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Consumer Responses to Food Products Produced Near the Fukushima Nuclear Plant

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Background of study

- On march 2011, the Fukushima Daiichi nuclear power plant (FDNP) was hit by a tsunami and this resulted in a meltdown of three reactors.
- Substantial amounts of radioactive materials (770 quadrillion Bqs) were released into air.

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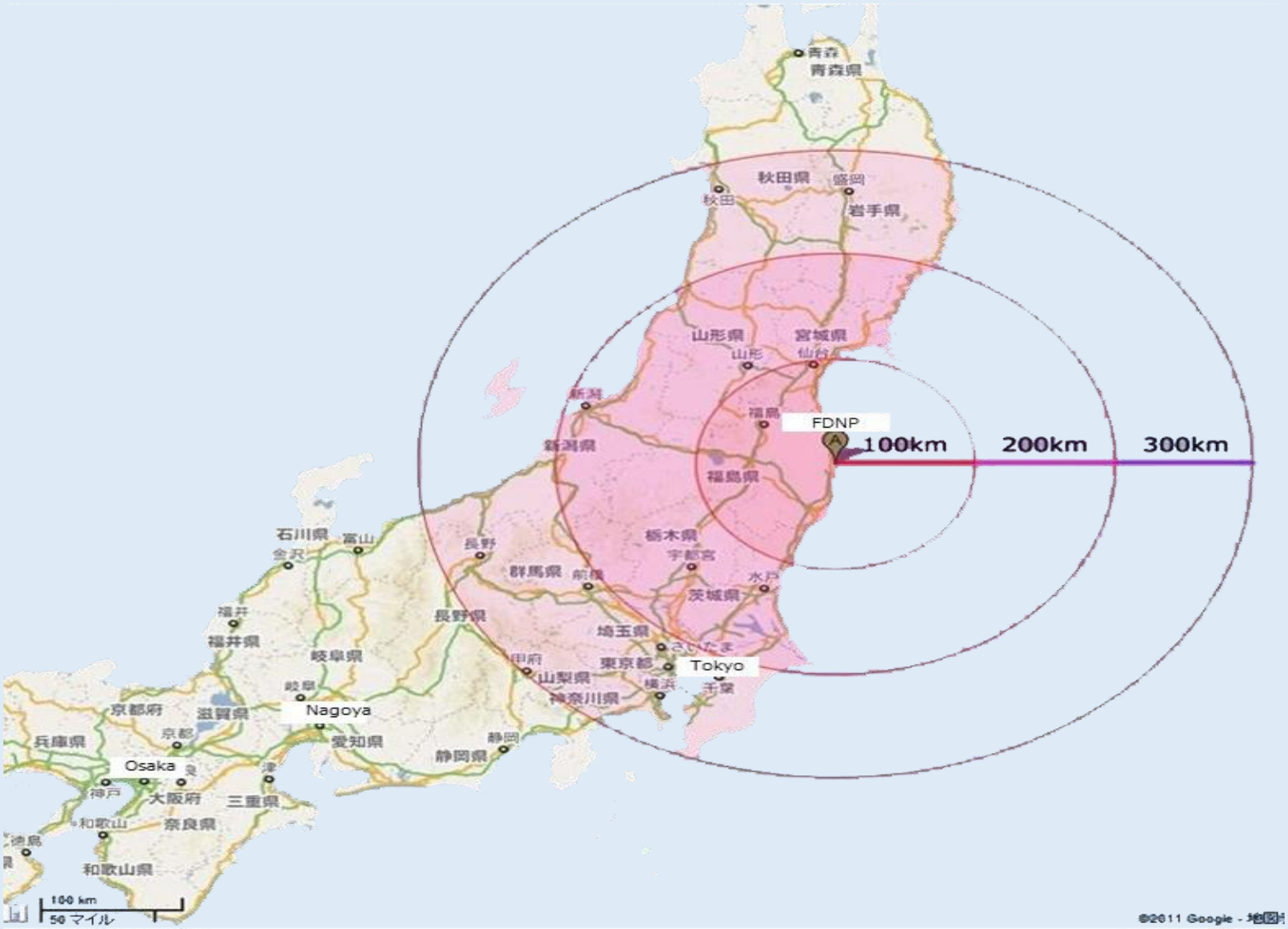

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Background of study

- Many food products have been contaminated with radioactive material.
- Japanese government has restricted the distribution of food that are contaminated with radioactive material.

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Current standard limits of radioactive cesium in Japan

Products	Standard
Drinking water	10
Milk	50
General food products	100
Infant food	50

(Unit: Bq/kg)

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Motivation of study

- Even after four years since the Fukushima incident, there are consumers who avoid purchasing products from Fukushima prefecture.
- After the Fukushima incident, agricultural products from Fukushima are sold at lower price compared to those produced in other regions (Norinchukin Research Institute, 2012).

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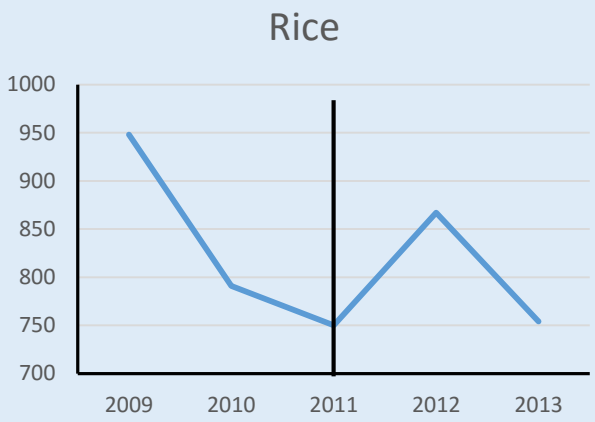
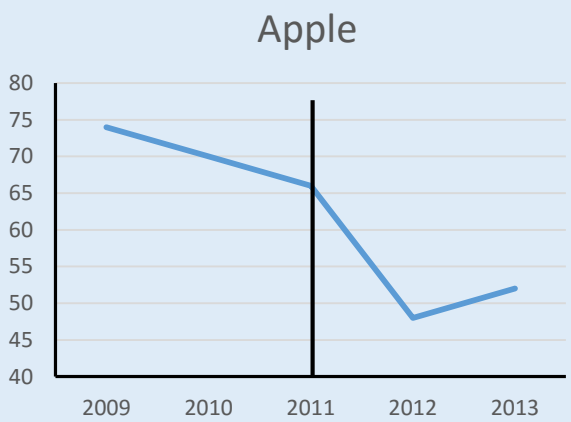
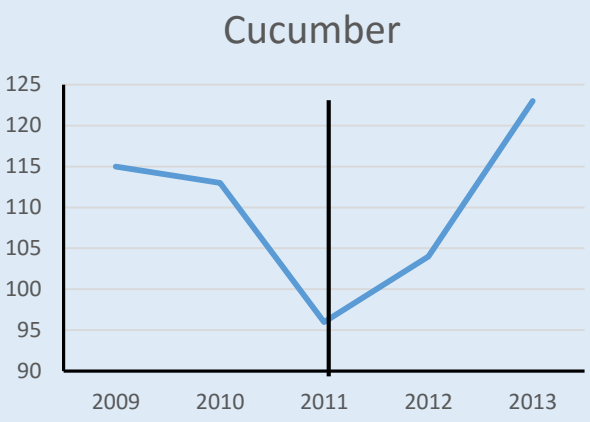
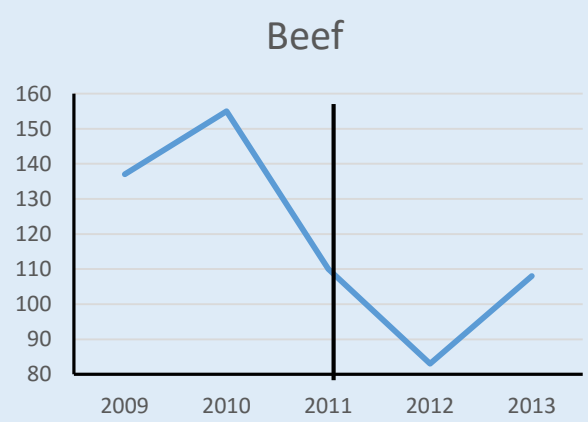
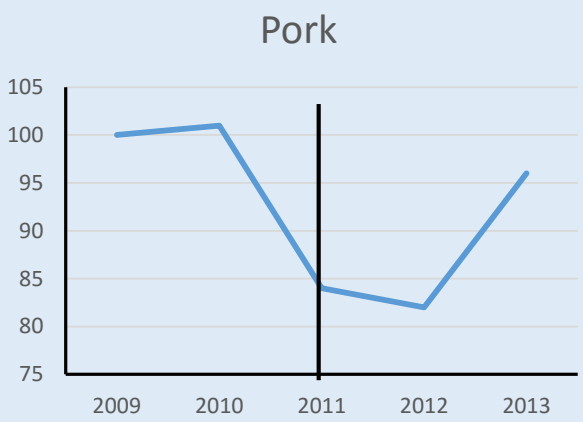
Agricultural production change in Fukushima before and after the nuclear incident (billion yen)

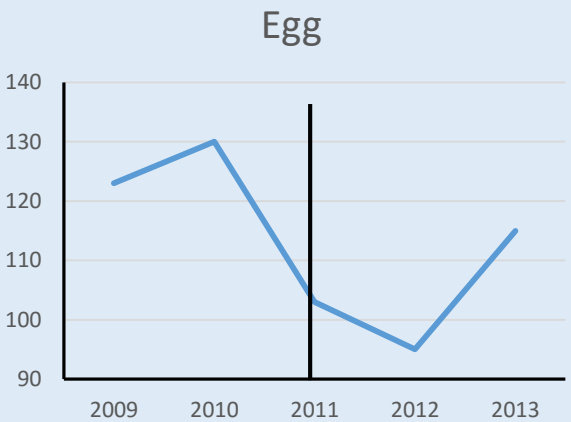












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Motivation of study

- Fukushima and regions near the FDNP need to recover its sales.
- Studies need to be done to understand the characteristics of consumer response toward agricultural products produced near the Fukushima nuclear plant.

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Objectives

- To find out factors and attributes that affect consumers' purchasing behaviors for seven agricultural products produced near the FDNP.
  - Seven products investigated are rice, apple, cucumber, beef, pork, egg, and shiitake mushrooms.
  - This is important for constructing effective marketing strategies.

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Previous Studies

- GM products
  - McCluskey et al. (2003) Consumer response to genetically modified food products in Japan. *Agricultural and Resource Economics Review*
  - Consta-Font et al. (2008) Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. *Food Policy*

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Previous Studies

- Mad cow disease
  - Pennings, J., B. Wansink, and M. Meulenberg (2002) A note on modeling consumer reactions to a crisis: The case of the mad cow disease. *International Journal of Research in Marketing*
- E. coli O157.
  - Brady, J. T., P. Li, and D. Brown (2009) Consumer perception of food-borne illness risks before and after the 2006 E. Coli Events. *Family and Consumer Sciences Research Journal*

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Previous Studies

- Radioactive contamination
  - Ujiie, K. (2012) Consumer's evaluation on radioactive contamination of agricultural products in Japan: decomposition of WTA into a part due to radioactive contamination and a part due to area of origin. *Food System Studies*
  - Yoshida, K. (2013) An econometric analysis of consumer's averting behavior caused by the radioactive contamination of agricultural, forest and fishery products. *Journal of Rural Economics*
  - Aruga, K. (2014) Are environmentally conscious consumers more likely to buy food produced near the Fukushima nuclear plant? An investigation from a consumer survey. *Papers on Environmental Information Science*

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Methods: Economic model

$$WTA_i = x_i'\beta + \varepsilon_i$$

- WTA_i: An indicator variable for the individual's latent WTA value for various agricultural products.
- x_i': A vector of explanatory variables that have potential effects on the willingness to accept for different agricultural products.
- ε_i: A normally distributed error term.

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Methods: Econometric model

- Ordered probit model

$$WTA_i = x_i'\beta + \varepsilon_i$$

$$\mathrm{WTA}_i = \begin{cases} 1 & \text{if } \mathrm{WTA}_i^* \leq 0, \\ 2 & \text{if } 0 < \mathrm{WTA}_i^* \leq 0.6, \\ 3 & \text{if } 0.6 < \mathrm{WTA}_i^*. \end{cases}$$

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Dependent variable

- 1: Willing to purchase the product at zero discount rate.
- 2: Willing to purchase the product at a discount rate between 10% to 60%.
- 3: Not willing to purchase the product even at a 60% discount rate.

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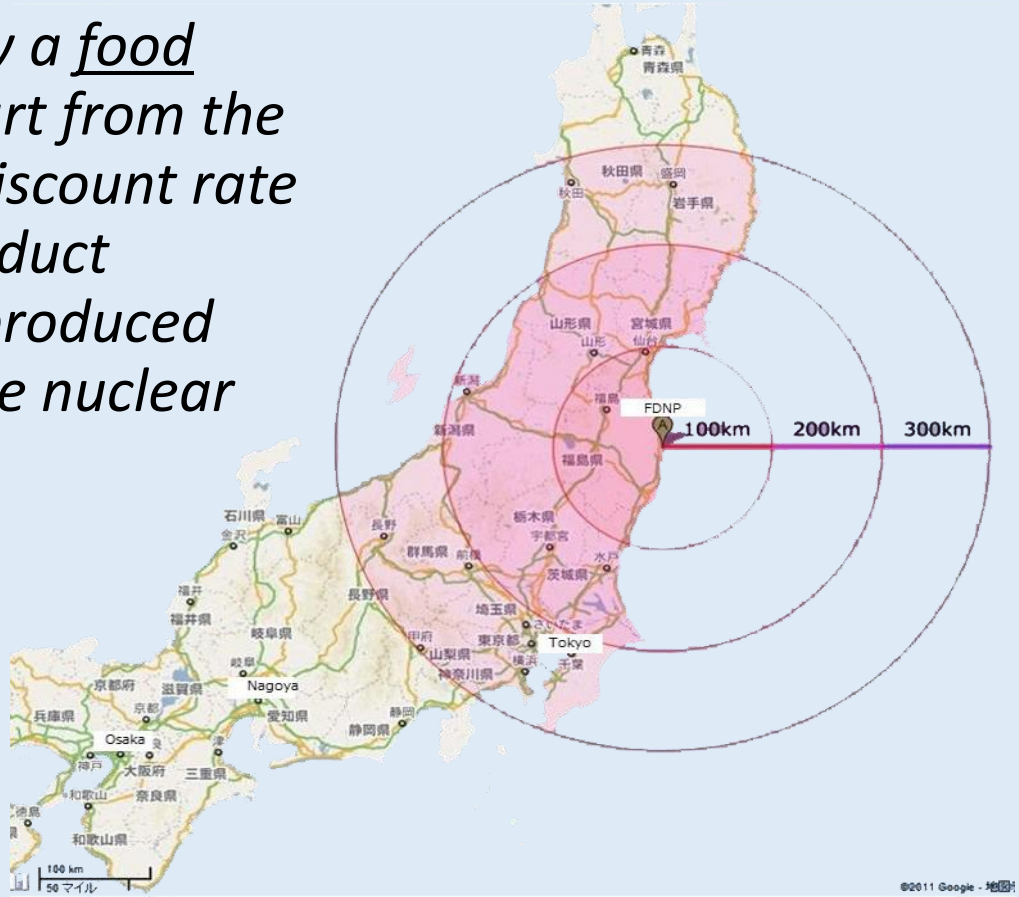
Questionnaire for configuring the consumer's WTA

Are you willing to buy a <u>food</u> produced 100km apart from the nuclear plant if the discount rate was __% for this product compared with one produced 300km apart from the nuclear plant?



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Independent variables

1. Safety: perceptions toward food safety
2. Trust: trust on the current Japanese safety standard
3. Radiation knowledge
4. Risk perception toward radiation-contaminated food
5. Environmental consciousness

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Independent variables: demographic variables

6. Distance of the respondents' dwellings from the nuclear plant
7. Number of children within the household
8. Age
9. Gender
10. Education
11. Income

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Data

- The data is gathered by an internet survey
  - Details of the survey
    - Term of the survey
      - Jan. 30, 2014 ― Feb. 4, 2014
    - Subjects
      - Total of 6945 individuals from all parts of Japan who are between 20 to 69 years of age.
    - Title of the survey
      - “A survey for food safety related to radioactive contamination”

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Age and gender distribution of the sample

	Rice	Apple & Cucumber	Beef & Pork	Egg & Mashroom
Sample size	1710	1757	1768	1710
Male percentage	52.5%	49.9%	52.1%	53.1%
Ages 20-29	15.4%	15.9%	16.2%	15.5%
Ages 30-39	22.6%	22.9%	21.7%	21.8%
Ages 40-49	15.7%	15.1%	17.3%	16.7%
Ages 50-59	18.2%	18.4%	16.5%	18.3%
Ages 60-69	28.0%	27.6%	28.4%	27.8%

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Results of the ordered probit model

	Rice		Apple		Cucumber		Beef		Pork		Egg		Shiitake	
	Coeff.	Z-stat	Coeff.	Z-stat	Coeff.	Z-stat	Coeff.	Z-stat	Coeff.	Z-stat	Coeff.	Z-stat	Coeff.	Z-stat
Safety	0.30 ***	4.48	0.21 ***	3.40	0.18 ***	2.75	0.24 ***	3.74	0.21 ***	3.41	0.23 ***	3.70	0.27 ***	4.30
Trust safety standard	-0.15 ***	-8.12	-0.12 ***	-7.27	-0.11 ***	-6.36	-0.15 ***	-8.48	-0.13 ***	-7.66	-0.14 ***	-7.92	-0.15 ***	-8.38
Radiation knowledge	-0.14 *	-1.78	-0.19 **	-2.53	-0.22 ***	-2.85	-0.23 ***	-3.07	-0.23 ***	-3.16	-0.22 **	-2.00	-0.14	-1.29
Risk perception	0.27 ***	15.39	0.22 ***	13.27	0.23 ***	13.59	0.24 ***	14.81	0.24 ***	14.75	0.21 ***	12.90	0.21 ***	13.03
Distance	0.12 ***	4.43	0.08 ***	2.97	0.09 ***	3.50	0.09 ***	3.27	0.12 ***	4.56	0.07 **	2.47	0.04 *	1.70
Environmental consciousness	-0.09 ***	-4.95	-0.08 ***	-5.14	-0.09 ***	-5.42	-0.05 ***	-3.18	-0.05 ***	-2.90	-0.04 **	-2.26	-0.03 *	-1.66
Children	0.07 **	2.44	0.12 ***	3.76	0.11 ***	3.38	0.09 ***	2.90	0.10 ***	3.41	0.06 **	2.05	0.09 ***	2.82
Age	-0.03	-1.47	-0.03	-1.43	-0.01	-0.48	-0.02	-1.09	-0.01	-0.57	-0.07 ***	-3.36	-0.07 ***	-3.32
Sex	-0.13 *	-1.80	-0.20 ***	-3.01	-0.20 ***	-2.88	-0.29 ***	-4.31	-0.23 ***	-3.44	-0.10	-1.51	-0.04	-0.62
Education	-0.02	-0.80	-0.01	-0.34	-0.01	-0.64	0.00	-0.17	-0.01	-0.30	0.03	1.14	0.01	0.47
Income	0.02	0.96	0.08 ***	3.55	0.06 ***	2.99	0.07 ***	3.29	0.06 ***	2.66	0.03	1.29	0.02	0.88

Note: ***, **, * represent significance at 10%, 5%, and 1% levels.

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Attributes that affect positively on WTA	
Safety	significant in all seven products
Risk perception	significant in all seven products
Distance	significant in all seven products
Children	significant in all seven products
Income	significant in apple, cucumber, beef, and pork

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Attributes that affect negatively on WTA	
Trust on safety standard	significant in all seven products
Radiation knowledge	significant in rice, apple, cucumber, beef, pork, and egg
Environmental consciousness	significant in all seven products
Age	significant in egg and shiitake
Gender	significant in rice, apple, cucumber, beef, and pork

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People who trusts safety standard have lower WTA

Improve safety standard

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Conclusions (cont'd)

People with radiation knowledge have lower WTA

Make people become more knowledgeable about radiation and radioactive materials

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Conclusions (cont'd)

People with interests in environmental problems have lower WTA

Conduct marketing strategies for consumers that are somewhat altruistic

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For further studies

- Are altruistic people more willing to buy food products of regions near the FDNP thinking this will help the economy of these regions?
- How consumers of outside of Japan behaves toward food products of regions near the FDNP?

I am looking for a help with this research!

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Thank you for your attention!

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Acknowledgement

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Independent variables

- Safety
  - Do you put importance on food safety when buying food products?
    - Yes=1, No=0.
- Trust safety standard
  - How much do you trust the current safety standard for radioactive material concentrations in food?
    - Rate your perception on a scale from 1(Do not trust at all) to 10(Highly trust the current standard).

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Independent variables(cont'd)

- Radiation knowledge
  - What do you know about radiation or radioactive materials?
    - There are three types of radiation rays, alpha, beta, and gamma rays, and these rays have different abilities to pass through materials.
    - Radioactive isotopes continue to decay until they become a stable isotope.
    - Among the units to indicate the level of radioactive materials in food, Sievert represents the degree of influence on human body while Becquerel is used to measure the strength of radioactivity.
    - Regardless of human activities, radiation exists in nature such as cosmic rays, earth rays, and so on.
    - It is said that when additional amount of radiation received exceeds 100 mSv the probability of developing cancer in a lifetime increases about 0.5%.
    - I do not know anything about it.
  - The independent variable is created by taking 1 if the respondent had any of the above knowledge about radiation and 0 if he/she picked "I know nothing."

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Independent variables(cont'd)

- Risk perception
  - How do you perceive the risk of radiation-contaminated food sold at groceries after the Fukushima incident?
    - Rate your risk perception on a scale from 1(low risk) to 10(high risk).
- Distance
  - How far do you reside from the Fukushima nuclear plant?

1. Within 100km
2. Between 100km and 200km
3. Between 200km and 300km
4. Between 300km and 400km
5. More or equal than 400km.

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Independent variables(cont'd)

- Environmental consciousness
  - How much are you willing to support environmental activities such as conserving ecosystem and preventing climate change?
    - Rate your perception on a scale from 1(Not willing to attend at all) to 10 (Very much willing to attend).
- Children
  - Number of children under the age of fifteen in your family

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Independent variables(cont'd)

- Age
  - What is your age?
  1. Between 20 to 29
  2. Between 30 to 39
  3. Between 40 to 49
  4. Between 50 to 59
  5. Between 60 to 69
- Sex
  - Are your male or female?
  1. Male
  2. Female

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Independent variables(cont'd)

- Education
  - What is the highest level of school you have completed?

1. Primary and junior high school
2. High school
3. Junior college
4. Some college credit, no degree
5. Bachelor's degree
6. Master's degree
7. Doctorate degree.

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Independent variables(cont'd)

- Annual income
  - What is your annual income for this budget year?

1. Less than two million yen (About 16,700US$)
2. Between two to four million yen
3. Between four to six million yen
4. Between six to eight million yen
5. Between eight to ten million yen
6. Between ten to twelve million yen
7. Between twelve to fourteen million yen
8. Over fourteen million yen (About 116,670US$)

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