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Determinants of Willing to Pay (WTP) for Renewable Energy in Post-Fukushima Japan: Results of Ordinal Multinomial Logit and Tobit Regression Models

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Key messages:

- The study is based on an energy use survey of 4000 people in four Japanese cities following the 2011 Fukushima nuclear crisis.
- The study uses a series of multivariate logistical regression models to determine variables that are positively correlated with respondents' willingness to pay (WTP) for renewable energy.
- The results indicate
  - Respondents who are older and wealthier are more likely to indicate a higher WTP; and
  - Respondents with greater knowledge of energy issues and who are inclined to participate in community activities exhibit greater WTP.
- Future studies should focus on understanding about what kinds knowledge should be transmitted to register the deepest impression on energy use behavior. Interactions between participatory action, knowledge acquisition and behavioral change also warrant further exploration.

1. Introduction

Climate change poses a grave and enduring threat to the health and well-being of current and future generations (IPCC, 2014). Academics and environmentalists generally agree that there is no single silver bullet solution to climate change; rather well-integrated, long-term climate strategies are needed. Yet adopting and implementing coherent forward-looking strategies is often less about achieving a consensus among scientists and environmentalists than overcoming several persistent barriers to policy change. Science-based solutions need to be embedded in supportive enabling environments need to overcome these barriers.

This paper offers insights into what factors could constitute an enabling environment that can help surmount one of the most intractable barriers to policy change: namely, willingness to pay (WTP) for renewable energy. In particular, the paper focuses on what variables affected Japanese citizens' WTP

for renewable energy following the March 2011 Fukushima triple disaster. The results are based on survey responses from a stratified random sample of 4000 respondents from four cities in Japan. The survey was conducted in 2013, two years after the Fukushima nuclear crisis that caused a nationwide debate on the shift from nuclear to alternative energy sources. This was also at a juncture when Japan reinstated the feed in tariff system that led to a rise of 18-45 yen (equivalent to US$0.16-US$ 0.41) per month for an average household due to the introduction of renewables into the energy mix.1

To analyze possible determinants of WTP, the study divides potentially influential factors into individual attributes (income level, education, age, gender), social context (home ownership and house structure), and knowledge and participation. It then tests hypotheses on linkages between these variables and WTP with ordinal multinomial logit and tobit regression models.

The paper finds that respondents with higher income levels indicated a greater WTP. Surprisingly, the opposite holds true for employment; respondents without a job or in part-time work tended to have a greater likelihood of WTP. The results further suggest that wealthier respondents and respondents more inclined to participate in community activities (in some model specification) were correlated with a higher WTP. Most notably, respondents with greater knowledge of energy issues indicated a higher WTP. The results of the research could help design an enabling environment for climate policies. The paper also reflects on limitations on the data and model. It concludes by proposing future areas for inquiry, including extending the findings to action-oriented research involving awareness raising.

The paper is divided into five sections. The next section reviews literature on possible determinants of higher WTP and environmental consciousness/activism. This literature helps to develop a series of testable hypotheses. The paper then uses the aforementioned regression models to evaluate the potential contributions of the three categories of variables in Japan. The penultimate section discusses findings and limitations. The final section points to areas for future research.

2. Literature review

2.1. Individual attributes

One of the clearest linkages in the energy literature is the relationship between WTP and income. In general, studies show households with higher income levels have the greater WTP for renewables in the United Kingdom, Germany, Italy, China and Kenya (S.L. Batley, 2000; Archtnicht, 2011; Abdullah, 2011; Liu, 2013: Bigerna, 2014) The causal connection in these studies is straightforward: wealthier people have more disposable income and are thus willing to spend more money on cleaner energy. These arguments also correspond with claims that wealthier people, who have basic material needs may be more interested in investing in post-material goods and services (Inglehart and Welzel, 2005; Nordhaus and Shellenberger, 2007; Buck, 2013). Extending this logic further, this would include paying more for energy that would protect the climate for future generations.

Claims involving age offer several reasons why younger people have a higher WTP. Some contend younger generations tend to be more interested in environmental issues (Jones and Dunlap, 1992;

[1] Since the feed in tariff system was reinstated in 2012, the surcharge to introduce renewables into the mix for households has ranged from 0.06 yen/kWh to 0.15 yen/kWh depending on the regional utility for fiscal year 2013. (Tokyo Electric 0.06 yen/kWh, Chubu Electric 0.11 yen/kWh, Kyushu Electric 0.15 yen/kWh.) If monthly consumption of electricity per household was 300kWh then surcharge could range between 18 yen – 45 yen per month.

Dunlap and Jones, 2002). One set of potentially pertinent claims—based on life-cycle effect theory—holds that younger people perceive themselves as being the victim of today's pollution (Murphy, 1994). They are hence more willing to invest time and energy in solving environmental problems. Another set of arguments suggests that the younger generation tend to value a better quality of life over simple material accumulation, again with a possibly positive effect on WTP (Israel and Levinson, 2004). This may also be because younger people are able to access a greater variety of media highlighting the virtues of individual actions to solve environmental problems (Murphy 1994). As a result, they may be willing to spend more on clean energy.

There are two contrasting views concerning the relationship between gender and WTP. One is that men have less interest in the quality of environment as they tend to be more engaged in activities related to economic growth; in consequence, support for environmental issues runs counter to their main interests. This argument runs parallel to survey results noting that women are more willing to support environmental issues than men (Van Liere and Dunlap, 1980; Blocker and Eckberg, 1997). These arguments are reinforced by claims that women's support for greener issues stems from a relatively stronger interest in family health and food safety issues (Davidson and Freudenburg, 1996). A contrasting perspective envisages gender as a variable mediating other determinants. More concretely, this more indirect view suggests that men tend to be stronger supporters of environmental issues than women because they receive more education and are more socially engaged (Van Liere and Dunlap, 1980). Another more indirect line of reasoning holds that women also tend to be more aware and sensitive to health and/or the environment risks (Xiao and McCright 2012); the higher level of risk perception could lead to greater support for investing in clean energy.

A final set of individual attributes that positively correlate with WTP in past research are education levels. Simply stated, across many countries and contexts more educated people appear more likely to pay more to mitigate climate change (Akter, 2011; Archtnicht, 2011).

2.2. Social context

While many studies show that energy related behavior is dependent on individual factors (i.e. income, age, gender), social context can also be correlated with WTP. In other words, individuals tend to be influenced by the larger social groups to which they belong.

Studies in the United Kingdom, for instance, argue that an individual's energy related behavior is affected by a combination of income and social status (S.L. Batley, 2000). While income had the strongest effect on energy related behavior, a composite social group variable made up of income, household structure, employment, ownership of a house, and housing structure (i.e. detached houses were preferred over apartments as citizens climbed up the social ladder) also co-varied with higher social groups. There was, however, no correlation between the social group and the premium amount an individual was willing to pay, suggesting possible thresholds on this effect.

Another similar study looked at cross-national differences in sociocultural contexts. Illustrating this approach, Allo (2014) measures the impact of "national cultures" on WTP by comparing the results of 58 relevant studies taken from eleven different countries. She concludes that societies where individuals have a greater sense of autonomy plan long term, stress gender equity, or are led by left-wing governments, are also societies that have a greater WTP.

A third set of arguments opines that those who subscribe to more progressive ideologies exhibit

more eco-conscious attitudes and behaviors (Scott, 1990). This is also compatible with the argument on new-middle-classism and post-material worldview towards environmental sustainability. This has been argued over many years by Inglehart (1977; 1989; 1995; 2008) whose focus is on post-material perspective values social and cultural human relationships i.e. civil right, public participation, community resilience and so on.

2.3. Knowledge and participation

A final set of variables focuses on the acquisition of knowledge and/or participation in community activities. To varying degrees, these two sets of variables sit at the intersection of individual attributes and social context. That is, they require an individual to acquire knowledge or participate in activities that make them more aware of the broader social benefits of environmental goods and services.

Knowledge of the benefits of cleaner energy aligns closely with WTP. Studies show that people with greater "knowledge of renewable energy and how it helps to reduce climate change" or "beliefs on social impacts and negative consequences" have higher WTP. For example, research from rural China showed "knowledge" had an especially strong marginal effect (Liu, 2013). Many of the same results applied to Japan. In a particularly relevant study, respondents were divided into four groups based on information on the following: 1) the benefits of nuclear power; 2) the negative impacts of nuclear power; 3) the overall background on the nuclear debate; and 4) all three sets of information (Morita 2012). Results showed that WTP for solar power was highest for those knowledgeable about the negative side effects of nuclear as well as those given basic information about the nuclear debate.2 This suggests WTP is not merely influenced by existing information but the acquisition of new knowledge.

Studies also find engagement in community activities has similar positive effects. Participating in social organizations can change minds and attitudes on environmental issues (Tarrow, 1998). On this point, Morita (2012) also finds respondents who are more engaged in participatory activities have a higher WTP. Interestingly, this participation does not always focus on environmental issues. For example, research in Japan shows "the most active energy savers belonged to groups organized around child rearing and motherhood…" (Nakamura, 2013). A comparable conclusion comes from Daggy et al (2015) that finds cities with higher concentrations of environmental and gender non-profit organizations saved more energy following the Fukushima crisis.

Table 1 Summary of studies on potentially influential variables

Literature	Independent variables	Category	WTP	Location
Liu 2013, Batley 2000, Abdullah 2011, Bigerna 2014	Income	Individual attributes	Positive	China, UK, Kenya, Italy
Liu 2013, Bang 2000	Knowledge	Individual attributes	Positive	China, USA
Akter et al 2011, Archtnicht 2011, Abdullah 2011, Bigerna 2014	Education level	Individual attributes	Positive	Australia, Germany, Kenya
Liu 2013, Akter et al 2011	Belief about social costs and impacts	Individual attributes	Positive	China, Australia
Liu 2013, Archtnicht 2011	Age	Individual attributes	Positive	China, Germany
Archtnicht 2011	Gender (women)	Individual attributes	Positive	Germany
Batley 2000	Social group with higher income level	Social norms	Positive	UK
Abdullah 2011	Home ownership	Social norms	Positive	Kenya
Abdullah 2011	Employment	Social norms	Positive	Kenya
Allo 2014	Individual's sense as autonomous individual	Social norms	Negative	Global
Allo 2014	Justice towards cheating on taxes	Social norms	Positive	Global
Allo 2014	Propensity to plan long term	Social norms	Positive	Global, Australia
Allo 2014	Masculine society	Social norms	Negative	Global
Allo 2014	Political right wing governments	Social norms	Positive	Global
Akter et al 2011	International support for mitigation	Social norms	Positive	Australia
Akter et al 2011	Media familiarity	Social norms	Positive	Australia
Daggy et al (2015) Nakamura 2013	NPOs promote behavior change	Social norms	Positive	Japan

Note: Not all of these studies involve WTP some propose relationships between possible determinants and pro-environmental attitudes and behavior more generally.

2.4 The conceptual model

Figure 1 presents the conceptual model that underpins the remainder of the paper. It suggests that individual attributes, social context, as well as participation and knowledge can have a positive effect on WTP. It also illustrates that there are possible correlations between sets of independent variables; more specifically, that individual attributes and social context can influence participation, while social context can influence attributes. The hypotheses and tests presented that follow do not directly capture these interrelationships. The interrelationships are nonetheless important to keep in mind and discussed further in the conclusion.

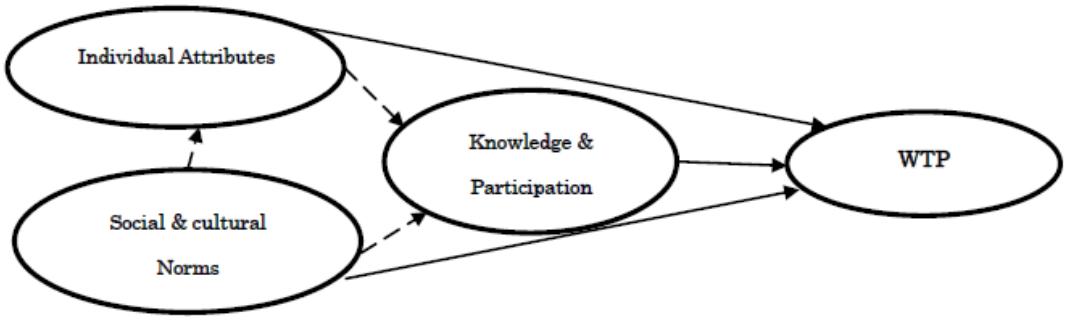


Figure 1 Correlation of indicators which effect WTP

3. Hypotheses

The literature review (summarized in Table 1) and conceptual model lead to the hypotheses in Table 2. The hypotheses follow the results from previous studies. In cases where there are conflicting views, the hypotheses are based on the authors' sense of which arguments best fit Japan. As per Table 2, the paper uses eight independent variables to test the hypotheses. The dependent variable in all models is the WTP for renewable energy specified in three different ways described later in the paper.

Table 2 Hypotheses

Individual attributes	1. People with higher household incomes will have a higher WTP 2. Younger people will have a higher WTP 3. Females will have a higher WTP 4. People with more education will have a higher WTP
Social context	5. People whose homes are detached houses (wooden or concrete) have a positive WTP compared to those living in apartments. 6. People who hold a full time job will have a higher WTP
Knowledge and participation	7. People with more knowledge on renewables will have a higher WTP 8. People active in participating in local community activities have a higher WTP

4. Analysis of individuals' willingness to pay for energy prices generated from renewable energy in Japan

4.1 Survey Data

The data used to test these hypotheses was collected through an internet survey on post-Fukushima energy use. In total, 4000 responses were gathered between 21 and 23 November 2013. As the survey was intended to analyze differences across cities, 1000 respondents were taken from four megacities with populations over one million, namely:

1) Yokohama-a sprawling suburban commercial port not far from Tokyo;

2) Kawasaki-an industrial center located in the outskirts of Tokyo;

3) Nagoya-the third largest metropolitan city situated to the west of Tokyo; and

4) Kitakyushu-an industrial city located on Japan's southernmost island.

The respondents were picked randomly from a larger pre-registered respondent pool. Those belonging to this pool were offered shopping points with a monetary value of approximately 20 yen (equivalent to US$0.18) in exchange for responding to a survey. To ensure gender balance, 500 men and women respectively were selected from each city. Respondents were also further divided into two groups in each city based on the framing of the WTP question (discussed in greater detail in the variable description section).

4.2 Contingent valuation method and payment card approach

This paper uses the CVM to assess WTP. Four variants of CVM are commonly applied: 1) the bidding game; 2) the payment card approach; 3) the open-end approach; and 4) the dichotomous approach. The paper used the payment approach in which respondents were asked to choose one value from several options that represents their maximum WTP. The true WTP is assumed to be higher than the value chosen and lower than the

next highest value. The benefits of the payment card approach are that respondents tend to state the WTP upon hearing the question; the open-ended approach requires respondents to deliberate upon various situations and may differ with the environment in which they are situated when responding.

4.3 Specifying the Dependent Variable

The dependent variable, WTP, is specified in three ways corresponding to three relevant questions in the survey. The first specification involved a question that asked respondents how much they would be willing to pay above their regular electricity bills if renewables were included in the energy mix. The respondents were told that adding renewables would reduce nuclear power, fossil fuel use, and carbon dioxide (CO_2) emissions, thereby mitigating climate change. The above described payment card method was used wherein respondents could select "not pay at all" and four other progressively greater 1000 yen/month options. As suggested in Figure 2, more than half the respondents fell into the lowest below 1000 yen/month group (roughly equivalent to 10% of the average energy bill in Japan). Since it is the payment card method in which the true WTP is assumed to be higher than the value chosen and lower than the next highest value, respondents whose preference is between 1-999 yen would choose "not pay at all" due to the structure of the question.

In fact, the non-parametric Turnbull estimator suggests the range of the average WTP fell between 690 yen/month and 1669 yen/month; alternative specifications of the variable are therefore discussed below. 3 Given the relatively large number of respondents with 2,000 yen or more, a decision was made to divide the dependent variable into a group that was not WTP, a group with WTP between 1000 and 1999 yen, and a group WTP 2000 yen or more. This decision had the effect of transforming the dependent variable into a trichotomous variable. The frequency histogram for the variable is presented in Figure 2.

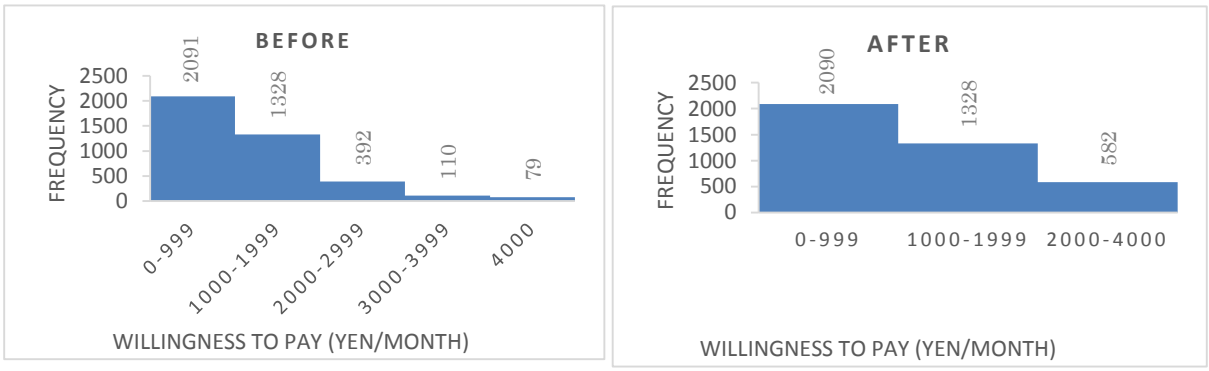


Figure 2 Frequency Histogram Before and After Variable Transformation

A second way of specifying the dependent variable involved analyzing responses to a question posed to approximately half of the respondents (Group A):

"If the renewable energy tariff were 15% more expensive for every 10% increase of renewables in the energy mix, how much would you be willing to pay?"

[3] The lower bound estimate of average WTP: 0.52 (0) + 0.33 (1000) + 0.10 (2000) + 0.03 (3000) + 0.02 (4000) = 690. The upper bound estimate of average WTP: 0.52(999) + 0.33 (1999) + 0.10 (2999) + 0.03 (3999) + 0.02 (4000) = 1669

Eleven options ranging from 0% to 100% were offered with each tied to a 90 yen tariff increase. The number of respondents accepting the change in the energy mix is presented below. The non-parametric Turnbull estimator for the average WTP falls between 309 yen/month and 393 yen/month for this group. The modal response was 40%.

Table 3 Willingness to Pay Options for Group A

Number	Renewable mix	Rise in tariff from JPY 6,000
1	0%	JPY 6000/month
2	10%	JPY 6090/month
3	20%	JPY 6180/month
4	30%	JPY 6270/month
5	40%	JPY 6360/month
6	50%	JPY 6450/month
7	60%	JPY 6540/month
8	70%	JPY 6630/month
9	80%	JPY 6720/month
10	90%	JPY 6810/month
11	100%	JPY 6900/month

A third way of specifying the dependent variable involved analyzing responses to a question given to the other 500 respondents (Group B):

"If the renewable energy tariff were 5% more expensive for every 10% increase of renewables in the energy mix, how much would you be willing to pay?"

Once again, eleven options ranging from 0% to 100% were offered with each tied to a 30 yen (equivalent to US$0.27) tariff increase. The number of respondents accepting the change in the energy mix can be seen in Table 4. The non-parametric Turnbull estimator was used to derive the range of the average WTP as falling between 123 yen/month and 148 yen/month for this group.[4] The modal response was again 40%. When the average WTP for both groups are compared, it is apparent respondents were generally WTP for having around 40% of renewables. This result is discussed again in the conclusion of this paper.

Table 4 Willingness to Pay Options for Group B

Number	Renewable mix	Rise in tariff from JPY 6,000
1	0%	JPY 6000/month
2	10%	JPY 6030/month
3	20%	JPY 6060/month
4	30%	JPY 6090/month
5	40%	JPY 6120/month
6	50%	JPY 6150/month
7	60%	JPY 6180/month
8	70%	JPY 6210/month
9	80%	JPY 6240/month
10	90%	JPY 6270/month
11	100%	JPY 6300/month

[4] The lower bound estimate of average WTP: 0.18 (0) + 0.06 (90) + 0.14 (180) + 0.11 (270) + 0.13 (360) + 0.22(450) + 0.03(540) + 0.02(630) + 0.01(720) + 0.003(810) + 0.06(900)= 309. The upper bound estimate of average WTP: 0.18 (89) + 0.06 (179) + 0.14 (269) + 0.11 (359) + 0.13 (449) + 0.22(539) + 0.03(629) + 0.02(719) + 0.01(809) + 0.003(899) + 0.06(900)= 393

4.4 Independent Variables

Nine independent variables were selected to test the hypotheses. The independent variables were as follows: 1) income levels; 2) gender; 3) age; 4) education levels; 5) working status; 6) home ownership; 7) house structure; 8) knowledge on energy policies; and 9) participation in local community activities.

As noted previously, responses were taken from an equal number of male and female respondents. The roughly even proportions were the same for all four cities (Table 5).

Respondents were between 20 and 69 years old. The mean age was 45.64 years. An effort was made to retain a balance across age groups; the sample nonetheless skews older, with fewer respondents in their twenties compared to older age groups. This may be due to the relatively greater availability of older respondents to reply to survey questions.

Household income was divided into five categories (see Table 5). The age of the respondents below the 3 million yen range appears slightly higher than national averages. This may be attributable to the decision to offer monetary compensation for responses; less wealthy people may be more inclined to answer when there is payment. The slightly higher concentration of lower income respondents notwithstanding, the distribution of income levels tends to be roughly parallel to national household incomes (Ministry of Health Welfare and Labor, 2015).

Education levels were based on whether respondents indicated they had formal education from an undergraduate degree or not. According to Japan's national statistics bureau, 51 % of students move on to obtain undergraduate degrees (Ministry of Internal Affairs and Communication, 2015). This was indeed very close to the breakdown in the sample as shown in Table 5 below.

Questions used to capture social variables included whether the respondents owned or rented a house and the structure of the house. As detached houses are generally more expensive in Japan, the social status of owning one is generally higher than those living in an apartment with the similar number of rooms.

The variable for knowledge of energy policy was constructed based on responses to three sets of questions. Each question was coded as follows: 1) no points if the respondent had not heard of the issue previously; 2) one point if they had some knowledge of the issue; and 3) two points if they were well-versed on the issue. The three questions focused on the following: 1) the Japanese government's plan to make energy-saving building material mandatory for newly constructed buildings beyond 2020; 2) the Japanese government's intentions to deregulate the retail electricity market; and 3) the Tokyo Municipal government's intentions to generate energy locally and construct a natural gas power utility on government-owned property to substitute for the loss of nuclear energy after the Great East Japan Earthquake. In theory, the highest point would have been 6 points (i.e. three questions multiplied by 2 points) but the actual data shows the highest was 4; the variable is hence coded from 0 to 4.

The participation variable was based on whether respondents participate in local community chambers were identified by asking whether respondents contributed to neighborhood associations or not.

Table 5 Demographic characteristics

Category		Number	age
Gender	Male	2000	50%
	Female	2000	50%
Age*	20s	536	13.4%
	30s	915	22.9%
	40s	908	22.7%
	50s	870	21.8%
	60s +	771	19.3%
Location	Yokohama (total population)	1000 (3,703,998)	25.0%
	Kawasaki (total population)	1000 (1,448,196)	25.0%
	Kitakyushu (total population)	1000 (982,388)	25.0%
	Nagoya (total population)	1000 (1,034,154)	25.0%
Education level	Up to high school degree	2011	50.3%
	Undergraduate degree and over	1989	49.7%
Household Income	Under 3 million	794	19.2%
	3 million ~ under 5 million	1088	27.2%
	5 million ~ under 7 million	928	23.2%
	7 million ~ under 10million	706	17.1%
	Over 10 million	484	12.1%
Working Status	Unemployed or part-time worker	1482	37.1%
	Working on a full time basis	2518	63.0%
Home ownership	Renting a home	1376	34.4%
	Own a home	2624	65.6%

*Mean and SD for Age: Mean 45.6, SD 12.75

**Figures in ( ) under the category "location" indicate the city population as of October 2013.

5 Regression Results

5.1 Models 1.1-1.3: Ordinal Logistic Regression Results

An ordinal logistic regression is used to test the hypotheses on the first question. As indicated in clause 4.3, this question involved transforming responses from a variable with initially five to three categories: the variable was coded 0 if the respondents selected a WTP of 0-999; 1 if the respondent accepted a WTP from 1000 to 1999 yen; and 2 for a WTP anywhere from 2000 to 4000 yen. Ordinal logistic regression allows for comparing more than two categories (in this case three) of the dependent or outcome variable. It uses maximum likelihood estimation to evaluate the probability of being in one of these categories (Orme et al, 2001.)

For ordinal logistic regression, one category is chosen as the reference category. The reported results are then compared to this reference. Separate odd ratios are estimated for all independent variables. The individual coefficients represent the change in the odds of the dependent variable being in a particular category compared to the reference category when there is a unit shift in an independent variable. Three separate models are estimated for the first question. Model 1.1 includes the individual attribute variables; Model 1.2 adds the social context variables; Model 1.3 adds the knowledge and participation variables.

Table 6 Ordinal logistic regression coefficients

	Model 1.1	Model 1.2	Model 1.3
Intercept 0 -999| 1000-1999	1.29 (0.09)	1.33 (0.10)	1.44 (0.10)
Intercept 1000-1999 | 2000-4000	2.3 (0.09)	2.52 (0.11)	2.53 (0.10)
Gender (female) (standard error	-0.01 (0.04)	-0.05 (0.04)	0.009 (0.04)
Education (standard error)	-0.04 (0.04)	-0.06 (0.06)	-0.006 (0.04)
Age (standard error)	0.02* (0.001)	0.014 (0.002)	0.01 (0.002)
Household income (standard error)	0.24 (0.02)	0.16 (0.01)	0.14 (0.01)
Working status (standard error)		-0.10 (0.04)	-0.09 (0.04)
House structure (standard error)		0.03 (0.009)	0.04 (0.009)
Knowledge (standard error)			0.16 (0.02)
Participation in local community chamber (standard error)			0.16 (0.04)
Residual deviance Log-likelihood	7589	7570	7452
AIC	7601	7586	7472

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 7 Odds ratio for Model 1.3

	Odds Ratio	Confidence interval 2.5% 97.5%
Age	1.01	1.01 1.02
Annual revenue	1.15	1.11 1.18
Female	1.008	0.93 1.09
Highest education	0.99	0.92 1.07
House structure	1.04	1.02 1.06
Working status	0.91	0.84 0.99
Knowledge	1.17	1.13 1.20
Participatory action	1.18	1.09 1.28

The results of the regression which is shown in Table 7 as odds ratios suggest the following about the magnitude and certainty of the effects of the individual predictors. The effect of gender is not statistically distinguishable from zero; the hypothesis that females have a higher WTP than males is not supported. This may be in line with the literature that is far from unanimous on gender effects. Education also shows little significance. This result may be due to the fact that the education variable is coded as a 0-1 rather than a finer grained variable. It is also possible that there is no significant difference in attitudes between varying levels of education in Japan. Age shows positive effects in contrast to the hypotheses. Older respondents exhibited a greater likelihood of being in the higher WTP categories. Annual household income has substantively and statistically discernible effects; income supports the hypothesis that higher household income people are more likely to indicate a WTP.

The social context variables registered the hypothesized effects for one of the two cases. For house structure, the odds of switching in general mapped into higher WTP for households residing in detached housing. For employment, results ran

counter to hypotheses. The data analysis suggested that respondents with no job or only part-time work indicated a higher WTP.

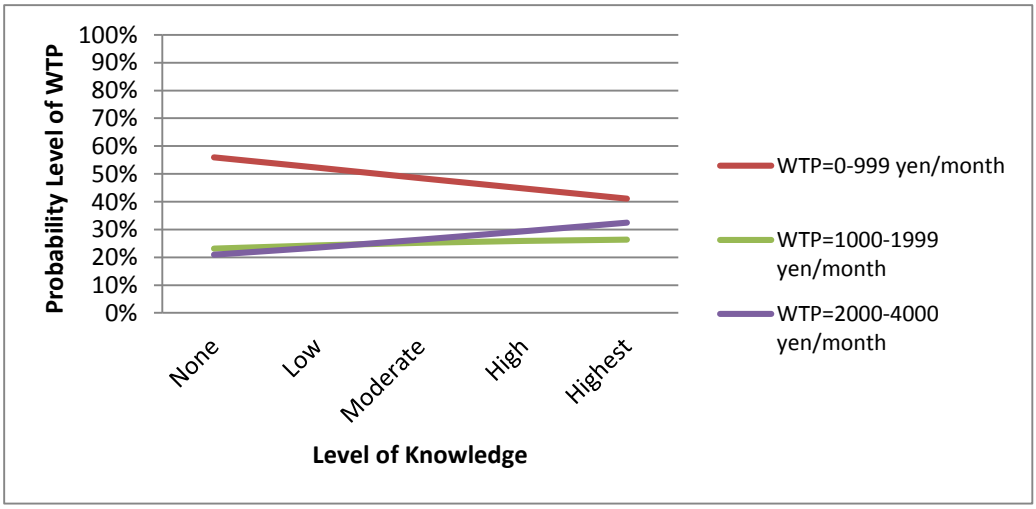
Participation in local activities appears to have a positive impact on WTP. If a respondent who usually does not participate in local activities chooses to participate the odds of "2000-4000 yen/month" applying versus "0-999 yen/month" or "1000-1999 yen/month" are 18% greater, holding other variables constant. Arguably the most interesting results were the substantively and statistically significant effects of knowledge. For Model 1.3, results fell in line with the authors' hypothesis that people equipped with more knowledge on energy could choose to shift to a higher WTP category. In other words, when a respondent's knowledge increases by 1 point, the odds of moving from "0 yen/month" to "1000 yen/month" is 17%; the same applies to moving from "1000 yen/month" to "2000-4000 yen/month."

Due to the difficulties inherent in interpreting logit coefficients, the authors computed the estimated probabilities of fitting into three categories as a respondent moved across the 0 to 4 range of the knowledge variable, holding other variables constant at their mean for continuous variables or at their maximum for dummy variables. As illustrated in Table 8, moving from the lowest to the highest level of knowledge decreases the likelihood of being in the WTP=0 category by about 15% and increases the likelihood of being in the "1000-1999" by 3 % and "2000-4000" by about 12 % respectively.

The Akaike Information Criterion (AIC) is used to measure the relative quality of statistical models and is also used to discern which of the three models is relatively better to the others. The smaller the AIC, the better that model is for the dataset. In this case, Model 1.3 demonstrates the best fit of the three models. This is equivalent to suggesting that the inclusion of the participation and knowledge variables significantly improves the overall fit of the regression.

Table 8 Estimated probabilities for knowledge variable under Model 1.3

Knowledge	None	Low	Moderate	High	Highest
WTP= 0-999 yen/month	56%	52%	49%	45%	41%
WTP=1000-1999 yen/month	23%	24%	25%	26%	26%
WTP=2000-4000 yen/month	21%	23%	26%	29%	33%



5.2 Models 2.1-3.3: Tobit Results

A tobit regression is used to test the hypotheses on the second and third questions. The second question was given to approximately half the samples labeled Group A. It focused on WTP for a "renewable energy tariff that was 15% more expensive for every 10% increase of renewables in the energy mix." Eleven options ranging from 0% to 100% were offered; each option was tied to a 90 yen (equivalent to US$0.82) tariff increase. The third question was given to approximately half the samples labeled Group B. It focused on WTP for a "renewable energy tariff that was 5% more expensive for every 10% increase of renewables in the energy mix, how much would you be willing to pay?" Eleven options ranging from 0% to 100% were offered; each option was tied to a 30 yen (equivalent to US$ 0.27) tariff increase. In contrast to the first question and ordinal logit results, the responses for the tobit models aim to understand whether the hypothesized relationships hold for smaller increment changes in WTP for those respondents falling in the 0 to 999 yen group.

The tobit model, also called a censored regression model, estimates relationships between variables when there is either left- or right-censoring on the dependent variable (Orme et al, 2001). This model is employed because the WTP options were "censored" within a range of "0" and "900" yen for Group A, and "0" to "300" yen for Group B. Note that the previous set of questions that some respondents have a WTP that extends as high as 4000 yen/month. For some respondents, their choice could also be negative, indicating they would prefer to get paid for accepting an increase in renewables rather than pay for that increase. The tobit model presumes a latent or unobservable set of responses that fall below or above the categories presented for the respondent.

The marginal results of the individual predictors are reported in Table 9. The results of the regression suggest the following about the latent variable. As with previous models, the effect of gender is not statistically distinguishable from zero in any of the models. Also similar to the previous models, education is significant at the .10 level for two out of the six models; however the sign runs opposite to the predicted direction. It may be that there is little difference between varying levels of education in Japan. Also countering the hypotheses and similar to the Model 1, age shows positive effects. Older respondents were more likely to fall in the higher WTP categories. Further comparable to the first set of ordinal models, annual household income has substantively and statistically significant effects; income supports the hypothesis that those with higher household income are more likely to fall into the higher level WTP.

The hypothesized effects outlined for the social variables held for some of the models. For house structure, the probability of switching to a higher WTP was moderately more likely for households residing in detached housing. For employment, results were different than expected though similar to the first set of models. Respondents with no job or only part-time work indicated a higher WTP than those with a job in all four models. In two of the models (for Group B), those results were clearly different from zero.

The last set of effects involved community participation and knowledge. Participation in local activities had a discernible effect in the Group A model. Again the results with clearly the most significant results involved knowledge. Respondents possessing more knowledge were more likely to be in higher WTP categories. On average, an additional unit of knowledge increases the WTP by approximately .25 units in both Models 2 and 3 for the average respondent; a four unit increase has the effect of increasing the WTP by one unit.

Table 9. Marginal effects under the tobit model

Marginal Effects	Group A			Group B		
Total Left-censored (0% renewable) Uncensored Right-censored (100% renewable)	1690 316 1272 102			1706 301 1191 214		
Gender (female) (standard error)	-0.03 (0.14)	-0.07 (0.14)	0.02 (0.15)	0.18 (0.16)	0.03 (0.17)	0.12 (0.18)
Education (standard error)	-0.26' (0.13)	-0.25' (0.13)	0.03 (0.15)	-0.23 (0.16)	-0.22 (0.15)	-0.15 (0.16)
Age (standard error)	0.03*** (0.005)	0.03*** (0.006)	0.02*** (0.006)	0.03*** (0.007)	0.03*** (0.007)	0.02** (0.007)
Household income (standard error)	0.18*** (0.05)	0.19*** (0.05)	0.15** (0.05)	0.19** (0.06)	0.22*** (0.06)	0.18** (0.06)
Working status (standard error)		-0.10 (0.15)	-0.09 (0.15)		-0.41* (0.18)	-0.37* (0.18)
House structure (standard error)		0.05 (0.03)	0.06' (0.03)		0.05 (0.04)	0.06 (0.04)
Participation in local community chamber (standard error)			0.26' (0.15)			0.16 (0.17)
Knowledge of energy policies			0.27*** (0.06)			0.25*** (0.06)
Coefficient Log-likelihood	-3814	-3813	-3800	-3965	-3961	-3954
Degree of freedom	6	8	11	6	8	11

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

6 Discussion and the Way Forward

To determine which factors contributed to WTP, this paper organizes literature around three sets of plausible determinants (income level, knowledge, education, age, gender), social context, and participation (which lies at the intersection of individual and institutional variables). It then employs multinomial ordered logit and tobit regression models to determine whether and to what extent relevant variables influenced a respondent's WTP.

The results suggest that gender does not affect WTP, while the education and age effects run counter to expectations. Meanwhile, income appears to have the predicted effects. Social background has some discernible effects in a few but not all cases. Moreover, participating in local community activities tended to increase the likelihood of belonging in higher WTP categories. The clearest and most consistent finding is that people with more knowledge tended to fall in categories with higher WTP. In many cases the factors influencing WTP differ from other countries, but the acquisition of knowledge is not one of them. For policymakers hoping to introduce renewable energy policies, awareness raising and information dissemination appear to be critical.

While the importance of improving knowledge clearly follows from the study results, there are also a few notable limitations to this work.

The first and arguably most important involves the estimation of WTP. The survey responses suggest that there are potentially significant variations in the amount of money respondents were comfortable paying for renewables. Furthermore, this variation seems to be closely associated with the way that the WTP questions are framed rather than the objective view of the participants. For example, the range of the WTP for the first set of questions is considerably higher than the second and third set of questions. In fact, the responses to questions 2 and 3 appear to suggest that for many respondents in the 0-999 yen group the overriding concern is the amount of energy being generated

from renewable power sources.

A second set of limitations involves the specification of some of the independent variables. For the social context variables, one could reasonably argue that selection of the housing structure and employment are not the best measures of some of the arguments advanced in the relevant literature. A related critique could involve the information variables. In this case, some may view as problematic the inclusion of a measure that tracks knowledge of energy policy generally as opposed to renewables specifically. It should, however, be noted that the inclusion of a proxy for knowledge of renewable energy did not alter the main results of this study.

A third set of limitations related to the fact that the questions were asked at quite a unique point in the history of Japanese energy when the memory of the nuclear disaster was firmly in the minds of many people. It is not clear whether the same results would hold as memories of the Fukushima triple disaster fade.

A final set of limitations involves the conceptual model underpinning the research. As illustrated in Figure 1, the study is premised on the belief that there are interrelationships between some of the independent variables which are not captured in the models. These interrelationships merit further study, although it should be noted that tests of multicollinearity between the independent variables did not suggest that these cross-variable relationships altered the sign or certainty of the estimated coefficients. Last but not least, as a survey it can only capture the respondents revealed preference for WTP; it cannot actually determine whether that preference will lead to action.

The study result also opens the door for future research. One potentially fruitful avenue could focus on understanding about what knowledge should be transmitted to induce action. A growing body of work on sustainability transitions, social learning, and collaborative governance point to the potentially virtuous effects of engaging in activities that change attitudes that lead to actions (Geels et al. 2008; Kemp et al. 2007; Markard et al. 2012). Connecting the data-driven work in this study with more action-oriented research has a particular promise to illuminate where, when and how knowledge conditions preferences for WTP.

Another possible way forward is looking at interactions between participatory action and knowledge acquisition. It may be that these two areas could be mutually reinforcing, leading to results that are greater than either of these variables by themselves.

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