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Deregulation and status quo bias: Evidence from stated and revealed switching behaviors in the electricity market in Japan

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Abstract:
This study investigates consumers' status quo bias against new alternatives after deregulation in the residential electricity market in Japan. We conducted two choice experiments using online surveys before and after deregulation, and analyzed the relationship between consumers' stated preferences and their revealed switching behaviors. The results indicate that the average Japanese consumer experiences status quo bias in electricity plan choice; consumers preferred to remain with their default provider despite the obvious 5% bill savings that could be gained from switching to a new provider. Moreover, respondents who did not switch in the real market became twice as attached to their default plan after their actual decision. In addition, respondents who switched soon after deregulation had a higher stated preference for renewable energy sources. This implies that new electricity plans that enhance clean energy have more potential to moderate consumer status quo bias in electricity plan choice. By simulating the potential share of new providers in the liberalized market, we found that a 50% renewable-energy plan has a larger potential market share than a plan that offers a 7% bill reduction under price competition.

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1. Introduction

In recent economic studies, consumers' status quo bias in plan choice has been observed in many market and non-market situations (Madrian and Shea, 2001; Miravete, 2003; Birol et al., 2006; Benartzi and Thaler, 2007; Abildtrup et al., 2013; Einav et al., 2013; Handel, 2013; Handel and Kolstad, 2015).[3] The electricity market is no exception (Herter, 2007; Jimenez et al., 2013; SMUD, 2014). For example, in a field experiment among electricity customers in the Sacramento Municipal Utility District (SMUD), opt-in enrollment rates in dynamic pricing tariffs were less than 20%, in sharp contrast to more than 90% in the case of opt-out enrollment (Jimenez et al., 2013; SMUD, 2014). This indicates that only a small portion of customers choose to opt-out when they are automatically enrolled to a new plan by default, while only about 20% of customers enroll on their own when they must opt-in.[4]

There is evidence that people stick with default options even though they know it is not optimal, or because they think the default was chosen by others for good reasons, as an implicit recommendation (e.g., Choi et al. 2004; Madrian and Shea 2001). In addition, in particular, the complexity of the choice situation could make them more likely to accept default options (O'Donoghue and Rabin 1999).[5] Thus, an unfamiliar choice situation, for example the kind of situation that appears right after deregulation, would cause them to suffer more from default bias. In the recent liberalized residential electricity market in Japan, consumers, who had traditionally bought electricity from local, monopolistic companies, are now exposed to an unfamiliar choice situation. From the perspective of limited personal experience (List, 2003), they would thus now be suffering from a strong default bias.[6]

The Japanese electricity market has been experiencing the largest deregulation in its history, as has also been the case in many European countries and the US in recent decades.

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[3] These include areas such as cell phones (Miravete, 2003), health insurance (Einav et al., 2013; Handel, 2013; Handel and Kolstad, 2015), retirement savings plans (Madrian and Shea, 2001; Benartzi and Thaler, 2007), and non-market valuations (Birol et al., 2006; Abildtrup et al., 2013).

[4] This tendency is useful to enhance the demand for positive public goods. For example, Pichert and Katsikapoulos (2008) found that setting green energy as a default plan for residential customers had a large impact on green-shift in electricity markets in both the natural field and a laboratory experiment.

[5] Complexity also might lead people to more errors (de Palma et al. 1995), or adopt heuristic decision rules (Heiner 1983).

[6] List (2003) provided experimental evidence that experienced subjects suffer less from default bias. More recently, Löfgren et al. (2012) found that decisions of experienced people are not affected by pre-set default options, in a field experiment study of carbon-offset purchasing behavior.

Electricity deregulation in Japan started in March 2000, initially in the large-scale industrial sector (over 2000 kW, e.g., large factories and buildings), which consumes a quarter (26%) of total domestic electricity. Subsequently, deregulation expanded to middle-scale industry (over 500 kW, e.g., medium-sized factories and buildings) in 2004 and to small-scale industry (over 50 kW, e.g., small buildings, small factories, major supermarkets) in 2005, for 62% liberalization in total. Nonetheless, the smallest sector (less than 50kW), comprising small shops and residential customers and accounting for 38% of the total domestic electricity, remained regulated for almost a decade after. It finally was opened on April 1, 2016, five years after the great earthquake and subsequent nuclear plant accidents in Japan.[7]

This deregulation has entailed the new opening-up of a market of almost 70 billion dollars (8.1 trillion JPY), including approximately 78 million residential customers and 7 million small shops and offices, previously monopolistically operated by 10 vertically integrated electricity power companies (EPCOs). This reform is expected to bring competition to this market and thereby improve the efficiency of power generation and retail services, and lower electricity prices for residential customers. However, according to previous studies investigating electricity price trends using historical data in the US electricity market, it is unclear whether electricity prices will actually reduce due to deregulation, even with improvements in efficiency (Goto and Tsutsui, 2008; Razeghi et al., 2017). Since the electricity price trend is affected by some uncertainty around fuel prices, customers do not always observe lower prices after deregulation.

Despite this price uncertainty, it is clear that deregulation of the electricity retail market has had two important benefits. First, the Japanese consumer can select from an expanded set of electricity services and providers. This means that, to a certain extent, consumers may directly impact and restructure the future energy mix. For example, if a considerable number of consumers comply with emissions reductions by choosing renewable energy sources despite their strong aversion to nuclear energy, as established through previous studies (Murakami et al., 2015), retail market deregulation may encourage a drastic change in the generation mix toward more intermittent sources.[8] According to the plan for the national energy portfolio in 2030, which was announced by Japan's Ministry of Economy, Trade and Industry (METI) in April 2015, the Japanese government seeks to double the share of renewable energy in national consumption to 24% in 2030, comprising 9% hydro, 7% solar, 5% biomass, 2% wind, and 1% geothermal.

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[7] METI (2018) presents a brief history of electricity deregulation in Japan.

[8] Murakami et al. (2015) examine consumers' willingness to pay (WTP) for nuclear and renewable electricity as two alternatives to fossil fuel sources.

Thus, consumer choice in the retail electricity market has the potential to be a driving force in accomplishing this goal.

Another important benefit from deregulation is the rise in expected peak-time energy savings from demand-side management. Faruqui and Sergici (2010) surveyed 15 empirical assessments of residential dynamic pricing programs and found that time-of-use (TOU) tariffs induce reductions in peak consumption ranging from 3% to 6%. Since most Japanese residential consumers are currently charged flat-rate tariffs, switching to TOU tariffs after deregulation could lead to considerable reductions in peak-time energy usage. Furthermore, when the government has finished installing digital smart meters in all Japanese households (about 50 million) by 2024, per its plan, more advanced dynamic pricing tariffs, such as critical-peak pricing (CPP) and real-time pricing (RTP), can be introduced to residential energy consumers to encourage more efficient electricity usage.[9] This fact is actually beneficial for many consumers, as it should lead to reductions in both private electricity bill and social energy cost.

Despite the clear benefits that consumers may gain from consumer-oriented future energy mix and peak-time energy savings via demand-side management, Japanese residential electricity customers prefer default flat-rate tariffs.[10] Although this tendency is partially due to the fact that many of the new electricity plans provide benefits to only those customers who consume large amounts of electricity daily rather than the more numerous low consumption customers, since retail deregulation is only beginning, their status quo bias bears mentioning as another potential reason. To Japanese customers, who have traditionally bought electricity from local monopolistic electricity companies, switching providers or plans may naturally be accompanied by some psychological burden. This phenomenon implies that it can be expected that consumers will remain with their default plans despite obvious savings that may be gained from switching to a different provider or a new electricity plan.

This study investigates whether Japanese consumers suffer from status quo bias when choosing alternative plans in the recently liberalized residential electricity market, the extent of the bias, whether it could change after deregulation, and how it could be moderated to increase switching rate. In addition, to explore whether consumer choice in the electricity retail market after deregulation will support the future energy mix plan, it

[9] A number of field experiment studies have shown that dynamic pricing affects household electricity consumption. For example, the CPP tariff has the effect of decreasing peak usage between 13% and 20% (Faruqui and Sergici, 2010; Ito et al., 2018).

[10] At the end of January 2017, more than 90% of the consumers remained with their default plan. A total of 7.7% had switched electricity plans. Of those, half (3.9%) had switched providers. Three years after deregulation, these rates have increased almost 20% (METI, 2018).

is useful to understand Japanese consumers' recent preference for dependency on renewable and nuclear sources in the fuel mix.

We assess current consumer preferences for alternative electricity plans after Japanese deregulation using a choice experiment. There are extant studies that use a choice experiment approach to explore consumer behavior with respect to electricity choice (e.g., Goett et al., 2000; Carlsson and Martinsson, 2008; Abdullah and Mariel, 2010; Pepermans, 2011; Cicia et al., 2012; Buryk et al., 2015; Murakami et al., 2015). However, these mainly focus on the stability of energy supply, such as a reduction in the risk of outage (Carlsson and Martinsson, 2008; Abdullah and Mariel, 2010; Pepermans, 2011), and on the ratio of renewable sources in the fuel mix (Cicia et al., 2012; Murakami et al., 2015). Buryk et al. (2015) were the first to evaluate the effect of consumer status quo bias in electricity tariff decisions using a choice experiment design that included dynamic pricing. Although their sample size was small, their preliminary results indicated status quo bias in electricity plan choice; eliminating such bias is one of the most important issues in energy policy.[11]

We consider two new attributes: a new provider and a TOU tariff (the simplest type of dynamic pricing). This is the first study to explore consumers' preferences for these new alternatives introduced after electricity deregulation using a choice experiment. We also investigate recent Japanese consumer preference for dependency on renewable and nuclear energy and compare the results with previous relevant results to examine the shift in trends after the Fukushima nuclear crisis.

Additionally, we investigate whether consumers' status quo bias would change as a result of their own choice between a default and a new alternative in the actual electricity market. This is done by comparing their stated preferences before and after deregulation. Information about their revealed switching actions (i.e., whether or not consumers chose the new alternative) was obtained through our second survey, thereby enabling the analysis of differences between pre-stated and post-stated preferences based on actual decisions. Such choice-induced preference change is psychologically explained by the "cognitive dissonance" theory (Festinger, 1957). People tend to value the chosen alternative more and the rejected alternative less after choosing between options (Brehm, 1956; Izuma et al., 2010; Sharot et al., 2012). In economic literature, Akerlof and Dickens (1982) exemplified this idea to work in nuclear power plants and found that once people

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[11] Another recent interesting study focuses on demand-side management in the electricity market in Sweden (Broberg and Persson, 2016). Using a choice experiment approach, it investigates customers' discomfort due to external controls, such as daily control of their residential heating system by utility companies during certain hours, and estimates willingness to accept this discomfort if given compensation.

choose a risky option, they tend to presume their risky choice to be safe. More recently, Ida et al. (2015) found that the difference between a chosen and a rejected alternative increased after a choice decision involving a trade-off relationship between dependency on nuclear power generation and electricity rate. This study investigates whether these choice-induced changes could be observed in the Japanese electricity market and the implications for establishing a competitive electricity market. Furthermore, we explore how to moderate the bias and increase switching rates by examining predictors of actual early switchers and simulating potential share of new companies using our estimation results.

The main conclusions can be summarized as follows. First, the average consumer suffers from status quo bias in electricity market in Japan. They prefer to remain with their default provider, despite the obvious 5% bill savings can be gained from choosing a new alternative. Second, soon after deregulation, where consumers face an unfamiliar choice situation, their status quo bias tends to be larger after actually choosing a default because of their tendency to justify decisions associated with psychological discomfort. This fact may suggest an unexpected impact on competitiveness in the liberalized market. Third, higher stated preference for renewable energy sources is a significant predictor of early switching behavior as well as lower status quo bias against new alternatives. This implies that new electricity plans that enhance clean energy can reduce consumers' status quo bias in their electricity plan choice. Finally, by quantitatively analyzing the potential market share of new entrants, focusing on the electricity bill and dependency on the renewable energy source, we found that a 50% renewable energy strategy has the same impact on market competitiveness as a 7% bill-reduction strategy under price competition.

The rest of this paper is organized as follows. Section 2 explains the methodology, including the internet-based stated preference survey method, choice experiment design, and econometric model used for estimation. Section 3 describes the statistics of the respondents. Section 4 presents the details of the estimation results. Section 5 adds further discussion, and Section 6 concludes.

2. Methodology

2.1. Survey and design

We conducted two web-based surveys: in January 2016, approximately three months before the full deregulation of the Japanese electricity market on April 1, and in October 2016, approximately six months after deregulation. In the first survey, we randomly drew a sample of 11,000 Japanese households from registered respondents with MyVoice Communications, Inc., a Japanese research agency, considering geographic characteristics, gender, and age in order to represent the general Japanese population. The respondents were asked 17 questions, including 8 on hypothetical electricity plan choice situations. The respondents received a small amount of remuneration for completing the questionnaire. In the second survey, we provided them almost the same questionnaire with some follow-up questions to assess whether they had switched their electricity provider in the real market. We used data from 8,087 households that completed both questionnaires.[12]

First, the questionnaire asked about a recent monthly electricity bill in the summer, the current electricity tariff type they subscribed to, ownership of private power generation systems such as a rooftop photovoltaic (PV) system, and their awareness of electricity deregulation in the retail market to understand their current situations related to electricity consumption. Then, the questionnaire provided explanations around total electricity deregulation, including the opening of the retail market in April 2016, so that the respondents would understand that they would be able to choose desirable alternatives among the plans, for example, discount plans with other family bills such as gas (other energy), cellphone, or internet (telecom), dynamic pricing rate plans, and electricity from renewable sources. Subsequently, we surveyed respondents' intention to switch to a provider that was different from their current one. Important factors that determined provider choice after retail deregulation were also surveyed. Finally, the questionnaire posed eight hypothetical electricity choice situations, described below. In the second survey, we asked additional questions to understand switching behavior, such as whether respondents switched electricity providers after deregulation, which provider they chose if they switched, and whether their monthly electricity bill had decreased after deregulation, regardless of whether or not they had switched.[13] Figure 1 presents an overview of the survey timeframe and procedures.

＜Figure 1. The timeline and procedures of the surveys＞

2.2. The discrete choice experiments

As summarized in Table 1, the attributes of the choice experiment are (1) electricity

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[12] The follow-up rate was 74%.

[13] In the second survey, we asked the respondents whether someone usually stays home on weekdays, which is important information related to household electricity consumption.

provider, (2) dynamic pricing, (3) dependency on renewable power generation, (4) dependency on nuclear power generation, and (5) monthly electricity bill. Specifically, we considered whether residential electricity was provided by the current provider that the respondents traditionally used or a new provider after deregulation. The attribute levels for dynamic pricing were a flat-rate plan, currently the most common tariff as the default, and a TOU plan, expected to become more common in the future and a gateway to more efficient dynamic pricing tariffs as alternatives. The generation rates of nuclear and renewable energy were both influential factors on electricity decisions among Japanese respondents, especially after the Fukushima nuclear plant accident (Murakami et al., 2015). Thus, we set the attribute levels for dependency on nuclear and renewable power generation at 0%, 20%, and 40%, each.[14] The attribute levels for the monthly electricity bill were no reduction (default), 10% lower, and 20% lower.

We established 16 profiles using the orthogonal planning method, divided them into alternatives 1 and 2, and posed them with the status quo option (alternative 3). Table 2 shows an example of one of the choice sets provided in the questionnaire. In the questionnaire, the respondents were asked to choose their preferred option from three alternatives; Plans 1 and 2 were potential situations after deregulation, and Plan 3 referred to the current tariff situation with the flat rate, 10% dependency on renewable, 10% dependency on nuclear power generation, and no reduction in the electricity bill.[15] Notably, each alternative was presented under the same provider label across the eight choice situations. Thus, Plan 1 was always provided by a new provider, while Plans 2 and 3 were provided by the current provider. The status quo option (Plan 3) was included in all the choice situations so that the respondents could always compare the hypothetical situations with the status quo.[16] Each respondent faced eight hypothetical plan choice questions.

＜Table 1. Attributes and levels used in the choice experiment＞

＜Table 2. An example of one of the choice sets provided in the questionnaire＞

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[14] In Japan, current electricity generation by fuel is denoted as the following combination of renewable and nuclear energy: 9.6% (with 8.5% hydroelectric) and 28.6%, respectively, in 2010 just before the Fukushima crisis; 14.5% (with 7.6% hydroelectric) and 1.7% in 2016, respectively; and 22–24% (with hydroelectric) and 20–22%, respectively, based on the government-projected future energy mix in around 2030.

[15] We set the level of dependency on renewable and nuclear power generation at 10% each.

[16] The respondents who had already switched to a TOU tariff (approximately 15% of all respondents) were asked to answer the choice experiments while assuming that they were still flat-rate customers.

2.3. Econometric specification

The response data collected from the surveys were statistically analyzed using a random parameter logit (RPL) model, which has greater flexibility than a conditional logit (CL) model, by assuming stochastic variation in the preference intensity. The RPL model allows random taste variation (McFadden and Train, 2000) and is based on the random utility theory, which assumes that utilities vary at random. A utility function involving a defined term *V* and a random term ε is given by:

$$U_i = V_i(x_i,\ m_i) + \varepsilon_i, \qquad (1)$$

where x_i is an attribute vector of an alternative *i* including a new provider, TOU rate, dependency on renewable power generation, and dependency on nuclear power generation, and m_i is a monetary attribute, which is the bill reduction rate (%).

In linear-in-parameter form, the utility function can be written as follows.

$$V_{nit} = \gamma' \ m_{it} + \beta_n' \ x_{it}\,, \qquad (2)$$

where m_{it} and x_{it} denote observable variables, γ denotes a fixed parameter set as a numeraire, and β_n denotes random parameter vectors. Subscript *n* represents distinctive parameters for each individual and subscript *t* represents choice situation. Thus, V_{nit} denotes the conditional utility of respondent *n* choosing alternative energy service *i* in choice situation *t*. To explore the differences between those who switched and others who did not, we incorporate additional interaction terms as follows.

$$V_{nit} = \gamma' \ m_{it} + \beta_n' \ x_{it} + \delta' \ x_{it} S_n\,, \qquad (3)$$

where S_n denotes the dummy variable for the switchers, which is one when a respondent switched until the second survey, so that δ denotes mean-shift parameters, which show the average differences between the revealed switching behaviors.

Assuming that parameter β_n is distributed with density function $f(\beta_n)$ (Louviere et al., 2000; Train, 2003), the model specification allows repeat choices by each respondent such that the coefficients vary according to the respondent but are constant over each respondent's choice situation. The logit probability of respondent *n* choosing alternative energy service *i* in choice situation *t* is expressed as

$$L_{nit}(\beta_n) = \prod_{t=1}^{T} \left[\exp(V_{nit}(\beta_n)) / \sum_{j=1}^{J} \exp(V_{njt}(\beta_n)) \right], \qquad (4)$$

which is the product of normal logit formulas given parameter β_n, the observable portion of utility function V_{nit}, and alternatives $\mathrm{j} = 1, \ldots, \mathrm{J}$ ($\mathrm{J} = 3$ in this study) in choice situations $\mathrm{t} = 1, \ldots, T$ ($T = 8$ in this study). Therefore, choice probability is a weighted average of logit probability $L_{nit}(\beta_n)$ evaluated at parameter β_n with density function $f(\beta_n)$, which is written as

$$P_{nit} = \int L_{nit}(\beta_n) f(\beta_n) d\beta_n. \quad (5)$$

Accordingly, we demonstrate variety in the parameters at the individual level using the maximum simulated likelihood (MSL) method for estimation, with a set of 200 Halton draws.[17] We estimate formulas (2) and (3), and derive WTP values for each attribute using these formulas. Each respondent completed eight questions in the choice experiment; the data formed a panel and we applied standard random effect estimation.

Because γ indicates the marginal utility of the electricity bill (%), the marginal WTP (MWTP) for the lth attribute is calculated from the ratio of β_l to γ,[18] which is given by the following:

$$\text{MWTP}_l(\%) = -\frac{\beta_l}{\gamma} \quad (6)$$

To obtain the MWTP (monetary unit), we use the following equation:

$$\text{MWTP}_l = -\frac{\beta_l}{\gamma} \times \frac{\text{average monthly bill}}{100}. \quad (7)$$

Since we simulated individual parameters β_n using the RPL model, we also obtained individual MWTP for each respondent. By using individual WTP, we also analyze what type of customers switched their electricity providers soon after deregulation (in the first six months), assuming the probability that S_n equals one is explained as a function of their WTP derived from the stated preference data in the first survey conducted three

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17 Louviere et al. (2000) suggested that 100 replications are sufficient for a typical problem involving five alternatives, 1,000 observations, and up to 10 attributes (see also Revelt and Train, 1998). The adoption of the Halton sequence draw is an important issue (Halton, 1960). Bhat (2001) found that 100 Halton sequence draws were efficient for simulating a mixed logit (ML) model with over 1,000 random draws.

18 A total differentiation of formula (2) gives: $dV_{nit} = \frac{\partial V_{nit}}{\partial m_{it}} dm_{it} + \frac{\partial V_{nit}}{\partial x_{kit}} dx_{kit}$, where subscript ki denotes the kth attribute of alternative i. When the utility level does not change ($dV = 0$) and attributes other than the said attribute are invariable ($dx_{kit} = 0 \; for \; all \; k \neq l$), the marginal WTP (MWTP) of an electricity bill rate equivalent is obtained, which gives: $\text{MWTP}_l(\%) = \frac{dm_{it}}{dx_{lit}} = -\frac{\beta_l}{\gamma}$ (6)$'$. When the respondent n is a switcher ($S_n = 1$), MWTP is calculated by $\text{MWTP}_l(\%) = -\frac{\beta_l + \delta_l}{\gamma}$ by definition.

months before deregulation. Moreover, we subsequently analyzed the potential market share of new providers by considering several feasible competitive strategies and focusing on the electricity bill and dependency on a renewable energy source based on our estimated results.

3. Descriptive statistics

3.1. Statistics for all respondents

Table 3 presents the summary statistics for the respondents, including age, gender, annual household income, education, household size, whether they were with or without children (0–12 years old), and house ownership, as demographic information. There are no crucial or significant deviations from the general Japanese population, because of stratified random sampling. Among all respondents, a total of 6.4% switched their electricity providers before our second survey (in the first six months after deregulation). We also surveyed the characteristics related to their current energy plans. The monthly electricity bill was approximately $85 before and after deregulation, on average. A total of 15.7% (before) and 16.7% (after) of the respondents subscribed to TOU tariffs. The ratio of private power generator owners was 7.6% (before) and 8.1% (after). Before deregulation, the ratio of respondents who knew about deregulation in the Japanese electricity retail market was 25.9%, which increased to 35.0% after deregulation. Regarding their intention of changing providers, the ratio decreased from 32.2% (before) to 16.7% (after), while 57% of respondents had no clear preference for changing providers.

＜Table 3. Summary statistics of all respondents＞

3.2. Statistics by revealed switching behavior

Table 4 presents the summary statistics by actual switching behavior. The right column shows the characteristics of the respondents who switched (6.4%), and the left shows the others (93.6%). Considering their demographic characteristics, the respondents who switched providers are characterized by relatively higher levels of income, education, and weekday stay-at-home rates. The differences are more obvious in terms of their monthly electricity bills. There is no change in their electricity bill from before ($84.5) to after ($84.1) deregulation for respondents who had not switched. In contrast, for respondents who did switch, the average monthly bill decreased drastically, by approximately 7%, from $95.6 to $88.6, which was 13% higher than the others before deregulation. The differences also appear obvious in their perceptions. In response to the question on their perception of their monthly bill from the recent summer, approximately 85% of the respondents who had not switched replied “the same” (67.7%) or “more” than that of the last summer (16.7%), while 51.2% of the respondents who had switched replied “less” than that of the last summer. Regarding their electricity consumption, large customers, who had paid higher electricity bills before deregulation, switched in the first six months, with a 7% discount on average.

Another interesting point was the similar tendency in their willingness to switch, despite their different situations. The ratios for those who planned to change providers were 30.2% (non-switchers) and 60.4% (switchers) before deregulation, and these ratios both dropped to about half their values after deregulation (16.1% for non-switchers and 25.5% for switchers), despite non-switchers not changing their providers. While respondents who switched stuck to the plan they had chosen, others who had not switched also stuck to their chosen plan (i.e., the original plan), regardless of whether or not they intended to choose.

＜Table 4. Summary statistics by switching behaviors in the real market＞

4. Results

4.1. Stated preferences before and after deregulation

Table 5 shows the estimation results for all respondents using the utility function (2). We assumed that the parameters were distributed normally. The mean and standard deviation values are reported, except for a monthly electricity bill that is set as a numeraire. First, the parameter of the monthly electricity bill is negative and statistically significant at the 1% level, implying that the respondents’ utility decreases with an increase in the monthly electricity bill. All standard deviations of random parameters are also statistically significant at the 1% level, indicating the existence of taste variations among the respondents.

All random parameters are statistically significant at the 1% level. The statistical mean estimates represent ASC1 (-), ASC2 (-), TOU (+), renewable (+), and nuclear (-). Note that the symbols in the parentheses are the signs for each estimate. The parameters for ASC1 and ASC2 are negative, which implies that the average respondent had a status quo bias in switching to a new alternative plan regardless of whether it was provided by a new entrant or a current provider, although the status quo bias for switching to a new entrant was more than double that for the current provider. The parameter for TOU is positive, which implies that the average respondent did not have a status quo bias after a brief explanation of the TOU's purpose, benefits, and average expected savings on electricity bills. In addition, the parameters for an increase in dependency on renewable energy and nuclear power were positive and negative, respectively. Thus, the average respondent had a positive preference for an increase in renewable power and a negative preference for an increase in nuclear power.

Table 5 also summarizes the average WTP values, which are calculated using equation (7), in both JPY and USD. The results show that the respondents had a negative WTP of -$4.55 on a monthly basis for a new electricity alternative provided by a new entrant before deregulation, and -$8.52 after deregulation. Similarly, they had a negative WTP of -$1.30 for a new electricity alternative from the current company before deregulation, and more than double that (-$3.56) after deregulation. These results indicate that respondents had a strong status quo bias for their chosen plan, especially considering electricity provided by new entrants, and that this tendency became stronger after deregulation. On average, consumers would not consider switching to a new provider unless a 5% (before) to 10% (after) bill reduction could be expected, while a 2% (before) to 4% (after) bill reduction sufficed for them to consider switching to a new plan provided by the current company.

The respondents were willing to pay $1.16 (before) and $0.81 (after) for the TOU tariffs. This indicates that they expected larger savings than the average by switching to a TOU tariff before deregulation, but their expectations decreased after the first six months.[19] Regarding their WTP for different energy sources, Japanese consumers' WTP for a 1% increase in dependency on renewable and nuclear power was $0.18 and -$0.35–$0.37 per month, respectively, with some decrease during the three years since the recent previous study.[20]

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[19] In the questionnaire, we briefly explained TOU tariffs with their social benefits from peak time energy shifts, and provided the following message, "For many customers who currently contract flat-rate tariffs, about 5%–10% savings in electricity bills could be expected when switching to TOU tariffs." Compared with this value, their expected value of a TOU plan (WTP for TOU in Table 5) is a fifth smaller, which is equivalent to 1%–1.4% of their electricity bill ($1.16 before; $0.81 after), indicating only small expected values of switching to TOU for the average Japanese customer. For reference, we estimated another model adding a TOU mean shift term, to identify whether the preferences of respondents who usually stayed at home on weekdays differed from those who usually did not. Based on the result, the mean estimate of the TOU parameter is significant only for the respondents who usually did not stay at home on weekdays (that is, who could have gained from energy savings when shifting to TOU).

[20] According to the results of Murakami et al. (2015), average marginal WTPs for a 1% dependency on renewable and nuclear sources were respectively $0.28 (31 JPY if $1=110 JPY)

＜Table 5. The estimated utility function before and after deregulation＞

4.2. Stated preferences by revealed switching behavior

Table 6 shows the estimation results using utility function (3) to investigate the differences between the respondents who switched (6.4%) and others (93.6%). Among the switchers' mean-shift parameters, ASC1, ASC2, and renewable are positive and significant at 1% both before and after deregulation. This implies that the respondents who switched providers showed not only modest status quo bias when switching providers but a stronger preference for dependency on renewable energy sources.

WTP values described in the lower part of Table 6 imply changes in respondents' (un)willingness to switch to new providers (ASC1). Respondents who had changed providers (6.4% of all respondents) had originally preferred to opt out from the default ($0.41, positive WTP) and then switched; they had no more willingness to switch on average (-$3.13, negative WTP). This is reasonable, because the situation changed as they chose. A more interesting tendency is observed in the WTP of non-switchers (93.6% of all respondents). They were originally reluctant to switch to a new provider (-$5.43, negative), and this reluctance became stronger (-$9.36, negative) after deregulation. This means that the respondents who had not yet changed their providers became more strongly attached to their original provider or plan, given that their situation remained unchanged.

A recent economic study regarding cognitive dissonance indicates that the difference between a chosen and a rejected alternative increases after the decision (Ida et al., 2015). In this study, ASC1, which indicates the difference between the chosen (current status, Plan 3) and rejected alternatives (new entrant, Plan 1) for non-switchers, increased by 72% from $5.43 (before) to $9.36 (after) after the decision in the real electricity market.[21] This fact could be interpreted to show that Japanese consumers facing an unfamiliar choice situation in the newly liberalized electricity market feel psychological conflict and therefore tend to enlarge their status quo bias as they choose their current status in the

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and -$0.65 (-72 JPY if $1=110 JPY).

[21] The nine months between the first and second survey could possibly have allowed another situation, for example, a change in consumers' knowledge. Additional experience after deregulation could relatively lower the endowment effect on the default, which could induce lower status quo bias (List, 2003). On the other hand, additional knowledge about new alternatives could also induce higher status quo bias in the case where they realized that no new alternative plan met their needs.

liberalized electricity market.

＜Table 6. The differences between switchers and non-switchers＞

5. Discussion

5.1. Who switched early?

We obtained simulated individual WTP for each respondent using the RPL model as shown in Table 5. To explore which customers had switched their electricity providers soon after deregulation (in the first six months), we estimated the marginal impacts of their individual WTP for electricity plan attributes on their actual switching behaviors by using simple logistic regression models. Table 7 shows the estimated results, assuming that the switching probability is explained as a function of their individual WTP stated in the first survey conducted before deregulation, and using their demographic characteristics as control variables. Concerning the demographic characteristics, the significant estimates were large customers (+), TOU customers (-), familiarity with electricity deregulation (+), age (+), male (+), household size (-), children (+), and weekday stay-at-home (+). As for residential areas, the significant estimates were for Hokkaido (+), Kanto (+), Chubu (+), and Kinki (+), where the switching rates were higher than in other areas, as officially reported.

After controlling for demographic heterogeneity, consumers who switched soon after deregulation, were not only unbiased against change, but also stated a higher WTP for renewable energy sources. Thus, smaller status quo bias and higher preference for dependency on renewable sources could be significant predictors of consumers' revealed switching behaviors. This finding indicates that new electricity plans enhancing clean energy have a large potential to moderate customers' status quo bias in electricity plan choice, including new alternatives after deregulation.

＜Table 7. The determinants of revealed switching behaviors＞

5.2. Potential share of new entrants and strategies for competition

Using our estimated results in Table 5, we analyzed the potential market share of new entrants in several feasible competitive strategies, focusing on the electricity bill and dependency on the renewable energy source, which is one of the significant predictors of early switching behaviors in Table 7. We calculated the relative shares of new entrants [Plan 1] to current providers' new alternatives [Plan 2] under the given conditions of Plan 2 (the current provider, flat-rate-plan, 15% renewable power generation, 2% nuclear power generation, 5% lower monthly bill) and Plan 3 (the current provider, flat-rate-plan, 15% renewable power generation, 2% nuclear power generation, 0% lower or current level of monthly bill) by using the estimated parameters in the left column of Table 5.

According to the simulated result shown in Table 8, new alternatives enhancing renewable energy have considerable potential to increase the shares of new entrants. Under the given condition that a current supplier provides a 5% bill reduction plan as a new alternative (Plan 2), the current share of new providers is 11.9%. Despite that disadvantage, the strategic plan of 50% dependency on renewable energy (RE50) has a 33.5% potential share, which is larger than the 32.0% expected share when they provide a 7% bill reduction plan.

＜Table 8. Potential share of new providers＞

Figure 2 is a detailed graphical description of Table 8. The figure shows the degree of competitiveness of several RE strategies (RE15 (current), RE25, RE50, RE100) compared with price-reduction strategies given a targeting share. Targeting a 20% potential share, RE50 strategy has equal competitiveness to a 3–4% price-reduction plan, even though about a 4% additional bill is needed. Similarly, when new companies can provide a 100% renewable-energy plan (RE100), the share of new providers will be approximately 40%, even though they require a 10% additional cost. This target is equivalent to the case in which they offer a 9% bill-reduction plan under price competition.

＜Figure 2. Potential share of new providers (graphical description)＞

6. Conclusion

We investigated consumers' status quo bias against new alternatives after deregulation in the recently liberalized residential electricity market in Japan. Specifically, we conducted two choice experiments on consumer-stated preferences using online surveys before and after electricity deregulation and observed revealed switching behaviors in the initial six months. The results show that the average Japanese consumer suffers from status quo bias in electricity plan choice. Consumers stuck to their default plan despite obvious savings that could be gained from switching to a new alternative. While the respondents who changed providers preferred the recent status quo once they switched, respondents who had not switched also became more attached to their status quo, which was chosen with/without their intention.

These results could be interpreted to show that Japanese consumers facing an unfamiliar choice situation in the newly liberalized electricity market experience psychological conflict. Therefore, after choosing the status quo option, they tend to enlarge the value they attach to the chosen option to justify their decision and resolve the conflict. This tendency can be conceptualized as cognitive dissonance, which is avoidance of psychological discomfort, in this case possibly inducing a negative impact on competitiveness in the liberalized market. Right after deregulation, status quo bias could increase if one chose a default among unfamiliar options. Modifying these tendencies requires a policy that mitigates the relative endowment effect, for example by increasing consumers' familiarity with and knowledge about new alternatives. Otherwise, plans that are more attractive for reasons other than bill reduction should be provided by new entrants.

Despite the existence of status quo bias, an electricity plan enhancing dependency on renewable sources has the potential to extend market share in the liberalized electricity market, since respondents who had actually switched had a relatively higher preference for renewable energy sources. From our quantitative analysis, a strategic plan of 50% dependency on renewable energy (RE50) has a 33.5% potential share, which is more than the 32.0% expected share under a 7% bill reduction strategy.

We acknowledge that our results are based on data analysis of stated preferences, considering revealed switching behavior in the initial six months after deregulation. As of this writing, three years have passed since electricity deregulation in April 2016. In the interim, any other plan attributes that were not considered in this study could have become important factors in Japanese consumers' decisions in recent and future electricity markets. To understand what types of electricity plans would tempt Japanese consumers and enhance competition in the electricity sector, further research should investigate the dynamics after deregulation with additional follow-up surveys on actual switching behavior in the real market. In addition, further research should analyze consumer heterogeneity on preference and tendency on choice-induced preference so as to enhance the targeting strategies of new entrants, thereby ensuring that the liberalized electricity market becomes more competitive.

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Table 1. Attributes and levels used in the choice experiment

Attributes	Levels
Electricity provider	The current provider you traditionally subscribe to (default) A new provider (new)
Dynamic pricing	Flat-rate plan (default) Time-of-use plan (new)
Renewable power generation (%)	0%, 20%, 40%
Nuclear power generation (%)	0%, 20%, 40%
Monthly electricity bill	No reduction, 10% lower, 20% lower

Table 2. An example of one of the choice sets provided in the questionnaire

	Plan 1 New alternative by a new provider	**Plan 2** New alternative by the current provider	**Plan 3** as a default
Electricity provider	A new provider	The current provider	The current provider
Dynamic pricing	Flat-rate plan	Time-of-use plan	Flat-rate plan
Renewable power generation (%)	40%	20%	10%
Nuclear power generation (%)	20%	40%	10%
Monthly bill	10% lower	10% lower	No reduction

Note: Plan 1 was always provided by a new provider, while Plans 2 and 3 were provided by the current provider. Each alternative was presented under the same provider label across the eight choice situations.

Table 3. Summary statistics of all respondents (N=8,087)

Category	Mean	
Age (20-69) (mean)	46.7	
Gender (Male)	51.6%	
Annual household income		
Average	$57,301	
Less than $30,000	20.6%	
$30,000 to $50,000	27.8%	
$50,000 to $70,000	23.2%	
$70,000 to $100,000	17.5%	
$100,000 to $150,000	8.2%	
More than 150,000 USD	2.7%	
Bachelor's degree or more	48.6%	
Household size (1-7) (mean)	2.8	
Children (0-12 years)	16.3%	
House oweners	70.5%	
weekday stay-at-home rate [a]	63.3%	
The respondents who have changed providers (%)	6.4%	
	Before	**After**
Monthly electricity bill in summer (mean, JPY)[b]	9,375 ($85.22)	9,283 ($84.39)
TOU customers	15.7%	16.7%
Private power generator owners	7.6%	8.1%
Familiar with electricity deregulation [c]	25.9%	35.0%
Do you plan to change providers?		
1=Yes	32.2%	16.7%
2=I don't know/ No idea	56.9%	56.8%
3=No, I don't want to change providers	10.9%	26.5%

(a) The sum of the ratio of the respondents who replied "Someone is always at home in weekdays" to those who replied "Someone is usually at home in weekdays."

(b) 1 USD=110 JPY.

(c) Th ratio of the respondents who answered "I know the details about recent electricity deregulation." When add the ratio of those who replied "I have heard of that," the ratio are 93.5% (before) and 94.8% (after).

Table 4. Summary statistics by switching behaviors in the real market

Category	The respondents who ***haven't*** *changed* providers N=7,569		The respondents who ***changed*** providers N=518 (6.4%)	
Age (20-69) (mean)	46.5		49.4	
Gender (Male)	50.9%		60.6%	
Annual household income				
Average	$56,888		$63,407	
Less than $30,000	20.9%		16.2%	
$30,000 to $50,000	27.9%		26.8%	
$50,000 to $70,000	23.2%		22.8%	
$70,000 to $100,000	17.4%		17.8%	
$100,000 to $150,000	7.9%		12.6%	
More than 150,000 USD	2.6%		3.9%	
Bachelor's degree or more	48.1%		55.6%	
Household size (1-7) (mean)	2.82		2.85	
Children (0-12 years)	16.2%		16.6%	
House oweners	70.2%		75.7%	
weekday stay-at-home rate	62.6%		72.6%	
	Before	**After**	**Before**	**After**
Monthly electricity bill in summer (mean, JPY)	9,297	9,251	10,512	9,747
	($84.5)	($84.1)	($95.6)	($88.6)
latest bill is less than that of the last summer	-	15.6%	-	51.2%
latest bill is the same as that of the last summer	-	67.7%	-	41.7%
latest bill is more than that of the last summer	-	16.7%	-	7.1%
Familiar with electricity deregulation	24.9%	33.0%	40.5%	63.5%
TOU customers	16.7%	17.7%	1.9%	2.1%
Private power generator owners	7.7%	8.2%	6.2%	6.9%
Respondents' willingness to switch				
The ratio of those who plan to change providers	30.2%	16.1%	60.4%	25.5%
The ratio of those who are reluctant to change providers	11.5%	26.6%	4.1%	23.6%
The reason why they are reluctant to change providers				
1=No idea how to choose a new plan	11.2%	5.9%	9.5%	6.6%
2=No concrete image	10.4%	5.0%	9.5%	4.9%
3=Complicated procedure	25.8%	18.3%	19.0%	9.8%
4=No bill reduction expected	13.3%	21.6%	19.0%	8.2%
5=Satisfied with the current status	27.9%	37.9%	19.0%	59.8%
6=No reason in particular	11.4%	11.2%	23.8%	10.7%

*1 USD = 110 JPY

Table 5. The estimated utility function before and after deregulation

	Before Jan. 2016		After Oct. 2016	
	Coefficient		Coefficient	
	mean	s.d.	mean	s.d.
Fixed parameter				
Monthly bill	-17.7834 ***		-15.7483 ***	
（Current status＝1）	(0.2432)		(0.2224)	
Random parameters				
ASC1 [Plan 1]	-0.9497 ***	2.1396 ***	-1.5892 ***	2.4424 ***
(New plan by a new provider)	(0.0362)	(0.0378)	(0.0400)	(0.0408)
ASC2 [Plan 2]	-0.2704 ***	2.0077 ***	-0.6650 ***	2.3627 ***
(New plan by a current provider)	(0.0346)	(0.0366)	(0.0375)	(0.0389)
TOU（0,1)	0.2411 ***	1.5982 ***	0.1517 ***	1.4098 ***
	(0.0276)	(0.0345)	(0.0261)	(0.0351)
Renewable(%)	0.0375 ***	-0.0592 ***	0.0342 ***	-0.0542 ***
	(0.0011)	(0.0013)	(0.0010)	(0.0013)
Nuclear(%)	-0.0720 ***	0.1024 ***	-0.0690 ***	0.1027 ***
	(0.0014)	(0.0015)	(0.0014)	(0.0015)
Average monthly bill (JPY)	9,375		9,283	
Marginal utility for 1 JPY	-0.002		-0.002	
WTPs	**Before**		**After**	
	WTPs (JPY)	**WTPs (USD)**	**WTPs (JPY)**	**WTPs (USD)**
ASC1 [Plan 1 by a new provider]	-501	-4.55	-937	-8.52
ASC2 [Plan 2 by a current provider]	-143	-1.30	-392	-3.56
TOU（0,1)	127	1.16	89	0.81
Renewable(%)	20	0.18	20	0.18
Nuclear(%)	-38	-0.35	-41	-0.37
LR chi2(5)	23,284		27,041	
Log likelihood	-48625.006		-50036.413	

*Halton = 200

*1 USD = 110 JPY

*N of observation =194,088 (3×8×8087)

Table 6. The differences between switchers and non-switchers

	All respondents (N=8,087)							
	Before				After			
	coeff.		s.d.		coeff.		s.d.	
Fixed parameters								
Monthly bill	-17.7923	***			-15.7420	***		
(current status=1)	(0.2436)				(0.2224)			
Random parameters								
ASC1 [Plan 1]	-1.0106	***	2.1254	***	-1.6637	***	2.4274	***
(New plan by a new provider)	(0.0373)		(0.0376)		(0.0413)		(0.0408)	
ASC2 [Plan 2]	-0.3061	***	2.0053	***	-0.6977	***	2.3528	***
(New plan by a current provider)	(0.0356)		(0.0366)		(0.0387)		(0.0387)	
TOU（0,1)	0.2409	***	1.5978	***	0.1611	***	1.4145	***
	(0.0285)		(0.0344)		(0.0270)		(0.0352)	
Renewable(%)	0.0368	***	-0.0592	***	0.0335	***	-0.0542	***
	(0.0011)		(0.0013)		(0.0011)		(0.0013)	
Nuclear(%)	-0.0723	***	0.1025	***	-0.0687	***	0.1025	***
	(0.0015)		(0.0015)		(0.0015)		(0.0015)	
Mean shift (Fixed) for switchers								
Switched_ASC1 for Plan 1	1.0872	***			1.1074	***		
	(0.1422)				(0.1403)			
Switched_ASC2 for Plan 2	0.6397	***			0.5818	***		
	(0.1372)				(0.1401)			
Switched_TOU（0,1)	0.0137				-0.1180			
	(0.1100)				(0.1044)			
Switched_Renewable(%)	0.0095	**			0.0111	***		
	(0.0040)				(0.0038)			
Switched_Nuclear(%)	0.0059				-0.0040			
	(0.0054)				(0.0052)			
Average monthly bill (JPY)	10,512				9,747			
Marginal utility for 1 JPY	-0.002				-0.002			

WTPs	Before		After	
	WTPs (JPY)	WTPs (USD)	WTPs (JPY)	WTPs (USD)
Mean WTPs of non-switchers (93.6%)				
ASC1 for Plan 1 [new provider]	-597	-5.43	-1030	-9.36
ASC2 for Plan 2 [current provider]	-181	-1.64	-432	-3.93
TOU（0,1)	142	1.29	100	0.91
Renewable(%)	22	0.20	21	0.19
Nuclear(%)	-43	-0.39	-43	-0.39
Mean WTPs of switchers (6.4%)				
ASC1 for Plan 1 [new provider]	45	0.41	-344	-3.13
ASC2 for Plan 2 [current provider]	197	1.79	-72	-0.65
TOU（0,1)	142	1.29	100	0.91
Renewable(%)	27	0.25	28	0.25
Nuclear(%)	-43	-0.39	-43	-0.39

Note: Halton=200;

Table 7. The determinants of revealed switching behaviors

	Model 1			Model 2			Model 3		
	Coeff.	s.e.		Coeff.	s.e.		Coeff.	s.e.	
Plan attributes									
WTP for ASC1 [new provider]	0.0306	0.0066	***	0.0296	0.0068	***	0.0281	0.0067	***
WTP for ASC2 for [current provider]	0.0010	0.0071		0.0001	0.0073		0.0017	0.0072	
WTP for TOU （0,1)	0.0038	0.0090		0.0133	0.0094		0.0065	0.0092	
WTP for Renewable(%)	0.6623	0.2573	***	0.6481	0.2639	**	0.5808	0.2600	**
WTP for Nuclear(%)	0.0787	0.1134		0.1171	0.1166		0.0682	0.1142	
Control variables									
Customer characteristics									
Large customer (Monthly bill>100 USD)				0.0695	0.0000	***			
TOU customers				-2.7569	0.3282	***			
Private power generation owners				0.2947	0.2031				
Familiar with electricity deregulation				0.6892	0.0976	***			
Age				0.0170	0.0042	***			
Male				0.1903	0.1014	*			
Bachelor's degree or more				0.1623	0.0989				
Household size				-0.1202	0.0481	**			
Children (under 12)				0.4249	0.1446	***			
House owners				0.1703	0.1227				
Weekday stay-at-home				0.3355	0.1090	***			
Area **(**base=hokuriku)									
hokkaido							1.7666	0.4911	***
tohoku							0.5208	0.5261	
kanto							1.8743	0.4555	***
chubu							1.1793	0.4751	**
kinki							1.8027	0.4607	***
chugoku							-0.1694	0.6101	
shikoku							-0.6397	0.8413	
kyushu							0.7552	0.4901	
_cons	-2.6959	0.0912	***	-4.5304	0.2671	***	-4.1742	0.4577	***

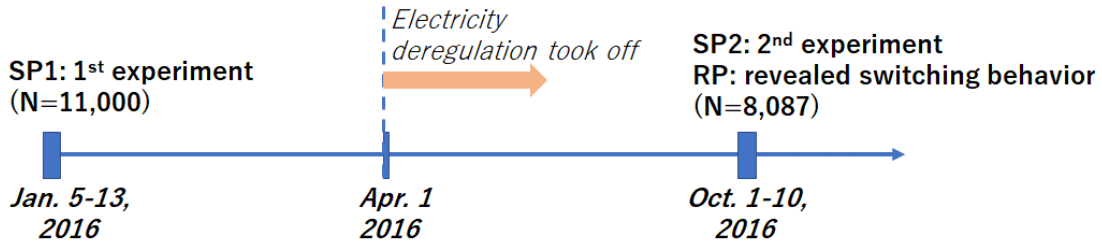
Pseudo R2 = 0.0121 ; 0.0893 ; 0.0518

Table 8. Potential share of new providers

Renewable energy→ ↓Bill		RE15 (current)	RE25	RE50	RE100
+20%		0.4%	0.6%	1.4%	9.8%
+10%		2.2%	3.2%	7.8%	39.0%
+7%		3.8%	5.4%	12.7%	52.2%
+5%		5.3%	7.5%	17.1%	60.9%
±0%	(current)	**11.9%**	16.5%	33.5%	79.1%
-5%		24.8%	32.4%	55.0%	90.2%
-7%		32.0%	40.6%	63.6%	92.9%
-10%		44.5%	53.8%	74.9%	95.7%
-20%		82.6%	87.4%	94.6%	99.3%

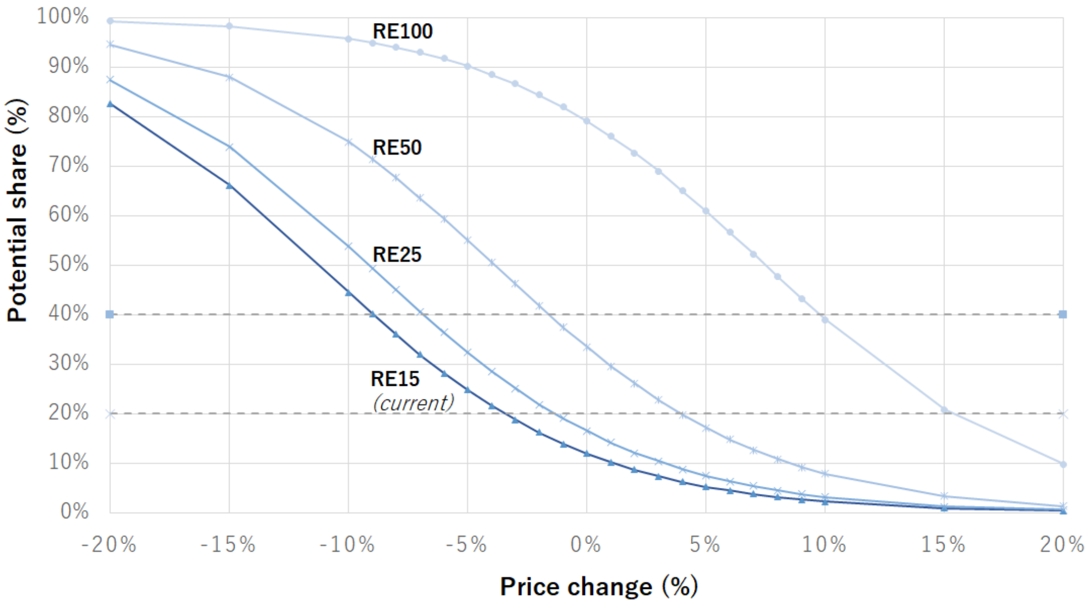
Note: We calculated the relative shares of new entrants [Plan 1] to current providers' new alternatives [Plan 2] under the given conditions of Plan 2 (the current provider, flat-rate-plan, renewable power generation 15%, nuclear power generation 2%, monthly bill 5% lower), and Plan 3 (the current provider, flat-rate-plan, renewable power generation 15%, nuclear power generation 2%, monthly bill 0% lower (current level)) by using estimated parameters in the left column in Table 5.

Figure 1. The timeline and procedures of the surveys



Note: SP means stated preference. RP means revealed preference.

Figure 2. Potential share of new providers (graphical description)



Note: This figure is a detailed graphical description of Table 8. The figure shows the degree of competitiveness of several RE strategies (RE15 (current), RE25, RE50, RE100) compared with price-reduction strategies given a targeting share. For example, targeting a 20% potential share, RE50 strategy has equal competitiveness to a 3–4% price-reduction plan, even though about a 4% additional bill is needed.