a gain. From this, we found that consumers understand whether they will earn or lose regardless of the information provided, thereby deciding which tariff plan to select.

Finally, in result (3), we analyze the gain per month (Gain) obtained when switching from FLAT to TOU. For Winners, the average probability of choosing to switch in the control group is 3.8% but this is not significant. However, depending on the amount of the gain, the choice probability rises by 0.03% with respect to the increase in the amount of gain and this is statistically significant at the 1% level. In addition, even if we provide information to the consumers, the effect on their choice probability is

[9] For robustness checks, we also estimated discrete choice models such as the probit and logit models. The marginal effects were almost similar.

hardly seen. The response is weaker by approximately 0.009% than the response to the increase in the gain amount of the control group (significance level 10%). However, even when receiving information, although the response is weaker than when there is no information, a response to the amount of gain is found at a significance level of 1% (F value = 20.9). For Losers, the average choice probability of the control group is 8.8%, and no effect of information provision is found. Summarizing the above, knowing that consumers lose by switching, we found that the attitude to choose the TOU rate plan is almost the same between the case where information is not given and the case where information is given. However, we also found that, in the case of gaining, the probability of selecting a TOU rate plan is increased according to the amount of gaining, regardless of the presence or absence of information. In addition, it was found that the degree of increase in the selection probability slightly decreases when information is received.

6. Discussion

Figure 5 shows the average WTP of TOU in the SP experiment for the control and treatment groups overall, the control group Winners and Losers, and the treatment group Winners and Losers. The upper and lower bars of the bar graph in the figure indicate the standard error. According to the analysis of the SP experiment, the average WTP of the control group was approximately 126 yen ($1.15). The approximately 135 yen ($1.23) evaluation amount fell once RECAP information was received, and the average WTP of the treatment group fell to -9 yen ($-0.08). The average WTP for the treatment group was not statistically significant.

< Figure 5: Average MWTP by group>

From this, we found that the average WTP of the control group is larger than 0, so there is a tendency towards overconfidence when there is no information. The average WTP of the treatment group dropped to nearly 0 yen after information was provided, which shows that the tendency of overconfidence was eliminated by giving information on the gain and loss from switching from FLAT to TOU.

Next, regarding whether the information given to the treatment group indicates a gain or a loss, we analyzed the cases of gaining and losing by switching. In the Winner case where a gain accrues, the average evaluation value of the control group was 181 yen ($1.65), and there was no statistical change in the evaluation even if information is given. As for the Losers, the evaluation value of the control group was 76 yen ($0.69), and it decreased by 188 yen ($1.71) by receiving the information. Thus, the average WTP of the Loser group dropped significantly to -112 yen ($-1.02). On this basis, the evaluation value approaches 0 yen in total and the tendency of overconfidence disappears. However,

the degree of correction differs between those who received positive information and those who received negative information. People who received positive information do not change ratings much compared to when they do not receive information, but when they receive negative information, they reduce their evaluation value significantly. The change in the evaluation value of Losers reduced the evaluation value of the entire treatment group.

Furthermore, in addition to whether the information received is positive or negative, by considering the degree of gain (or loss), the difference in how the evaluation value of Winners and Losers changes became clearer. Figure 6 shows the relationship between the evaluation value and the difference based on the estimation result (Table 6, result (3)) including the difference to the analysis in the SP experiment. Here, if the coefficient is not significant, it is treated as 0. In Figure 6, the straight line of the part where the amount of gain (horizontal axis) is positive shows the relationship between the evaluation of the Winners and the amount of the gain. Also, the evaluation value of the Losers is indicated by the straight line of the part where the gain is negative. Based on the estimation results, there is no difference in the evaluation value between the case where information is given and the case where it is not given. Therefore, the response to the evaluation value considering the difference is the same for the control group and the treatment group. As for the Losers, it is constant at 0 yen regardless of the increase or decrease in the amount of the gain. Furthermore, for the Winner, it is understood that the evaluation amount is 116 yen ($1.05) at the gain amount of 0 yen, and the evaluation amount is increased by 0.1 yen ($0.001) by the unit of gain increases.

< Figure 6: Relationship between MWTP and gain>

From the above, it can be understood that the tendency of overconfidence seen in the evaluation value for transfer is corrected by receiving the information. In addition, the correction of information is mainly made by the change of the evaluation value of people receiving information about a loss. People who receive information about a gain decide the evaluation value according to the degree of gain and this is affected by information provision. Furthermore, it is found that the person who receives loss information responds to the label of a ‘loss’ rather than the degree of the loss, and changes the evaluation amount. These tendencies can be found even when the information is not given; consumers are asymmetrically responding to loss and gain on the valuation.

Asymmetric attitudes towards positive and negative information have also been seen in previous studies. Ertac (2011) reports a weak response to giving positive information when a tendency toward overconfidence is observed, and a strong pessimistic response to negative information. By contrast, Eil and Rao (2011), Mobius et al. (2014), Sharot and Garrett (2016) report when negative information was given, no response was found, and when it was given positive information, a response similar to the Bayes’ rule was found.

In our study, as in Ertac (2011), the evaluation value did not change when positive information was given, and the evaluation value changed strongly pessimistically when negative information was given. These changes in valuation can be considered as follows. First, if consumers do not receive information, they will be optimistic about their lifestyle and attitude toward power saving, and think that they might benefit from switching to TOU. However, if it is revealed that they pay more if they switch, the psychology of loss avoidance works and avoids TOU regardless of the degree of loss. In addition, for those who received positive information, there is no difference in the average evaluation value regardless of the presence or absence of information, but it is thought that participants examined the transfer option in light of their potential benefit beforehand.

Next, Figure 7 shows the average WTP of TOU for the RP for the control group or treatment group as a whole, control group Winners and Losers, and treatment group Winners and Losers. The upper and lower bars of the bar graph in the figure indicate the standard error. According to the RP analysis, the average probability of choosing to switch for the control group was approximately 14.6%, and it was approximately 2.6% lower when RECAP information was given, but this was not a significant result. From this, there was no difference in the average choice probability among the control group and the treatment group, and there was no change in the choice based on the information provided.

< Figure 7: Average choice probability by group>

In addition, we divided the group depending on whether the information conveyed a gain or loss, and analyzed the two cases. For the Winners, the average choice probability for the control group was 20.3%, and for Losers, the average choice probability for the control group was 9.7%. Neither Winners nor Losers showed any effect on the average choice probability based on the provision of information.

Furthermore, in addition to whether the information received is positive or negative, we also consider the degree of gain (or loss). Figure 8 shows the relationship between the choice probability and the difference of the control group and the treatment group, based on the estimation results (Table 8, result (3)) including the difference in the analysis from the RP. Here, if the coefficient is not significant, it is treated as 0. In Figure 8, the straight line where the amount of gain of the treatment group is positive shows the relationship between the choice probability of Winners and the amount of gain. The choice probability of Losers is shown by the straight line where the amount of gain is negative. For Winners, the choice probability of the control group is 0% around the gain amount of 0 yen, and the choice probability increases by 0.03% as the gain amount increases by 1 yen. When information is given, the reaction to the amount of 0.009% gain weakens compared to the case without information, but the selection probability is increased by 0.02% as the amount of gain increases by 1 yen. In addition, no response to information was found for Losers, and the selection probability is constant at 8.8%.

From the above, the response to information as seen in SP is not found in RP, and even in the absence

of information, Losers have a lower choice probability than Winners. For Winners, as seen in SP, there is a relationship that the choice probability is determined according to the amount of gain. Also, by giving information to Winners, the response to the gain amount was slightly weakened, and the response tended to be conservative.

< Figure 8: Relationship between selection probability and gain>

It has long been known that there is a discrepancy between the results of SP data and RP data. Carson et al. (1996) report that results from SP data underestimate results from RP data. Also, Brown et al. (1996) and Seip and Strand (1992) have shown that SP results become excessive. In our results, unlike the estimation results based on SP data, in RP data, there is no decline in the selection probability due to giving negative information, and the reaction about a gain from switching becomes conservative based on the information provision.

From the estimation results of this SP data and RP data, it was found that the consumer's appropriate choice is boosted in SP data by giving RECAP information. However, for RP data, it did not result in boosting appropriate selection, but rather evidence of a reverses selection was found, even in the case of gaining. From this, we found that information such as RECAP information is not enough to spread TOU tariffs, and it is necessary to consider other means to promote consumer choice.

Finally, we will examine the relationship between the willingness to pay for TOU and the actual choice of the TOU rate plan. Figure 9 shows the distribution of WTP for the TOU rate plan of those who actually selected TOU and those who stayed in the FLAT rate plan, by control and treatment group. The red part of the figure represents the WTP of the person who selected TOU, and the blue part represents the WTP of others. For both the control group and the treatment group, the distribution of WTP is on the right of the TOU selectors compared to the non-TOU selectors. People with higher WTP in advance seem to actually select TOU better. In addition, it can be seen that some of the control and treatment groups who are in the negative area of WTP actually select TOU.

<Figure 9: Distribution of TOU selection / non-selection WTP by group >

Table 9 shows the results of the analysis of this relationship by OLS. Here, the explained variable is a binary variable that indicates the TOU selection, which takes 1 if TOU is selected, and 0 otherwise. Additionally, we use the RECAP dummy, positive WTP dummy, and the cross term of RECAP dummy and WTP dummy as the explanatory variables. The RECAP dummy variable equals 1 for the treatment group and 0 for the control group. The WTP (+) dummy is a variable that takes 1 if WTP (+) takes a zero or positive value, and 0 otherwise. From the results in Table 9, no statistical significance is found for the RECAP dummy, and the cross terms of the RECAP dummy and the WTP (+) dummy. Therefore,

the presence or absence of intervention has no effect on the relationship between the positive WTP and the actual choice. The constant term can be thought of as the probability that the positive WTP actually leads to choosing a TOU for a person with a negative value. Here, the constant term is 0.077 (statistically significant at the 5% level), so it can be interpreted that the TOU choice probability for people with the negative WTP is approximately 8%. Furthermore, the coefficient of the WTP (+) dummy is 0.1016 (statistically significant at the 5% level). Here we can see that the choice probability for people with positive WTP is approximately 10% higher than that for people with negative WTP. From this, we found that the choice probability of the person who showed high evaluation in the SP is approximately 10% higher than the person who made a low evaluation. We also found that there was a certain degree of correlation between SP and RP.

<Table 9: Relationship between TOU selection probability and WTP by OLS >

7. Conclusion

From the results of the SP experiment, it was found that the evaluation amount (the limit payment intention amount) was approximately 126 yen when participants did not have information on the gain or loss resulting from switching, and the evaluation amount decreased to nearly 0 yen once information was provided. In addition, those who received information that they would lose money due to switching changed their evaluation value significantly. The evaluation value did not change significantly based on information about earnings. Furthermore, if we consider the degree of loss or gain, in the case of loss, participants respond greatly to information about a loss, and the evaluation amount decreases. By contrast, in the case of gains, the evaluation value increased according to the degree of gain regardless of receiving information itself.

Additionally, for RP, we obtained different results from those of SP. If information is not given to those who are likely to gain from switching, the probability of switching is not statistically different from 0%, and even if the information is given, the result does not change. The choice probability does change according to the increase in the gain amount. Unexpectedly, we found that the likelihood of switching decreased based on the information about the gain amount. By contrast, for those who suffer a loss from switching, we found that the choice probability does not statistically change and is constant at 8.8%, even when the information about the loss amount is provided.

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Appendix 1: Balance check of household attributes

Table 10 shows the average and standard deviation of participant attributes by group, and the number of respondents. The fourth column of the table shows the difference between the average of the control group and the treatment group, the standard error, and the total number of respondents. First, the gender of the participants is 8.5% for the control group and 9.6% for the treatment group, with 0 for male and 1 for female. The difference is 1.2% and not statistically significant (t value = 0.63). Next, regarding the working conditions of the participants, the dummy variable is 1 when doing some work (including part-time), and 0 when not. The mean is 56.0% in the control group and 51.7% in the treatment group. The difference is 4.3% and not statistically significant (t value = 1.11). As for the

household annual income, the average value in the control group is 7,702.9 thousand yen ($70.03 thousand) and the average in the treatment group is 7,423.8 thousand yen ($67.49 thousand). The difference is 27.9 thousand yen ($0.25 thousand) and not statistically significant (t value = 0.71). Next, for the attributes of the house to be inhabited, we first look at whether it is a detached house or an apartment house. Here, 1 is taken for single-family homes and 0 for multi-family homes. It is 87.0% in the control group and 85.8% in the treatment group. The difference is 1.2% and not statistically significant (t value = 0.52). Next, we examine if it is an owned home or a rental house. Here, 1 is taken for the owner's house, and 0 for the rental house. The mean value is 99.6% for the control group and 99.8% for the treatment group. The difference is 0.2% and not statistically significant. Finally, the number of people in the household is 3.28 for the control group and 3.03 for the treatment group. The difference is 0.25, with a statistically significant difference (t value = 2.51).

＜Table 10: Balance check of household attributes＞

Appendix 2: Analysis of attrition

Here, we analyze the attrition between the Stated Preference and Revealed Preference experiments. Table 11 shows the attrition rates. First, the attrition rate from the SP experiment is approximately 7% in the control group and approximately 8% in the treatment group. No significance is found for the difference in attrition rates in the two groups (t value = 0.88). In addition, the attrition rate of the RP experiment is approximately 34% in both the control group and the treatment group, and again, no significance is observed (t value = 0.09).

＜Table 11: Analysis of attrition＞

Figures and Tables

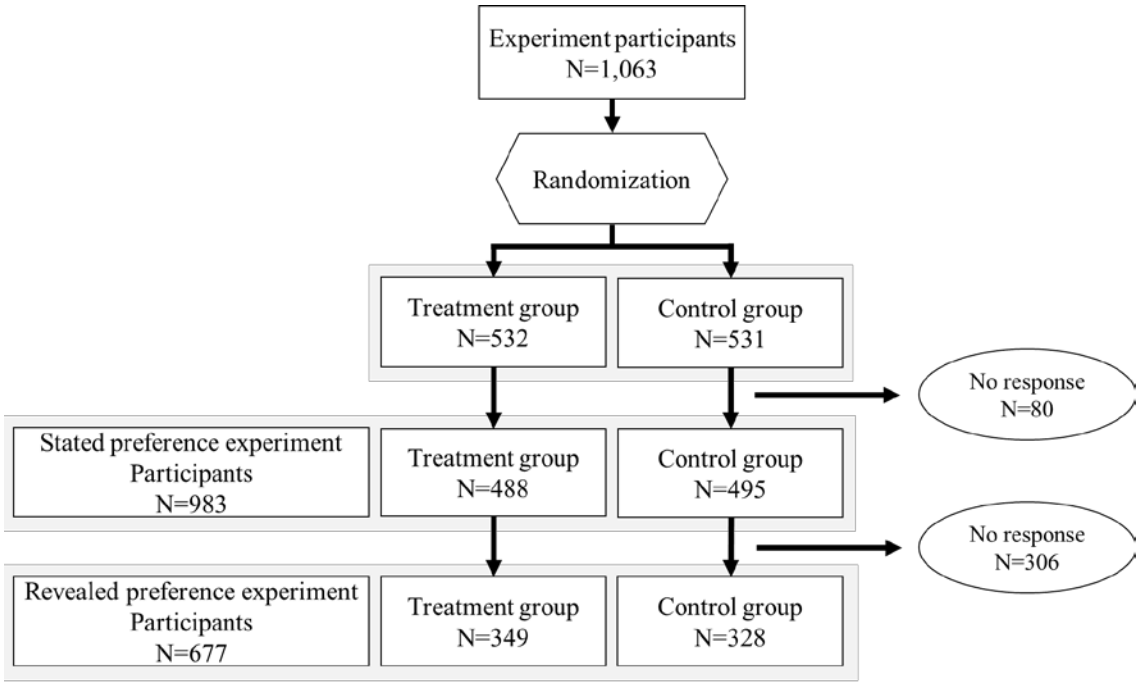

Figure 1: The flow of the experiments

Mr. ○○ ○○

Questionnaire response procedure

Kyoto University

Graduate School of Economics

Please follow the steps below to answer the questionnaire.

（１）First of all, please read the article " Which rate plan is better for you?" in the box.

（２）Based on this article, please continue to answer the "Electricity Questionnaire Survey". (Please fill in the answer postcard.)

Which rate plan is better for you?

We use your household's summer 2015 (July to September) electricity usage data (measured every 30 minutes by HEMS) to calculate electricity rate with two virtual electricity rate plans and compare them.

① Per-use lighting rate plan (24-hour flat rate)

Generally, it is said to be a recommended menu for those who want to use electricity without worrying about time of day or day of the week, or those who with a high rate of usage in the daytime.

[Virtual rate plan] 24 hours uniform Approximately 25 yen per 1 kWh

Summer electricity rate calculation result of your home 15,000 yen per month

② Time-of-use rate plan

Under this plan, usage at night is more advantageous. It is recommended for those households where the family is out during the daytime and there are many people at home at night.

[Virtual rate plan] Daytime (9 a.m. to 9 p.m.) Approximately 40 yen per 1kWh

Nighttime (9 p.m. to 9 a.m.) Approximately 8 yen per 1kWh

Summer electricity rate calculation result of your home 10,000 yen per month

③ Comparison of ① Per-use lighting rate plan and ② Time-of-use rate plan

Comparing the two virtual electricity rate plans,

When changing from ① Per-use lighting rate plan to ② Time-of-use rate plan,

5,000 yen cheaper per month

Figure 2: Intervention flyer

Table 1: Monthly rate difference according to the tariff plan

n=1,063	FLAT plan (JPY)	TOU plan (JPY)	Difference (JPY)
Mean	9,428.819	9,428.802	0.017
s.d.	4,433.424	4,515.220	883.082
Min	0	0	-3,534
Max	39,007	37,627	6,052

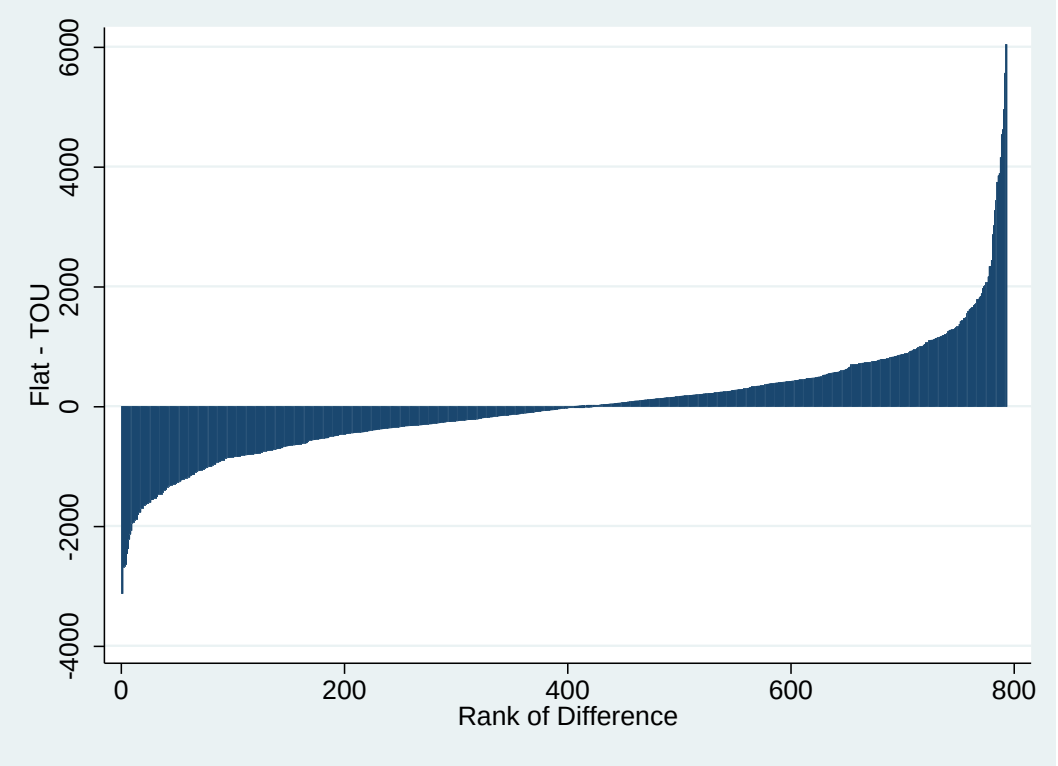

Figure 3: The distribution of monthly payment difference

Table 2: Balance check of average power consumption

	Control group	Treatment group	Difference
Daily (kWh)	12.922	13.024	-0.101
(s.d.)	(5.672)	(5.444)	(s.e. = 0.346)
Daytime only (kWh)	6.869	6.971	-0.103
(s.d.)	(3.184)	(3.019)	(s.e. = 0.193)
Nighttime only (kWh)	6.054	6.052	0.002
(s.d.)	(2.795)	(2.726)	(s.e. = 0.172)
N	531	532	

	Plan 1	Plan 2	Plan 3
Type of power company	New power company	Power company currently under contract	Power company currently under contract
Type of tariff plan	Time-of-use or Flat rate plan	Time-of-use or Flat rate plan	Flat rate plan
The ratio of renewable energy	0%, 20%, 40%	0%, 20%, 40%	10%
The ratio of nuclear energy	0%, 20%, 40%	0%, 20%, 40%	10%
Monthly electricity charge	Same as the present, 10% decrease, 20 decrease	Same as the present, 10% decrease, 20 decrease	Same as the present

Figure 4: Stated preference method question attribute values

Table 3: Estimated result by stated preference method

	Control group	Treatment group
Fixed parameters		
Electricity payment ratio	-23.912***	-23.146***
	(1.289)	(1.179)
Status quo	0.014	0.355***
	(0.110)	(0.110)
Random parameters (Mean)		
New company	-0.596***	-0.577***
	(0.098)	(0.106)
TOU	0.252**	-0.138
	(0.122)	(0.122)
Renewable energy ratio (%)	0.053***	0.051***
	(0.006)	(0.006)
Nuclear energy ratio (%)	-0.124***	-0.135***
	(0.008)	(0.008)
Random parameters (Standard deviation)		
New company	1.613***	1.795***
	(0.111)	(0.121)
TOU	1.796***	1.836***
	(0.132)	(0.150)
Renewable energy ratio (%)	0.079***	0.085***
	(0.007)	(0.006)
Nuclear energy ratio (%)	0.128***	0.138***
	(0.008)	(0.008)
R^2	0.412	0.389
LRI	-2557.545	-2619.778
obs	3960	3904

Standard errors are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 4: Marginal willingness to pay

	Control group	Treatment group
Marginal utility of money	-0.0034***	-0.0032***
	(0.0003)	(0.0003)
Marginal willingness to pay (JPY)		
New company	-238.043***	-252.977***
	(26.905)	(28.825)
TOU	125.926***	-9.038
	(26.521)	(26.676)
Renewable energy ratio (%)	22.401***	23.720***
	(1.221)	(1.483)
Nuclear energy ratio (%)	-49.070***	-56.405***
	(2.212)	(2.563)
N	464	488

Standard errors are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 5: OLS estimation results-Overall treatment effect (SP)

N=952	**(1)**
cons	125.926***
	(26.953)
RECAP	-134.964***
	(37.646)
$\boldsymbol{R^2}$	0.013
adj $\boldsymbol{R^2}$	0.012

Standard errors are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 6: OLS estimation result-Treatment effect (SP) on loss / gain

N=952		(2)	(3)
Winner	**cons**	181.040***	115.983**
		(38.742)	(49.604)
	Gain		0.100**
			(0.048)
	RECAP×Winner	-72.475	-111.285
		(54.306)	(69.435)
	RECAP×Winner × Gain		0.065
			(0.068)
Loser	**cons**	76.233**	26.138
		(36.787)	(55.283)
	Gain		-0.092
			(0.076)
	RECAP×Loser	-188.399***	-121.139
		(51.218)	(76.491)
	RECAP×Loser× Gain		0.121
			(0.101)
	R^2	0.036	0.053
	adj R^2	0.032	0.046

Standard errors are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 7: Estimation result by OLS-Overall (RP)

N=677	**(1)**
cons	0.146*** (0.019)
RECAP	-0.026 (0.026)
$\boldsymbol{R^2}$	0.002
adj $\boldsymbol{R^2}$	-0.000

Standard errors are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 8: Estimation result by OLS- loss / gain (RP)

N=677		(2)	(3)
Winner	**cons**	0.203***	0.038
		(0.027)	(0.034)
	Gain		0.00027***
			(0.00004)
	RECAP×Winner	-0.019	0.026
		(0.038)	(0.046)
	RECAP×Winner × Gain		-0.00009*
			(0.00005)
Loser	**Cons**	0.097***	0.088**
		(0.025)	(0.036)
	Gain		-0.00002
			(0.00005)
	RECAP×Loser	-0.033	-0.010
		(0.035)	(0.051)
	RECAP×Loser × Gain		0.00004
			(0.00007)
	$\boldsymbol{R^2}$	0.029	0.146
	adj $\boldsymbol{R^2}$	0.025	0.137

Standard errors are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

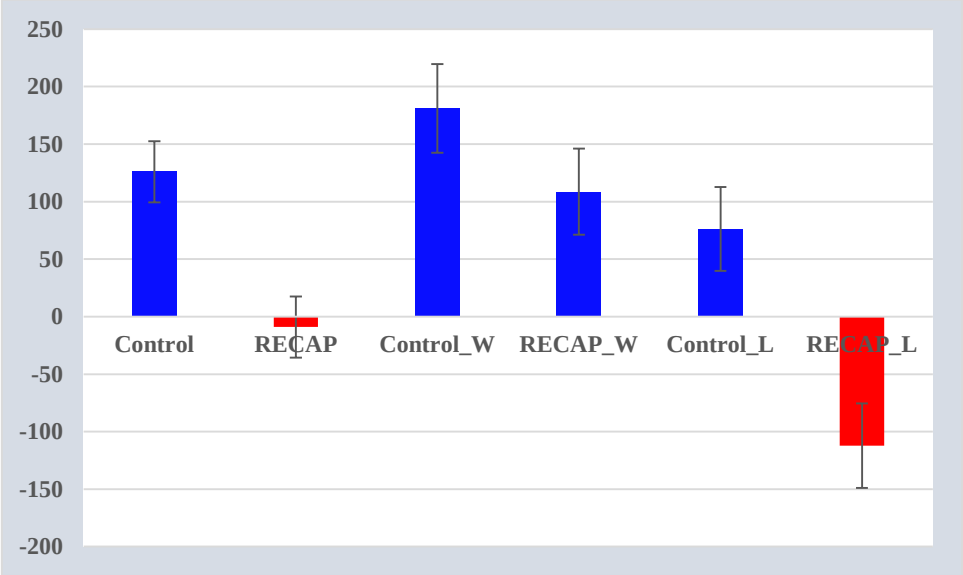

Figure 5: Average MWTP by group

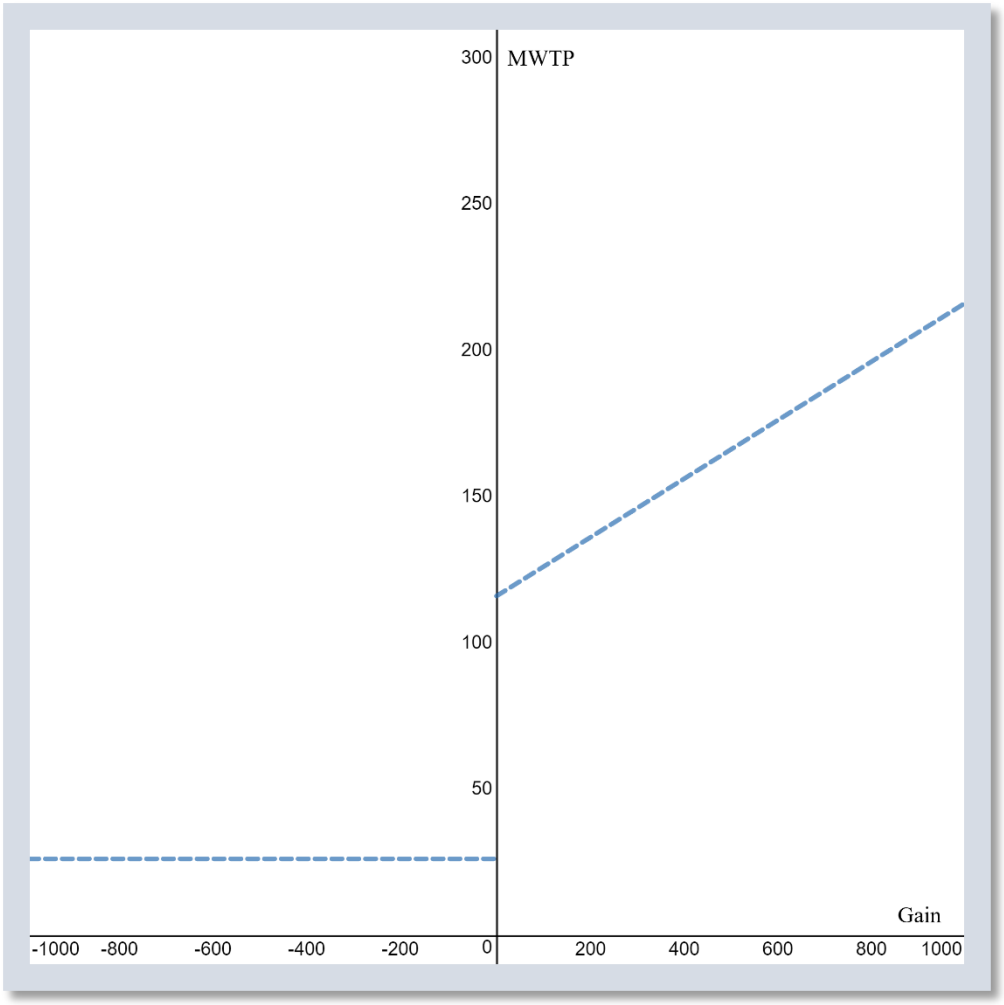

Figure 6: Relationship between MWTP and gain

The vertical axis represents MWTP, and the horizontal axis represents the gain amount due to the change of the rate plan. The dotted line in the figure shows the average MWTP of the control group.

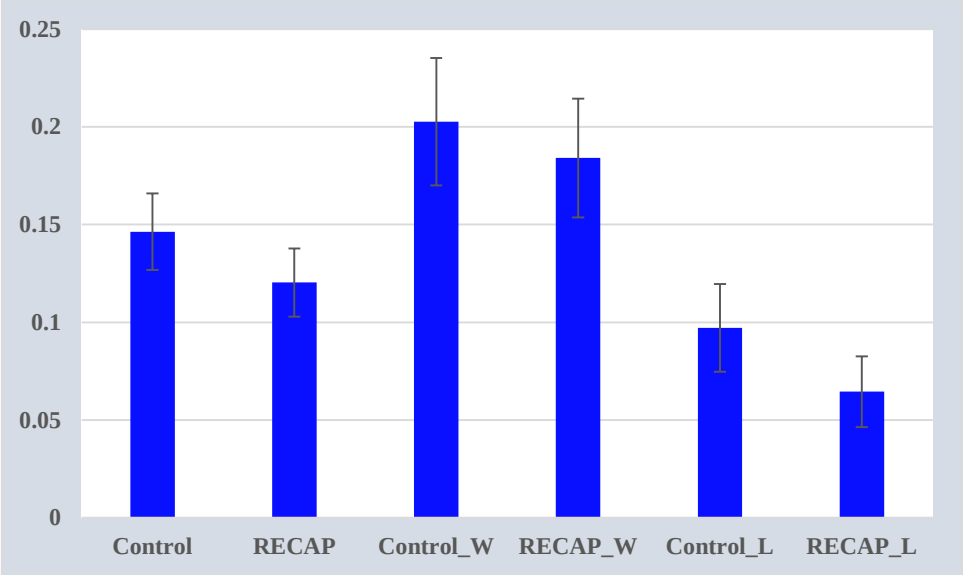

Figure 7: Average choice probability by group

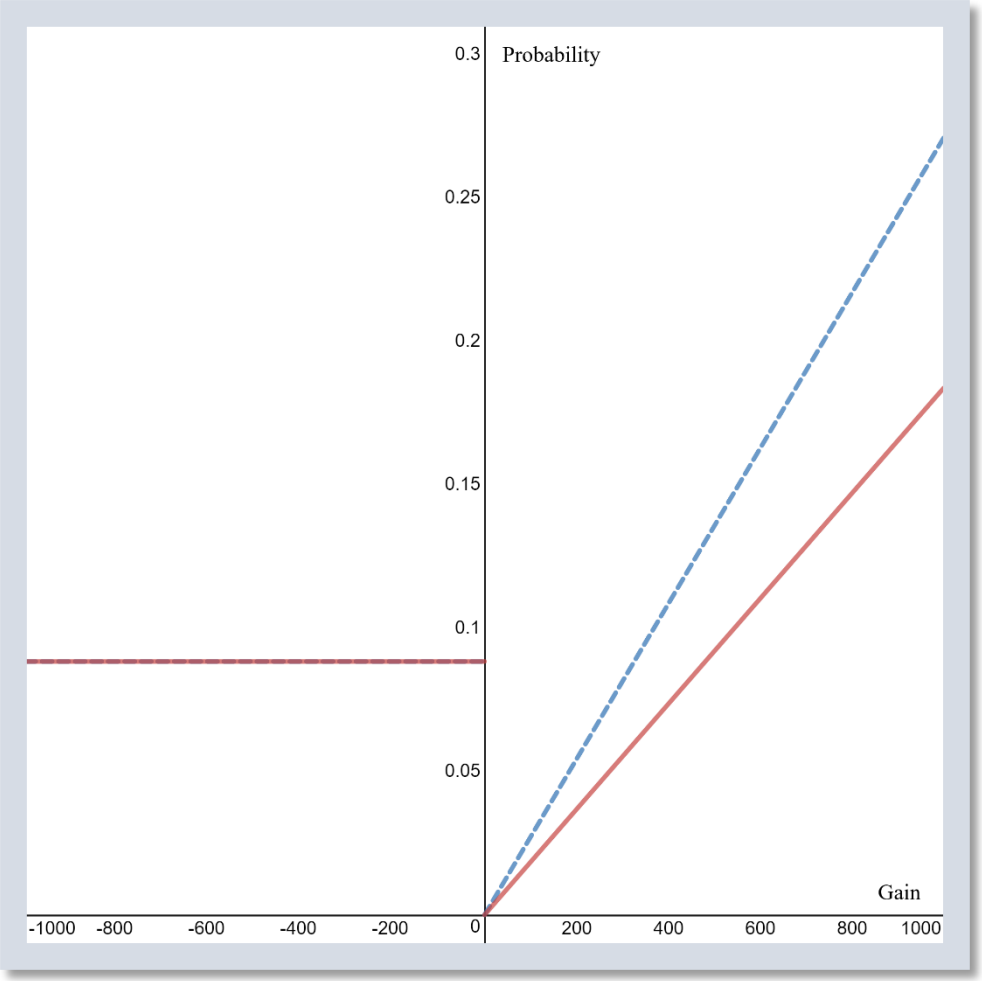

Figure 8: Relationship between selection probability and gain

The vertical axis shows the choice probability, and the horizontal axis shows the gain amount due to the change of the rate plan. The dotted line in the figure shows the average choice probability of the control group, and the solid line shows the average choice probability of the treatment group.

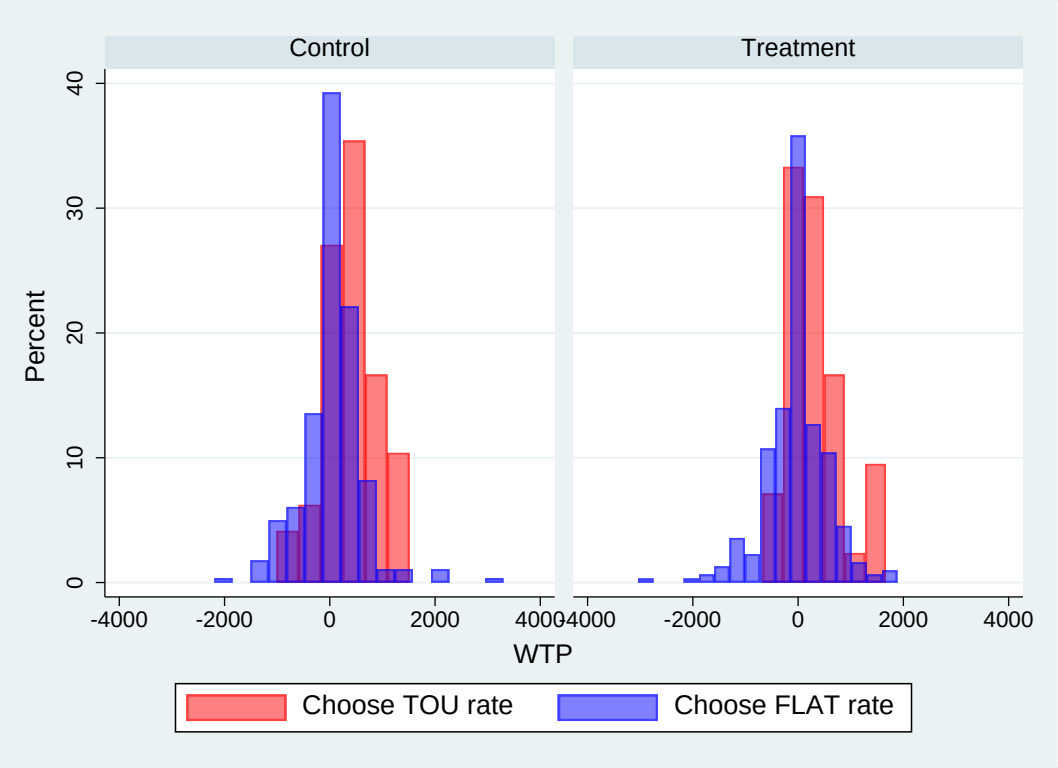

Figure 9: Distribution of TOU selection / non-selection WTP by group

Table 9: Relationship between TOU choice probability and WTP by OLS

N=677	(1)
cons	0.077** (0.033)
RECAP	0.003 (0.043)
WTP (+)	0.102** (0.040)
RECAP×WTP (+)	-0.030 (0.054)
$\boldsymbol{R^2}$	0.017
adj $\boldsymbol{R^2}$	0.012

Standard errors are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 10: Balance check of household attributes

	Control group	Treatment group	Difference
Sex	0.085	0.096	0.012
(s.d.)	(0.279)	(0.296)	(s.e. = 0.019)
N	484	477	(Total: 961)
Employment rate	0.560	0.517	0.043
(s.d.)	(0.497)	(0.501)	(s.e. = 0.039)
N	334	325	(Total: 659)
Household income	7702.869	7423.792	279.077
(s.d.)	(4275.833)	(4623.992)	(s.e. = 392.955)
N	244	269	(Total: 513)
House group classification	0.870	0.858	0.012
(s.d.)	(0.337)	(0.350)	(s.e. = 0.022)
N	475	471	(Total: 946)
Rental house classification	0.996	0.998	0.002
(s.d.)	(0.066)	(0.047)	(s.e. = 0.004)
N	464	451	(Total: 915)
Household number (person)	3.280	3.033	0.247
(s.d.)	(1.401)	(1.409)	(s.e. = 0.098)
N	418	399	(Total: 817)

Table 11: Analysis of attrition

	Control group	Treatment group	Difference
SPE attrition ratio (s.d.)	0.068 (0.253)	0.083 (0.276)	-0.014 (s.e.= 0.017)
RPE attrition ratio (s.d.)	0.341 (0.475)	0.344 (0.476)	-0.003 (s.e.= 0.030)
N	498	532	