PANEL ANALYSIS OF BEHAVIOURAL MODIFICATIONS BY THE GREAT EAST JAPAN EARTHQUAKE

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ABSTRACT

This study explores the properties of environmental education policies enhancing altruistic attitudes and behaviour by investigating (1) whether a specific environmental education policy, Mobility Management (MM), can stimulate a different aspect of pro-social behaviour (electricity consumption in this study), and (2) whether MM intervention group shows the different behavioural modifications by the Great East Japan Earthquake (GEJE) compared to the no intervention group. We first give a theoretical explanation on the learning mechanism of altruistic attitudes and behaviour, and then conduct an empirical analysis by using a panel data collected by JCOMM (Japanese Conference On Mobility Management) Executive Committee. The results indicate the existence of associations between (1) MM intervention and electricity consumption in ordinary situation, and (2) MM intervention and the changes in electricity consumption by GEJE. However, supplementary analyses on the possibility of making errors in judgement of our analysis (selection bias and linguistic imprecision) show that the cause-effect relations are ambiguous and further investigations are needed.

Keywords: Great East Japan Earthquake, Mobility Management, Environmental education policies, Electricity consumption, Behavioural modification

INTRODUCTION

This study investigates the properties of environmental education policies enhancing altruistic attitudes and behaviour (for both ordinary and emergency situations), especially by looking at the behavioural modifications by the Great East Japan Earthquake (GEJE). The importance of altruistic behaviour in both ordinary and emergency situations has been repeatedly emphasized (e.g., Van and Dunlap, 1980; Scott and Willits, 1994; Fujii and Taniguchi, 2006; Darnton, 2008; Moser, 2010; Chen et al., 2011). There are, however, still many challenges which need to be further addressed: Can the improvement of altruistic attitudes induce behavioural changes in other aspects? If such “spillover” effects exist, how should we design educational policies as a whole? And, even if matured altruistic attitudes could reduce energy consumption considerably, what are the intrinsic differences from the energy reduction by other measures such as technological innovation? In this study, we attempt to provide some basic information and discussions for these questions.

The Great East Japan Earthquake and altruistic behaviour

Soon after the GEJE, a number of Japanese citizens have modified their attitudes and behaviours even in non-disaster areas. NHK Broadcasting Culture Research Institute (2011) reported that, as of September 2011, 87.3% of the Japanese people donated for affected people and 7.5% of them participated in volunteer activities, which may come as a result of altruistic attitudes which may be enhanced by the earthquake (Ishino et al., 2011). Mizuho Information & Research Institute, Inc. (2011) reported that, in the summer of 2011, 96% (85%) of respondents voluntarily saved electricity by reducing their use of lights (air conditioning systems), and 69~96% of them (which vary depending on the type of action) intend to conduct the energy saving behaviours in the summer of 2013 as well. Such altruistic behaviours may be important to build a more resilient society with high adaptability to disasters, since we may not be able to eliminate all possible damages from natural disasters at least in near future.

A critical question here then is how we can stimulate such altruistic attitudes and behaviour. Broadly speaking, there are two different conceptual explanations on altruism: evolutionary altruism and vernacular altruism (Sober, 1988; Piliavin and Charng, 1990). Sober (1988) noted that the evolutionary altruism can occur in organisms that don't have minds and thus essentially looks at the consequences of behaviours, while the vernacular altruism has to be done with motives for acting with the goal of benefitting others and do not always have to be a beneficial result for others. Thus, from the former viewpoint, altruism can be viewed as a kind of biological trait of human, while altruistic attitudes may be formulated through social learning from the latter viewpoint. Although both mechanisms could exist as Piliavin and Charng (1990) mentioned, Rushton (1982) emphasized the importance of the view of vernacular altruism as follows:

> Although evolutionary theory suggests that the basic (genetic) nature of Home sapiens is altruistic, it must be emphasized that much of human behavior is acquired through social learning. This is particularly necessary to emphasize when we consider the question of individual differences in altruism…we are altruistic primarily because we have learned to be so, being genetically programmed to learn from our environments (p. 429).

Thus, we may be able to learn altruistic attitudes and behaviour, implying that there is a certain space for policy interventions enhancing altruistic motives through the improvement of learning environment.

Altruistic behaviour and learning

Learning altruistic attitudes and behaviour may not be a superficial thing. It may involve the updating of normative and mental state, and it might be different from simply learning about how we should behave in a given situation. Such difference between mental and behavioural learning was conceptualized by Vare and Scott (2007). They introduced two different educational approaches in the context of environmental education for sustainable development. The first type of education for sustainable development (ESD 1) is to promote behavioural changes by teaching pre-determined skills and behaviours that are socially accepted. The second education approach (ESD 2) is to build capacity to think critically about what experts say and explore the contradictions inherent in sustainable living. The difference between these two approaches can be further understood by looking at the difference between single and double loop learning (Darnton, 2008). The single and double loop learning was originally proposed to theorize organization learning (Argyris and Schon, 1978; Argyris, 1992). Single loop learning (corresponding to ESD 1) occurs whenever behaviour is modified without questioning or altering the underlying values of the system, while double loop learning (corresponding to ESD 2) occurs when behaviour is modified by first examining and altering the governing variables and then the actions. Thus, the critical difference between two education approaches is that the ESD 2 involves the updating of individual's mental model, while ESD 1 does not. Although both approaches can enhance altruistic behaviour, Vare and Scott (2007) emphasized the importance of ESD 2 because of the following two reasons. First, ESD 2 involves the development of learner's abilities to make sound choices in the face of the complexity and uncertainty of the future. This might be essentially important because the needs of altruistic behaviour may vary depending on situations, which may be difficult to be pre-specified before things happen. Recently, such idea has intensively discussed under the concept of "adaptive capacity" or "resilient learner" in the field of environmental educations for social–ecological resilience (e.g., Berkes et al., 2003; Lundholm and Plummer, 2010; Krasny and Roth, 2010; Sterling, 2010)). Second, Vare and Scott underscored that too much successful ESD 1 in isolation would reduce our capacity to manage change ourselves, potentially causing less adaptive behaviours. On the other hand, though it seems to be paradoxical, they also underscored:

> ESD 1 and 2 are complementary because people need to hear what the sustainability lobby and governments are telling us to do (thorough ESD 1) in order to have relevant subject matter to debate and test in our own contexts. ESD 2, although open-end, cannot exist in a vacuum devoid of content (p. 196).

Thus, people may acquire basic knowledge through ESD 1, while ESD 2 arises when people internalize the learning. This is quite suggestive in the formulation of environmental education policies in several ways. First, it may facilitate attention on to whom and how policy maker should provide learning opportunities. For example, a certain type of compulsory learning may not be appropriate for some learners, since internalization may not occur if they don't have a sufficient will to learn. In such case, it may be better to allow people to make a decision on participating in the learning program based on individual self-selection. Second, when learning on a specific matter improves their mental model, there is a possibility to induce attitudinal and behavioural changes in other aspects. For example, when learning on reducing car usage can improve learners' mental model, they may start to think about the risk of environmental damage in a broader context. If such spillover effects are unignorable, we may have to identify to what extent the spillover effects occur and put a series of educational policies as a long-term measure.

Learning and mobility management

Like other fields, a number of educational policies have been implemented in transportation field such as traffic safety education program and environmental education program. In this study, we focus on Mobility Management (MM) which is an environmental educational policy (e.g., Fujii and Taniguchi, 2006; Taniguchi et al., 2007). MM focuses on motivating individuals to voluntarily change to more sustainable transport modes by providing detailed travel information and incentives through interactive communication. MM was initially implemented in 1999 in Japan, and has then been widely introduced across Japan (Fujii, 2008). Although the details of MM vary across projects, broadly speaking, there are three different types of MM depending on the locations where MM implemented: residential areas, schools, and workplaces (Taniguchi et al., 2007).

Key common feature of MM is not only to inform *what* kind of travel behaviour is more environmentally-friendly but also to let them know *why* we should do so. Although health related information is also often provided and may cause some behavioural changes, people are basically promoted to altruistically behave for the benefit of others in terms of reducing environmental impacts. Therefore, MM potentially involves ESD 2. Actually, the impacts of MM have been conceptualized based on Schwartz's Norm Activation Theory (1977) (e.g., Taniguchi and Fujii, 2007) which involves consistent discussions with ESD 2. Concretely, from the viewpoint of the Norm Activation Theory, ESD 1 may correspond to the activation of social norms, and ESD 2 may correspond to the activation of personal norms. When social norms are internalized, they become personal norms (Schwartz, 1977, p. 268), just like a relationship between ESD 1 and ESD 2. Thus, it can be said that MM has been implemented with due consideration of ESD 2. On the other hand, it has not been well identified how updating mental model affects other behavioural aspects. If such spillover effects considerably exist, the impacts of MM are underestimated under the current evaluation which solely focuses on transportation related indicators.

Research objective

This study has two main objectives based on the above discussions. First, we attempt to identify whether MM intervention involves ESD 2 or not. If the mental model is updated by MM intervention, altruistic attitudes and behaviour may be strengthened even in the context of other behavioural aspects. We attempt to confirm it by comparing attitudes and behaviour of electricity consumption between MM Intervention and non-intervention group. If a significant difference is observed between these two groups, the impact of the educational policy in a certain field could spill over to other fields, indicating that ESD 2 type educational policies should be accessed in a broader context. Second, if the MM successfully updates the mental model, there could be some different behaviour modifications before and after the Great East Earthquake between two groups. Confirming it could be quite important because voluntary behaviour modification is one of the most significant adaptation measures, since it can be instantaneously activated in a bottom-up fashion when an unexpected event (such as earthquake) suddenly happens. We explore these two objectives by using a panel data collected by JCOMM (Japanese Conference On Mobility Management) Executive Committee in June 2011, September 2011, December 2011, and March 2012. After confirming the above mentioned things, we further conduct additional supportive analysis to explore the possibility of making errors in the judgement of our analysis. We first examine whether self-selection bias exists in MM participation or not. If the self-election bias exists, i.e., if people who have higher altruism attitudes self-select themselves to learn about MM, the opposite cause-effect relationship between MM and altruistic attitudes could be expected. We also discuss about linguistic imprecisions which might be difficult to avoid in the context of the current analysis.

In the next section, the panel data we used is briefly introduced. Then, after confirming the difference of electrical usage (before the earthquake) between MM Intervention and non-intervention group, the changes in electrical usage after earthquake are examined. We then investigate the possibility of making errors in our analysis by looking at self-selection bias and linguistic imprecisions. Finally, we summarize our findings, implications and future research tasks.

DATA

Soon after the GEJE, the JCOMM Executive Committee launched a panel web survey to trace changes in energy saving behaviour, travel behaviour and altruistic behaviour caused by the earthquake. The survey focused on individuals who are 20 to 69 years old and live in four different locations: Miyagi prefecture, Kanto region, Kansai region, and Hiroshima prefecture. For each wave, around 2,000 individuals were asked to report socio-demographic attributes, recognition of MM, affected people in respondent's social networks, travel mode, monthly car, electricity usage, and so on. The questionnaires are somewhat different across waves, although the core questions such as car and electricity usages had been asked throughout all waves.

In this study, we only focus on individuals who (1) live in Kanto and Kansai regions, (2) are not affected by the earthquake, and (3) are perfectly participated in whole four-wave surveys. 785 persons participated in whole waves, where 394 of them live in Kanto and Kansai. Among them, 356 individuals were not affected by the earthquake. The first selection rule is employed, because Miyagi prefecture has been physically affected by the earthquake, and in Hiroshima information on the past electricity usages was not available (this is because the past electricity usage is not described in the electric bill in Hiroshima). Also, outlier samples are identified based on the following rules: (1) the gap of electricity usage had more than tripled (or less than one third) as compared with a year ago, or (2) the gap of electricity usage between minimum and maximum electricity consumptions within an individual reached more than tenfold or less than one-tenth. After implementing the data cleaning, finally, 277 samples for each wave (1,108 samples in total) are obtained and used for the following analysis.

Whether the respondents were intervened or not is identified based on the question about the recognition of MM which was asked in the third wave survey. Originally, respondent were asked to choose one from the following three options: (1) I understand MM in detail, (2) I know MM but I'm not sure about the detail, and (3) I've never heard MM. We assume that respondents choosing first and second options belong to intervention group, and others are assumed to be no intervention group. Finally, 38 respondents are identified as belonging to MM intervention group, and 239 respondents are in no intervention group. Here, it should be noted that there are certain difficulties to precisely specify the intervention group at least because of the following two reasons. First, although we could take a more direct way to observe the state of MM intervention (i.e., asking whether the respondent formally participated in MM program or not), there are several types of MM policies, some of which are expected to cause indirect effects. Particularly, MM for students implemented at elementary school is intended not only to educate the students, but also to provide a learning opportunity for their parents by encouraging communications within family members. Thus, the formal MM participation may not correspond to the learning from MM. Therefore, in this study, we assume that recognition of MM might be a better index measuring MM interventions. Second, there would be linguistic imprecisions. Although MM is getting popular in practice, "mobility management" is not an intuitive word and most projects use more catchy names. Therefore, even people don't recognize the term "mobility management", there is a possibility that they were practically intervened. To mitigate such linguistic issue as much as possible, respondents were first asked to answer whether they recognize several major MM project names and then to answer the recognition of MM in general. This procedure was taken only in the third wave survey, and thus whether respondents were intervened or not is identified by using the third wave survey data in this study. Of course this is just a practical treatment of linguistic imprecisions. We will further discuss about linguistic imprecision issues in a later section.

THE IMPACTS OF MM ON ELECTRICITY CONSUMPTION

Electricity usage before the earthquake

In this section, different electricity consumption behaviours between MM intervention and no intervention group are examined. To avoid reflecting the impacts of GEJE, we only focus on the electricity usage before the earthquake. Table 1 shows the differences in the average monthly electricity consumption per household (Kwh/Month). In the table, as a benchmark, the electricity usages reported by Statistics Bureau of Japan (Accessed on October 10, 2012; URL: http://www.stat.go.jp/index.htm) is also presented. Note that Statistics Bureau of Japan calculated monthly electricity consumptions based on the family income and expenditure survey (conducted by the Ministry of Internal Affairs and Communications). The average electricity usages are higher than the average from our data set, but this is because the monthly electricity usages were calculated only based on two-or-more-person households.

According to the table, the electricity consumptions of intervention group are statistically lower than those of no intervention group in November and February. The average values across the survey period also indicate that intervention group use less electricity than no intervention group. Hence, given the assumption that MM intervention is randomly assigned to individuals, it could be said that MM intervention possibly causes changes in other behavioural aspects, i.e., MM intervention could involve ESD 2. This implies that MM intervention may have spillover effects, indicating that we may have to evaluate MM in a broader context.

Table I – Average monthly electricity consumption per household (Kwh/Month) before GEJE

	Before GEJE			
	No intervention	Intervention	t-stat	Statistics Bureau
May	12.11	11.32	0.484	14.60
August	14.72	13.03	1.112	15.09
November	11.69	9.43	1.894+	12.81
February	14.91	12.19	1.759+	21.21
Average	13.36	11.49	2.484*	15.93

Note: + Significant at <0.10; * significant at <0.05

Before and after comparison of the electricity usage

Table II show the changes in average monthly electricity consumptions before and after the earthquake. The results indicate that energy consumptions are decreased at all-time points after the earthquake. Especially in August, the significant reduction is observed in no intervention group. On the other hand, as we can confirm from Table II, although the electricity consumption in MM intervention group is smaller than that in no intervention group even after the earthquake, the amount of reduction in the intervention group is much smaller than that in no intervention group.

Implications from this result could be quite important in several ways. First, the result implies MM intervention group may not be able to afford to reduce more compared to no intervention group, probably because they have already reduced electricity usage. Thus, the reduction of electricity usage may depend on the initial state, indicating that the impacts of a program enhancing pro-environmental behaviour (such as MM) should not be evaluated by solely focusing on the changes in a certain behavioural aspect. There is a possibility that other interventions have already changed their mental model that can be the initial state for the subsequent situation. In this regard, Brandon and Lewis (1999) found that people who had not previously been engaged in many conservation actions were more likely to change their energy consumption by intervention. More interventions could result in less space for further electricity saving, even when the interventions don’t focus on the electricity saving itself.

Second, related to the first point, although it is recognized that altruistic attitudes and behaviour should be enhanced to have a more sustainable society, there is a possibility that the more altruistic attitudes are matured, the less adaptive behaviour could emerge. As is well known, the negative impacts of electric power shortage by the accident at the Fukushima nuclear power plant were reduced by taking electricity saving behaviour voluntary. However, our results indicate that such adaptive behaviour was mainly taken by those who belong to no intervention group who have less intention to reduce electric usage. This could be thought as a kind of *paradoxical* phenomenon, since more learning about pro-environmental behaviour could result in a less resilient society. Taking the thought one step further, if the total amount of electric supply in Japan is reduced according to the achievement of promoting voluntary energy saving behaviour, there is a possibility that the society becomes less resilient with respect to an unexpected event which requires further energy saving. In this sense, the energy reduction by enhancing altruistic attitudes and behaviour could not be seen as that by other measures such as technological innovations. We may have to take into account this difference in the discussions of electricity supply planning in future.

Table II – Changes in average monthly electricity consumption per household (Kwh/Month) before and after GEJE

	Before GEJE			After GEJE		
	No intervention	Intervention	Statistics Bureau	No intervention	Intervention	Statistics Bureau
May	12.11	11.32	14.60	11.30 (▲ 0.80)	11.10 (▲ 0.22)	13.51 (▲ 1.09)
Aug.	14.72	13.03	15.09	12.62 (▲ 2.10)**	11.96 (▲ 1.07)	13.18 (▲ 1.91)
Nov.	11.69	9.43	12.81	10.84 (▲ 0.84)	9.28 (▲ 0.15)	11.89 (▲ 0.92)
Feb.	14.91	12.19	21.21	14.70 (▲ 0.21)	12.15 (▲ 0.04)	20.58 (▲ 0.63)
Average	13.36	11.49	15.93	12.37 (▲ 0.99)*	11.12 (▲ 0.37)	14.79 (▲ 1.14)

Note: * Significant at <0.05; ** significant at <0.01

SUPPLEMENTARY ANALYSES

In this section, we further examine the possible fallacies of the findings in the previous section. We first focus on whether self-selection bias exits or not, since the discussions have been made under the assumption of perfectly random MM intervention. We then explore the linguistic imprecisions which are difficult to be perfectly avoided in the current study.

Self-selection bias

Broadly speaking, there are two ways to access the existence of self-selection bias. First, by using observed information, we can examine whether a certain population group participate more in MM program or not. Second, since some factors causing self-selection bias may not be observable (such as variables related to mental state), we can also examine unobserved associations between the program participation and outcome (in this study, MM and electricity usage). In the following analysis, we first explore the observed self-selection bias. We then focus on the unobserved self-selection bias.

To confirm observed self-selection bias, we do cross tabulation analysis as shown in Table III. The results show that certain population groups tend to be intervened by MM. Concretely, those who are male, 40-49 years old, worker, living with souse and child(ren), living in Kanto region, and having a higher income tend to be intervened by MM. The results are basically understandable, because most MM programs implemented at residential areas, schools and workplaces could directly and indirectly affect the workers who lives with child(ren). Also, the result of the income impacts is consistent with previous studies (e.g., Van Liere and Dunlap, 1980; Scott and Willits, 1994; Clark et al., 2003). The results also indicate that MM intervention group less use electricity than no intervention group in all cases except for the age group of 40-49 years old. And, interestingly, the segments that use more electricity than the population average (i.e., male, 40-49 years old, worker, living with souse and child(ren), living in Kanto region, and having a higher income) tend to be more intervened by MM, implying that intervention group may originally need more electricity than no intervention group. Thus, there is a possibility that the impacts of MM were underestimated in the analysis conducted in the previous section and these findings basically further support the implications made in the previous section.

Table III – Cross tabulation analysis for exploring observed self-selection effects

	Sample size			Electricity consumption	
	No intervention	Intervention	Ratio of intervention	No intervention	Intervention
Gender					
Male	460	100	17.9%	14.15	13.14
Female	496	52	9.5%	12.62	8.32
Age					
20-29 years old	116	14	10.8%	8.57	5.27
30-39 years old	165	27	14.1%	11.86	8.08
40-49 years old	125	35	21.9%	11.76	14.54
50-59 years old	246	34	12.1%	15.63	12.63
60-70 years old	304	42	12.1%	14.81	12.30
Occupation					
Student	15	1	6.3%	5.54	5.00
Worker	534	105	16.4%	13.55	12.42
Homemaker	218	27	11.0%	13.19	8.33
Unemployed/retired	115	13	10.2%	13.83	12.07
Residential location					
Kanto	450	84	15.7%	13.42	10.39
Kansai	506	68	11.8%	13.30	12.85
Live with spouse					
No	318	33	9.4%	10.41	8.19
Yes	638	119	15.7%	14.83	12.41
Live with child(ren)					
No	550	83	13.1%	11.46	9.28
Yes	406	69	14.5%	15.93	14.16
Live alone					
No	771	130	14.4%	14.63	12.45
Yes	185	22	10.6%	8.06	5.83
Household income					
-399 million yen	316	28	8.1%	10.56	8.19
400-799 million yen	412	72	14.9%	14.32	9.99
800- million yen	228	52	18.6%	15.49	15.35
Total	956	152	13.7%	13.36	11.49

Examining unobserved self-selection bias is crucially important, because the decision of an individual to participate or not participate in a MM program is based on individual self-selection in a number of MM programs. If people who have higher altruistic attitudes tend to participate in MM program, then there is a possibility that MM intervention group use less electricity than no intervention group just because they already have matured altruistic attitudes. However, it is usually difficult to measure altruistic attitudes before the intervention, in case that a comparison analysis before and after the intervention cannot be implemented. This is especially true for the current study, since the need for the investigation suddenly came up by an unexpected event, the earthquake. In such case, the initial state of altruistic attitudes may have to be dealt with as unobserved associations between the program participation and the outcome. Hereinafter, we introduce an endogenous switching model to capture the unobserved associations, and then model estimation results and the implications are discussed.

(1) An endogenous switching model

The benefits of social programs under the existence of both observed and unobserved self-selection can be evaluated by using an endogenous switching model (Maddala, 1983, pp.260-262). Let y_i be electricity consumption (in empirical analysis, the natural logarithm of the electricity consumption), and I_i be a dummy variable (I_i = 1 if the individual was intervened; I_i = 0 otherwise). Let y_{1i} be the electricity consumption by MM intervention group, and y_{2i} be the electricity consumption by no intervention group. Under these definitions, the electricity consumption can be written as follows:

$$y_i = \begin{cases} y_{1i} & if \quad I_i = 1 \\ y_{2i} & if \quad I_i = 0 \end{cases} \tag{1}$$

$$y_{1i} = \alpha \mathrm{x}_\mathrm{i} + \varepsilon_{1i} \tag{2}$$

$$y_{2i} = \beta \mathrm{x}_\mathrm{i} + \varepsilon_{2i} \tag{3}$$

where, α and β are the vectors of unknown parameters, x_i is the vector of explanatory variables, and ε_{1i} and ε_{2i} are unobserved random components. It is also assumed that whether the individual was intervened by MM is determined by the following equations:

$$I_i^* = \gamma \mathrm{x}_\mathrm{i} + \varepsilon_{3i} \tag{4}$$

$$I_i = \begin{cases} 1 & if \quad I_i^* > 0 \\ 0 & if \quad I_i^* \le 0 \end{cases} \tag{5}$$

Here, I^*_i is the latent variable that represents the propensity of being intervened by MM, γ is the vector of unknown parameters, and ε_{3i} is an unobserved component. We further assume that ε_{1i}, ε_{2i} and ε_{3i} follow the multivariate normal distribution:

$$(\varepsilon_{1i}, \varepsilon_{2i}, \varepsilon_{3i}) \sim MVN(0, \Sigma) \tag{6}$$

$$\Sigma = \begin{bmatrix} \sigma_1^2 & 0 & \rho_{1\varepsilon}\sigma_1 \\ 0 & \sigma_2^2 & \rho_{2\varepsilon}\sigma_2 \\ \rho_{1\varepsilon}\sigma_1 & \rho_{2\varepsilon}\sigma_2 & 1 \end{bmatrix} \tag{7}$$

Based on the above mentioned assumptions, the benefit of MM in terms of electricity saving can be calculated as follows:

$$E(y_{1i} - y_{2i} \mid I_i = 1) = \mathrm{x_i}(\alpha - \beta) + (\rho_{1\varepsilon}\sigma_1 - \rho_{2\varepsilon}\sigma_2)\frac{\varphi(\gamma \mathrm{z_i})}{\Phi(\gamma \mathrm{z_i})} \tag{8}$$

where $\varphi(\cdot)$ is a standard normal density distribution function and $\Phi(\cdot)$ is a standard normal cumulative distribution function. The first term of eq. (8) represents the observed differences of the expected electricity consumptions between the two groups, and the second term indicates the differences caused by the unobserved associations with the propensity of being intervened by MM. Thus, if $(\rho_{1\varepsilon}\sigma_1\text{-}\rho_{2\varepsilon}\sigma_2)$ is less than zero, people who are going to reduce electricity consumption more may tend to be intervened by MM. In this case, MM intervention with individual self-selection may reduce more electricity than random intervention.

(2) Estimation results and discussions

The estimation results of the endogenous switching model are presented in Table IV. The impacts of introduced explanatory variables are basically same with the impacts Table III showed. Rich males who live with spouse tend to be intervened by MM, and younger males who live alone tend to less use electricity. On the other hand, interestingly, some variables show the different impacts on electricity consumption between intervention group and no intervention group. While those who were not intervened by MM tend to increase electricity usage with the increase of household income, there is no significant impact of household income for intervention group. This result implies that there is a possibility that such educational policy could alleviate the positive impacts of income on energy consumption.

Looking at the estimation results of correlation terms, the energy consumption of intervention group shows a negative unobserved association with the propensity of being intervened by MM. This implies that those who have a higher propensity being intervened lead to less use of electricity. More quantitatively, the estimated mean of $\mathrm{x_i}\alpha$ is 3.423, $\mathrm{x_i}\beta$ is 2.492, $\rho_{1\varepsilon}\sigma_1\varphi(\gamma \mathrm{z_i})/\Phi(\gamma \mathrm{z_i})$ is -1.339, $\rho_{2\varepsilon}\sigma_2\varphi(\gamma \mathrm{z_i})/\Phi(\gamma \mathrm{z_i})$ is 1.005, and thus $E(y_{1i}\text{-}\ y_{2i} \mid I_i{=}1)$ is -1.412. These indicate that the greater energy reduction appears under individual self-selection, and this finding is basically consistent with Yamamoto (2011) where the existence of attrition bias was identified in the context of MM program participation. The result also indicates that forcing people to participate in MM may not work well compared to individual self-selection.

The existence of the self-selection effects requires further considerations of the findings in the previous section. First, it is showed that there is a possibility that those who are willing to take altruistic behaviour participate more in MM program, rather than MM intervention generates altruistic attitudes. In other words, there is a possibility that the differences in energy saving behaviour between MM intervention group and no intervention group reported in the previous section may occurs just as a consequence of the initial state of altruistic attitudes which may be independent from MM intervention. Even so, on the other hand, it could still be said that altruistic attitudes (regardless of the cause-effect relationship between MM and altruistic attitudes) may reduce the space for further behavioural modifications which are expected to emerge when further events or unexpected natural disaster happens. As we will discuss in the final section, this paradoxical phenomena should be paid more attention to in policy discussions of electricity supply planning in future.

Linguistic imprecisions

It is often difficult to identify whether the person was actually intervened by MM or not, by using questionnaire without a before-after comparison. One of the important reasons behind it might be the existence of linguistic imprecisions. Although the linguistic imprecision has been known as an uncertainty which can relatively be easy to be alleviated (Morgan and Henrion, 1990), there would be some intrinsic difficulty in case of capturing the impacts of intervention which has indirect impacts and especially in case that a comparison analysis before and after the intervention cannot be implemented.

As mentioned above, in the questionnaire design, we asked people to answer the recognition of several major MM projects, before asking the recognition of MM. The major projects include four different MM projects: Thinking Smart Car Use Project, Thinking Car and Public Transit Use Project, Eco-Commuters, and BEST (Bingo Environmentally Sustainable Transport) Action. The first two project names are most often used in practice, since people can intuitively understand what MM is. The contents of the projects vary across projects, and a number of projects have been implemented across Japan under these two titles. The third project only focuses on commuting travel. This type of mobility management is usually implemented by urging organizations such as corporations and local governments. A number

Table IV – Estimation results of endogenous switching model

	MM recognition (binary choice)			Electricity consumption (Intervention)			Electricity consumption (No intervention)		
	Parameter	t-value		Parameter	t-value		Parameter	t-value	
Constant	-1.812	-7.201	**	3.269	6.318	**	1.620	13.717	**
Male [D]	0.195	1.836	+	0.279	1.764	+	0.089	1.731	+
30-39 years old [D]	-0.038	-0.204		0.524	2.321	*	0.191	2.082	*
40-49 years old [D]	0.156	0.790		0.829	3.636	**	0.287	2.868	**
50-59 years old [D]	-0.146	-0.776		0.687	2.979	**	0.436	4.938	**
60-70 years old [D]	-0.051	-0.279		0.717	3.152	**	0.544	6.413	**
Full worker [D]	0.113	1.004		-0.012	-0.078		0.041	0.777	
Kanto [D]	0.060	0.605		-0.180	-1.297		-0.004	-0.062	
Live alone [D]	0.131	0.555		-0.852	-3.142	**	-0.254	-2.396	*
Live with child(ren) [D]	-0.113	-1.030		0.392	2.814	**	0.163	2.843	**
Live with spouse [D]	0.428	2.011	*	-0.701	-2.434	*	0.139	1.557	
Live with parent(s) [D]	-0.117	-0.617		0.302	1.425		0.209	2.232	*
HH income (mil. yen)	0.045	3.690	**	-0.018	-1.310		0.034	5.141	**
August [D]				0.199	1.669	+	0.216	3.582	**
November [D]				-0.144	-1.206		-0.021	-0.354	
February [D]				0.125	1.040		0.187	3.129	**
Correlation ρ				-0.904	-4.282	**	0.819	9.217	**
Residuals σ				0.909			0.754		
Initial log-likelihood1)					-3330.05				
Initial log-likelihood2)					-1719.20				
Final log-likelihood (correlations are fixed as zero)					-1528.34				
Final log-likelihood					-1510.66				
Sample size					1108				

1) Log likelihood obtained from the model estimation results only with residual parameters.
2) Log likelihood obtained from the model estimation results only with residual and constant parameters.

of Eco-Commuters projects have been implemented across Japan as well. The fourth project is a region specific project which has been implemented around Bingo region since 2006. This is a comprehensive MM project which has been implemented at residential areas, schools, and workplaces. In BEST Action, to continuously communicate with participants, feedbacks have also been made at monthly intervals. The number of participants reached 16,000 as of June 2010 (Matsueda, 2010).

Table V shows the relationships between the recognitions of MM and each project. From the Table, we can confirm that there are a number of persons who know the project but don't know MM, and vice versa. Although this is not a contradictory answer since each project uses its own name and usually it is not emphasized that the project is implemented under the concept of MM, this makes it difficult to identify who were actually intervened by MM. As we can confirm from Table V, the recognition of MM is basically lower than that of each project name, probably because the term "Mobility Management" is a kind of technical term. Thus, it can be expected that those who recognize MM may know not only what kind of behaviour is more environmentally-friendly but also why we should do so. On the other hand, when we employ the recognition of MM as an indicator of intervention, there is a possibility that it further enhances the apparent individual self-selection, i.e., those who have a matured altruistic attitude (regardless of whether MM contributes to it) may tend to be more in MM intervention group. On the other hand, when we use the project name as an indicator of intervention, another potential fallacy may emerge, since the name is somewhat ambiguous and some respondents may be more likely to mistakenly answer that they know the project even though they don't know it actually. In summary, using the recognition of MM as an indicator of intervention might be a conservative way which avoids a fallacy of putting people who were not actually intervened into the intervention group. This property should be kept in mind to properly understand the results of the analysis we made.

Table V – The relationships between the recognitions of MM and each project

	I know the project		I don't know the project	
	I know MM	I don't know MM	I know MM	I don't know MM
Thinking Smart Car Use Project	21	37	17	202
Thinking Car and Public Transit Use Project	23	38	15	201
Eco-Commuters	31	134	7	105
BEST Action	16	25	22	214

SUMMARY AND CNCLUSIONS

In this study, we have investigated the properties of educational policies enhancing altruistic attitudes and behaviour by exploring (1) whether MM intervention causes changes in other behavioural aspects, and (2) whether there are differences in behavioural modifications before and after the Great East Japan Earthquake (GEJE) between MM intervention group and no intervention group. The results indicated that associations between MM and electricity consumption (and its changes by the GEJE) exist. We also explored issues on self-selection bias and linguistic Imprecisions to mitigate and make clear the possible fallacies behind discussions we made. The results showed that, though the associations exist, the cause-effect relationship between MM and electricity consumption is still ambiguous. More theoretical and empirical studies on spillover effects are certainly needed before giving a general conclusion.

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