RADIATION KNOWLEDGE AND WILLINGNESS TO BUY MINERAL WATER OF REGIONS NEAR THE FUKUHIMA DAIICHI NUCLEAR POWER PLANT

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Overview

After the Fukushima disaster of 2011, prices of products from regions near the Fukushima Daiichi Nuclear Power Plant have been stagnant because many Japanese consumers are avoiding to buy products from these regions thinking these products might be contaminated with radioactive materials. To cope with this issue, many studies have performed consumer survey to find out how consumers react food products of regions near the FDNPP (Ujiie 2012; Ito and Kuriyama 2016; Wakamatsu and Miyata 2017). Among such studies some of them have shown that consumers having radiation knowledge are more likely to buy food of regions near the FDNPP (Aruga 2017; Lee et al. 2017). However, at the moment there are very few studies investigating what types of radiation knowledge are important for improving the consumers' willingness to buy products of regions near the FDNPP.

Hence, this study examines how difference in the types of radiation knowledge affects the consumers' willingness to buy mineral water of regions near the FDNPP. The types of radiation knowledge tested in this study are radioactive decay, difference between Sievert (Sv) and Becquerel (Bq), and effects of radiation on human body. We also compare the difference in the WTB between a consumer with some kind of radiation knowledge and that without any radiation knowledge.

This study is important for conducting effective education program to enhance consumers' knowledge on radiation and to improve the WTB toward food of regions near the FDNPP. Studies have shown that the so-called reputation damage exists in food of regions near the FDNPP due to lack in accurate radiation knowledge. This study should be helpful for removing such reputation damage by revealing what radiation knowledge need to be tought to the consumers.

Methods

Our econometric analysis is based on the random utility model presented in equation (1):

$$U_{ij} = V_{ij} + \varepsilon_{ij} = X_{ij}'\beta + \varepsilon_{ij} \quad (1)$$

where U_{ij} is the utility where the *i*th survey respondent obtains from picking choice *j*, V_{ij} is a deterministic utility expressed as a linear combination of the observed random factors. X_{ij}' is the vector of factors and respondent's attributes affecting the deterministic utility, β is the vector of parameters, and ε_{ij} represents the unobserved random factors. It is assumed that ε_{ij} follows a normal distribution with mean zero.

To examine the types of radiation knowledge affecting consumers' willingness to buy mineral water of regions near the FDNPP, we performed a survey using a contingent valuation method (CVM). Through the CVM, we identified the consumer's willingness to buy (WTB) mineral water of regions near the FDNPP. The WTB in our study is defined as a binary variable where the value takes one if the survey respondents are willing to buy mineral water of a region 100km apart from the FDNPP at the same price as one from a region 300km away from the FDNPP. The WTB is zero otherwise. Hence, our econometric model is analyzed using equation (2).

$$WTB_{ij} = X_{ij}'\beta + \varepsilon_{ij} \quad (2)$$

where $WTB_{ij} = \begin{cases} 1 & (WTB_{ij}^* > 0) \\ 0 & (WTB_{ij}^* \leq 0) \end{cases}$ and WTB_{ij}^* is an unobserved latent WTB. The independent variables included in equation (2) are the variables related to radiation knowledge and control varibles that are likely to have influence on the WTB.

For variables related to radiation knowledge we included the following dummy varibles: *isotopes*, *Sv & Bq*, *cancer*, and *ignorant*. *Isotopes* takes one if the respondents know that radioactive isotopes continue to decay until they become a stable isotope and zero otherwise. *Sv & Bq* is set to one if the respondents can dinstiguish between Sv and Bq and zero otherwise. *Cancer* takes one when the respondents have knowledge about the probability of developing cancer when exposed to radioactive material in a lifetime increases about 0.5% and zero otherwise. Similarly, *ignoran*t is one when the respondents have no knowledge about radiation and zero otherwise.

For the control variables we included variables related to the level of trust the respondents put on the current Japanese safety standard for radioactive material concentraions in food, awareness about safety issue when buying food prodcuts, awareness about supporting the disaster region, number of children, age, education, gender, and distance of the respondents' residence from the FDNPP. These variables are chosen because previous studies have

suggested the importance of including these variables in the model when analyzing the WTB food of regions near the FDNPP (Ujiie 2012; Aruga 2017; Hori et al. 2017).

Equation (2) is analyzed with probit and logit models. The data for analyzing equation (2) are gathered through online survey which was conducted during the Jan. 30, 2014 – Feb. 4, 2014 period. The number of respondents we obtained for the mineral water in this survey is 1709. The survey sample contains consumers of all parts of Japan and the survey is distributed randomly based on the most recent Japanese population distribution by prefectures.

Results

Table 1 Model estimation results

	Probit model		Logit model	
	Coeff.	Z-stat	Coeff.	Z-stat
Constant	-1.63 ***	-7.00	-2.67 ***	-6.90
Isotopes	0.19 **	2.40	0.32 **	2.41
Sv & Bq	-0.10	-1.26	-0.17	-1.31
Cancer	-0.13	-1.54	-0.21	-1.53
Ignorant	-0.17 *	-1.75	-0.29 *	-1.75
Trust	0.20 ***	11.29	0.32 ***	10.96
Support	0.09 ***	4.85	0.15 ***	4.75
Safety	0.32 ***	3.55	0.54 ***	3.56
Children	-0.08 ***	-2.65	-0.14 ***	-2.66
Age	0.05 **	2.21	0.09 **	2.24
Education	0.01	0.20	0.01	0.13
Gender	0.27 ***	3.90	0.45 ***	3.87
Distance	-0.07 **	-2.49	-0.11 **	-2.48

***, **, and * denote significance at 1%, 5%, and 10% levels.

Table 1 shows the results of our probit and logit model estimation. As seen in the table, radiation knowledge about radioactive isotopes to decay to stable isotopes have a positive effect on the consumers' WTB mineral water of regions near the FDNPP.

The table also shows that knowledge about Sievert and Becquerel and effects of radiation on human body do not have effects on the WTB mineral water of regions near the FDNPP.

Finally, it is clear from the coefficient for the *Ignorant* in the table that having no knowledge about radiation have a negative impact on the consumers' WTB. This indicates that consumers without any knowledge in radiation have a lower WTB mineral water of regions near the FDNPP.

Among the other factors affecting the WTB, trust, support, safety, children, age, gender, and distance were statistically significant and their results were consistent with those of previous studies.

Conclusions

The study investigated difference in the types of radiation knowledge affecting the consumers' WTB mineral water of regions near the FDNPP. The results revealed that consumers with knowledge about radioactive decay have a positive WTB while consumers without any knowledge about radiation have a negative WTB toward mineral water of regions near the FDNPP. This indicates the importance of understanding what types of radiation knowledge need to be provided when conducting education program to enhance the consumers' knowledge about radiation in order to improve their WTB toward products of regions near the FDNPP.

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