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Reputational damage and the Fukushima disaster: an analysis of seafood in Japan

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Abstract As the levels of radioactivity in seafood have fallen back into the safe range, Fukushima fisheries are considering reopening. However, even if seafood from the Fukushima area were sufficiently safe to distribute to seafood markets, its value may be undermined because of the damage done to its reputation by the Fukushima disaster. We quantified consumers' preferences for seafood from Fukushima and adjacent prefectures to examine the extent of the reputational damage to Fukushima seafood. We conducted a choice experiment to measure consumers' willingness to pay for seafood from the Fukushima area. We also measured the impact of displaying ecolabels [Marine Stewardship Council (MSC) and Marine Eco-label Japan (MEL)] on Fukushima products. The results indicated that Fukushima products are considerably discounted compared with products displayed as domestic; even products from adjacent prefectures are substantially discounted. By contrast, consumers positively evaluated locally labeled products. We also found that demersal fish are discounted more than pelagic fish that inhabit the ocean surface off the shore of Fukushima.

Keywords Choice experiment · Consumer preference · Fukushima disaster · Ecolabels

The original version of this article was revised. In the original publication of the article Table 5 is incorrectly published with Price value of "–0.01***" and an S.E. value of "0.00" missing. The correct version is updated in this original article.

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Introduction

A huge earthquake and concomitant tsunami hit the east coast of Japan on March 11, 2011, causing a meltdown incident at the Fukushima Daiichi Nuclear Power Plant (FDNP) (Tabuchi H, Sanger DE, Bradsher K, http://www.nytimes.com/2011/03/15/world/asia/15 nuclear.html, accessed 10 August 2017). At the same time, radioactively contaminated water was discharged into the Pacific Ocean, leading to a surge in radioactivity levels [1], negatively affecting marine life in the corresponding areas (Fig. 1). Even after the disaster, there were frequent leaks from the FDNP, which discouraged seafood consumers in Japan (Tabuchi H, http://www.nytimes.com/2013/08/21/world/asia/300-tons-of-contaminated-water-leak-from-japanese-nuclear-plant.html, accessed 10 August 2017). Accordingly, fishing operations in Fukushima were stopped until the radioactivity in seafood returned to safe levels. The Fukushima Fisheries Association set 50 Bq/kg as the safe level for shipping its products to market [2], while 1000 and 100 Bq/kg are the safe levels set by the Food and Agriculture Organization of the United Nations [3] and by the Japanese Government [4], respectively. The level of radioactivity in the Fukushima area has gradually declined to the safety level, and correspondingly, the radioactivity level in seafood has also declined [5–7].

Figure 1 illustrates that the number of test samples of seafood caught in the Fukushima area exceeding 100 Bq/kg decreased to zero after the second quarter of 2015, and no seafood has tested above this threshold since then. Limiting fishing to species that have not exceeded 50 Bq/kg for a while, the Fukushima Fisheries Association has started a trial fishing operation, with products being shipped to the market [2]. Although this trial operation currently runs once or twice a week, the association is aiming to gradually

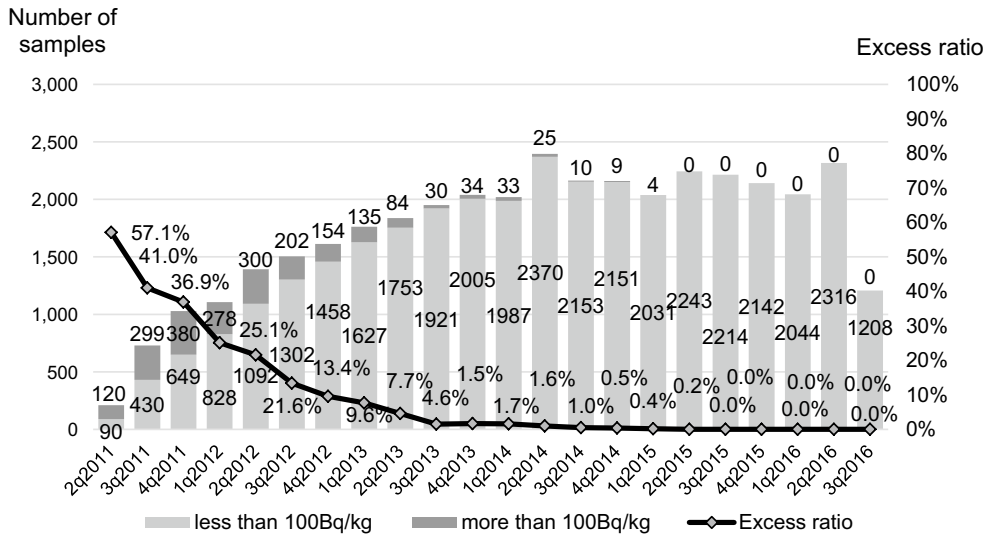

Fig. 1 Concentration of cesium in fishery products after Fukushima disaster, published by Fishery Agency (http://www.jfa.maff.go.jp/e/inspection/, accessed 10 November 2016), showing that no seafood has exceeded the criterion since the second quarter of 2015

increase its frequency with the goal of returning to the pre-quake level (Hirakawa N, pers. comm., 2013).

Table 1 lists all 73 species included in the above-mentioned trial operation in Fukushima. Although the landings of the trial operation are sold in local markets, the market remains limited, and thus these data are not useful as market data. The Tokyo Electric Power Company (TEPCO) currently compensates fishers with the landing value that they earned before the quake. The landing value from the trial operation is subtracted from this compensation when a trial operation is implemented. Therefore, the landing value of the trial operation does not matter to Fukushima fishers. Rather, they have implemented the fishing operation to maintain their fishing skills so they can restart operations and pass these skills onto the next generation (Hirakawa N, pers. comm., 2013). However, even if fisheries in Fukushima could resume their operations and ship their products to markets, there is still a huge concern about how consumers would react: Would Japanese consumers purchase seafood from Fukushima? If consumers' preferences for Fukushima seafood are impaired, the products would not be competitive in the market, and fishers would be forced out of business immediately after they reopened their fisheries.

The main objective of this study is to examine whether Fukushima seafood is competitive against other domestic products, and if not, what Fukushima fisheries can do to survive. We compared consumer preferences for Fukushima products with those from adjacent and other domestic areas to find any disparity between them. This study compares

Table 1 Species in trial operation as of May 2016 ($n = 73$) Source: Fisheries Agency

Species sorted by major categories

[Fish] 47 species

Aomeeso, plaice, *Doederleinia berycoides*, Pacific ocean perch, Ishikawa shirauo, black scraper, multi-necked giant sea bass, kagamidai, *Lepidotrigla microptera*, amberjack, *Lophius litilon*, felicity, kounago, southern mackerel, komonfugu, shark-skin flounder, halfbeak, Spanish mackerel, shousaifugu, shirauo, whitebait, chum salmon, pollock, souhachi, hairtail, chidai, tiger puffer, higanfugu, hireguro, yellowtail, gurnard, smooth dogfish, horse mackerel, sardine, littlemouth flounder, mackerel, red sea bream, cod, John Dory, balloonfish, migigarei, mushigarei, ridged-eye flounder, medal, willow mushigarei, and *Helicolenus hilgendorfii*

[Crustaceans] 8 species

Blue crab, horsehair crab, snow crab, higoromoebi, hiratsumegani, benizuwaigani, button shrimp, and northern prawn

[Cephalopods] 7 species

Kensaki cuttlefish, jindouika, sagittated calamary, octopus, *Enteroctopus dofleini*, yanagidako, and squid

[Shellfish] 9 species

Abalone, clams, ezoboramodoki, Shiraitomakibai, chijimiezobora, nagabai, himeezobora, Sakhalin surf clam, and mosusogai

[Others] 2 species

Okinamako, sea urchins

domestic products to standardize consumers' preferences for target species.

A growing body of literature has studied consumers' preferences for Fukushima products. Among contingent valuation methods, Ujiie first investigated consumers' preferences for Fukushima spinach and milk in 2012 [8], concluding that consumers may possibly purchase contaminated food based on their evaluation of the health risks. Aruga also investigated consumers' preferences for eight Fukushima products (rice, apples, cucumbers, beef, pork, eggs, shiitake mushrooms, and water) and found a negative willingness to pay (WTP) for all products in 2014 [9]. Both studies used the contingent valuation method (CVM) for their investigations. The Consumer Affairs Agency has conducted a survey each year since 2012, showing that Japanese consumers avoid produce and seafood from the Fukushima region because of fear of radioactive contamination (Consumer Affairs Agency, http://www.caa.go.jp/safety/pdf/130311kouhyou_1.pdf, accessed 13 May 2013). Regarding seafood, Wakamatsu and Miyata used market data from Tsukiji Market [10], and found that radioactivity levels (although not from Fukushima) have negatively affected the cod market in Japan. However, to date, no research has been conducted on consumers' preferences for Fukushima seafood, because Fukushima fisheries have been suspended. Looking toward their reopening, it is necessary to understand the potential demand for Fukushima seafood and develop an approach that reduces consumers' anxiety about radioactive contamination.

Inspection of radioactivity levels in seafood would be a major remedy to address consumers' anxiety about radioactive contamination. However, at present, radioactivity inspections are not carried out for all seafood products [4]. Additionally, the test involves destructive inspection, meaning that seafood that consumers eat is not inspected. Although a nondestructive testing method has been developed for some species and introduced at some fishing ports near Fukushima, this test is still based on random sampling (Ministry of Health, Labor, and Wealth, http://www.mhlw.go.jp/topics/bukyoku/iyaku/syoku-anzen/iken/dl/160210-1-miyagi-3.pdf, accessed 21 July 2017). Since not all seafood is tested, but randomly sampled, it is impossible to remove anxiety completely. In addition, while seafood safety information related to radioactive contamination might remove anxiety, it might also adversely affect consumers' preferences. Indeed, some researchers have found that consumers lower their preference for seafood once reminded about the radioactivity issue [11, 12]. Furthermore, compared with specific radioactive-free labeling [13], an indirect image of food safety is more effective in lessening reputational damage.

One option would be to sell seafood without reminding consumers about the radioactivity problem. However, the Act for the Standardization and Proper Labeling of Agricultural and Forestry Products (Paragraph 13, Article 19) obligates firms to display a product's place of origin. Since "Fukushima" is directly connected in consumers' minds with the FDNP disaster, it is difficult to avoid an adverse effect when it appears on products.

Hence, instead of displaying the place of origin, local areas could be used. Local labeling is effective when food regulatory agencies are not trusted by consumers [14]. The survey we conducted in this study showed that 55 % of respondents did not trust the information from the government. After the FDNP disaster, the government and TEPCO were criticized for failing to provide "disaster planning and crisis management" [15], which might undermine trust in the government. Local labeling might therefore compensate for the economic loss caused by the FDNP disaster.

Sustainable ecolabels are an alternative option. Ecolabeling indicates sustainable seafood, which has nothing to do with radioactive contamination; however, it is possible that it adds substantial value to seafood. A rich literature has discussed the price premium on applying ecolabeling [16–18]. In addition, Fukushima fisheries may qualify for Marine Stewardship Council (MSC) certification because no stock has been taken since 2011. Moreover, quality standards are not part of the criteria, so there are no guidelines concerning radioactivity levels.

The MSC assesses the legal framework that forces fisheries to test the radioactivity level of these products. If the fisheries comply with the laws, seafood safety from radioactive contamination is integrated into MSC certification. In addition, Fukushima Prefecture has considered introducing ecolabels as a measure to add value to its fisheries [19]. In this study, we thus introduce these two labels to understand countermeasures that might lessen the economic impact on Fukushima seafood, given the considerable damage to its reputation.

Materials and methods

Since there are no reliable market data, we used an experimental method in a hypothetical setting to elicit consumer preferences. There are several methods for use in hypothetical settings, including auction, contingent valuation, and choice experiments. The auction method is probably the best way to calibrate consumers' willingness to pay (WTP) for seafood, because the method involves a payment obligation on auction winners, which makes the bids placed by participants realistic. However, to conduct an auction, one would need either actual Fukushima seafood products, which are not currently available, or a special connection to the Fukushima fisheries. Both the contingent valuation method (CVM) and choice experiment are also realistic alternatives to measure WTP for Fukushima products. We

chose the choice experiment method because it measures not only the WTP for seafood, but also several detailed attributes, such as the value of origin or ecolabels, which suits our objective in this study.

We conducted the choice experiment in November 2015 with Japanese seafood consumers. Cross Marketing Inc. recruited participants, and the sample used was consistent with the national demographic profile of Japan. Although products from Fukushima used to be distributed in the area near Fukushima, including Tokyo, in this study we targeted general domestic seafood consumers because our aim was to estimate the preferences of general domestic consumers of Fukushima seafood and understand the potential demand in the domestic market. Table 2 presents an example of the choices with which participants were faced.

We selected five attributes to estimate consumers' WTP: price, origin, local label, ecolabel, and product type, as shown in Table 3. The levels of the price attribute were set according to market prices for two fillets of cod *Gadus macrocephalus* (125 g) and boiled whitebait *Engraulis japonicus* (80 g), which had the largest catches in Fukushima before the 2011 disaster. Cod is a demersal species, while whitebait resides near the ocean surface. Theoretically speaking, one can estimate WTP using two points with double-bounded choice CVM, and 2 or 3 levels of the attribute are sufficient when there are 5 or 6 attributes [20, 21].

The literature has discussed contamination of benthic species by radioactive material [6]. Consumers also regard radioactive materials as falling to the seafloor. Thus, we also explored the differences between demersal and pelagic species. In addition, the choice experiment was conducted in the fall, when these two products are popular with consumers.

The origin attribute included Fukushima, adjacent prefectures (Miyagi and Ibaraki Prefectures), and other domestic prefectures. The fisheries in the targeted prefectures share the same offshore fishing grounds as a common pool resource; hence, the fishery products from this area are shipped to any of the markets in these prefectures. Consequently, this design explores whether reputational damage affects not only products from Fukushima, but also those from adjacent prefectures. The local label attribute had seven levels: Shiogama, Ishinomaki, Soma, Iwaki, Joban, Hazaki, and no label as a reference. Local labels were selected from among the large landing ports around these areas. As confounding effects between prefectures and local areas will exist, we needed to factor out the effect of this interaction in the econometric analysis.

Table 3 Attributes of choice experiment

Attribute	Level	Alternative
Price	1	170 yen
	2	298 yen
Origin	1	Domestic
	2	Miyagi Prefecture
	3	Fukushima Prefecture
	4	Ibaraki Prefecture
Local label	1	No label
	2	Shiogama
	3	Ishinomaki
	4	Soma
	5	Iwaki
	6	Joban
	7	Hazaki
Ecolabel	1	No label
	2	MSC
	3	Marine Eco-label Japan (MEL)
Product type	1	Cod fillet
	2	Boiled whitebait

Ecolabels are also considered to be an alternative option for promoting Fukushima seafood. The moratorium in 2011 increased the stock in the fishing grounds of Fukushima, which allows Fukushima fisheries to qualify more easily for this kind of sustainable certification. In this study, we chose two label alternatives: MSC certification as a representative ecolabel, and MEL as a domestic one. Participants were provided with the following basic information on ecolabels before they made their decisions: "The following labels are called ecolabels. They are given to fisheries that do not overfish, minimize the impact on the ecosystem, and operate within legal frameworks. The MSC ecolabel is a globally distributed scientific fair label. MEL is certified by the Japan Fisheries Association." Table 2 presents an example of the choice card used in this study.

We designed the choice experiment so that the design was D-optimal using the R code "optFederov" in the AlgDesign package. However, the R code created unrealistic

Table 2 Example choice card

Items	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5
Origin	Miyagi	Fukushima	Ibaraki	Domestic	Not purchase
Local label	Ishinomaki	–	Hazaki	Iwaki	
Ecolabel	MEL	MSC	–	MEL	
Price (yen)	170	170	298	170	
Product	Cod fillets	Boiled whitebait	Boiled whitebait	Cod fillets	

combinations between prefectural origins because not all local areas belong to the same prefectures; For instance, Iwaki belongs to Fukushima Prefecture, but not to Miyagi and Ibaraki. Automatic programming sometimes created a choice card with Miyagi and Soma. Such unrealistic choices for consumers would bias the estimation when they are aware of these locations. In the survey, we asked whether participants recognized the location of local ports and the prefectures. Nearly 30 % of participants were aware of all the prefectures of the local fishing ports (Table 4). We therefore excluded unrealistic combinations from the design of the choice experiment. However, this exclusion may affect the D-optimality of the experimental design and create a confounding effect in the estimation. We treated this issue by introducing interaction terms between origins and local ports in the regression to factor out confounding effects.

Conceptual framework

Choice experiments are based on the random utility model. Suppose that the utility function U_{ij} of individual i to choose a seafood product is as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \tag{1}$$

where V_{ij} is a deterministic component that is a function of $f(\boldsymbol{x}_{ij})$. $\mathbf{x}_{ij}$ is a vector of the alternatives consisting of price, origin, local label, ecolabel, and product type. ε is an error term. The probability of U_{ij}, choosing the jth alternatives among the set of C, can be expressed using a conditional logit model as follows:

$$\text{Prob}(V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik}; j \neq k, \forall k \in C). \tag{2}$$

If the error term is independently and identically distributed with an extreme value distribution, the probability is expressed in the form of a conditional logit model:

$$L_i(j|\beta) = \frac{\exp\left(\beta \boldsymbol{x}_{ij}\right)}{\sum_{k \in C} \exp\left(\beta \boldsymbol{x}_{ik}\right)}. \tag{3}$$

The logarithmic form of the function to maximize is expressed by

$$\ln L = \sum_{i=1}^{I} \sum_{j=1}^{J} d_{ij} \ln\left(L_i\right), \tag{4}$$

Table 4 Descriptive statistics of the survey participants

Variable	Mean	SD	Description
Female	0.55	0.50	1 if female
Married	0.68	0.47	1 if married
Child	0.55	0.50	1 if child present
High education	0.44	0.50	1 if college or more
High income	0.15	0.36	1 if income >9 million yen
Low income	0.25	0.43	1 if income <3 million yen
Housewife	0.20	0.40	1 if housewife
Executive officer	0.06	0.24	1 if manager or more
Origin lover	0.61	0.49	1 if care about origin
Know MSC	0.15	0.36	1 if aware of MSC
Know MEL	0.15	0.36	1 if aware of MEL
Place recognition	0.28	0.45	1 if aware of all places displayed in survey
High cons (WH)	0.06	0.24	1 if eat whitebait every 2 weeks or more
High cons (Cod)	0.01	0.11	1 if eat cod ever 2 weeks or more
Low cons (WH)	0.64	0.48	1 if eat whitebait every 2 months or less
Low cons (Cod)	0.76	0.43	1 if eat cod every 2 months or less
Trust government	0.46	0.50	1 if trust test result by government
Trust nat institute	0.38	0.49	1 if trust test by the national research institute
Trust cons group	0.40	0.49	1 if trust test by consumer groups
Trust retailers	0.12	0.32	1 if trust test by retailers
Trust fish coops	0.20	0.40	1 if trust test by fishery cooperatives
Trust none	0.22	0.41	1 if trust none
Responsibility	0.26	0.44	1 if think him/herself responsible
Healthcare	0.13	0.33	1 if try to keep him/herself healthy
Fish expenditure	1381	1325	Expenditure on seafood per week in yen

Note: $N = 2378$ (871 were not seafood consumers and were excluded, while 751 were randomly removed because of uneven sampling by Cross Marketing)

where d_{ij} is a dummy variable taking the value 1 if i chooses alternative j.

Results

We obtained 4000 participant responses from the Internet survey; however, the effective number of observations was 2378. Cross Marketing Inc. failed to sample considering the Japanese age structure, and recruited a disproportionate number of participants in their 60s and 70s compared with other ages (Fig. 2, Appendix). We therefore randomly sampled the skewed group to reflect the proportion identified in statistics of the Japanese population (Fig. 3, Appendix). Thus, we removed 751 participants in their 60s and 70s. We also excluded 871 participants who do not purchase seafood. Since we recruited from a population similar to that of Japan, the age, gender, and region profiles in our study are representative of the demographics of Japan. Further, while adopting an Internet survey limits participants to web users, our sample was selected to be consistent with Japanese social and demographic statistics so that participants' age, gender, and residence areas correspond to actual Japanese statistics. Accordingly, the 2378 participants represented general Japanese seafood consumers.

Table 4 presents the descriptive statistics of the participants. Recognition of MSC certification and MEL Japan was around 15 %. More than one-quarter (27 %) of participants were aware of the prefectures in which the local fishing ports are located. Most rarely consumed cod and whitebait, because both species are seasonal products. They trusted the test results for the level of radioactive substances by the government, rather than consumer groups, national research institutes, or retailers. One-fifth did not trust any information at all. The consumption pattern of cod and whitebait was typical: whitebait is used for various dishes in Japan, at a frequency higher than cod. Since consumption of cod is limited to winter, its consumption frequency is lower than that of whitebait. However, this does not necessarily mean that respondents do not eat cod (although this may affect the estimation).

Table 5 compares the estimation results of the two models, with and without the interaction terms between prefectures and local labels. In the basic model without interactions, all variables were significant. The marginal WTP (MTWP) for cod fillets and boiled whitebait was 150 and 153 yen, respectively. Although the market prices for cod and whitebait are 289 and 170 yen, respectively, the estimated prices are similar to each other. It therefore follows that the MWTP for cod, a demersal species, is lower than that for whitebait, a pelagic species. When we introduced the interaction between cod and Fukushima, participants especially avoided cod (−11 yen) caught in the Fukushima area compared with whitebait.

All the MWTPs for the prefectures had negative values compared with those of domestic origin. In particular, respondents devalued seafood by 94 yen when it came from Fukushima. The prices in Miyagi and Ibaraki, adjacent to Fukushima Prefecture, were also more than 50–60 yen lower than those of other domestic products. However, most local labels had positive MWTP compared with unlabeled products. Only when the product came from Soma, which is closest to the FDNP, was the MWTP lower than that for unlabeled products. Further, ecolabels were positively evaluated: if an MSC (MEL) label was applied to seafood, participants were willing to pay 75 (56) yen more for labeled compared with unlabeled seafood.

In the interaction model, the coefficients of the main effects were similar to those of the basic model, showing that both models are robust. There may be a possibility of a confounding effect between prefectures and local places; however, according to the results, this effect was not severe and the interaction terms captured it successfully. The MSC and MEL labels were less effective when applied to Fukushima products because the MWTP of the interactions between Fukushima and MSC or MEL was −35 and −21, meaning that the 88 yen MSC premium was reduced by 35 yen when the MSC logo was applied to Fukushima products. The interaction between Fukushima and Joban was 9 yen, while the other interactions between prefectures and local places were also positive. This study also found a significant disparity of WTP between cod and whitebait when interacting with Fukushima, suggesting that consumers regard demersal fish as more dangerous species than species that live near the ocean surface.

Discussion

The results of this study have important market implications for Fukushima seafood. When marketers apply any prefectural brand name, especially the Fukushima brand, participants will substantially devalue the seafood. According to the results, the Fukushima brand has been devalued among seafood consumers because of the radioactively contaminated water from the FDNP. To consolidate brand equity, brand awareness and brand recall are thus necessary [22]. Consumers have been exposed to news about water leaks from FDNP, which may lead to negative brand awareness and recall of Fukushima. Similarly, products from the adjacent Miyagi and Ibaraki Prefectures have also become devalued because of the adverse effects of the FDNP disaster. This result concurs with that of an existing study that reputational damage is proportional to distance from the FDNP [9].

The application of local brand names is much more successful than prefecture brands. Under Japanese law, the place of origin must be displayed for fresh seafood. However, if local labels are applied, products still meet the standard of the law. Application of a local brand name will thus lessen the reputational damage to Fukushima seafood. It is known

Table 5 Estimation results of choice experiment

	Basic Model				Interaction Model			
	Coeff.		S.E.	MWTP	Coeff.		S.E.	MWTP
Main Effects								
Price	−0.01	***	0.00		−0.01	***	0.00	
Fukushima	−0.84	***	0.03	−94	−0.76	***	0.05	−84
Miyagi	−0.52	***	0.04	−57	−0.53	***	0.04	−59
Ibaraki	−0.44	***	0.04	−49	−0.40	***	0.04	−44
Iwaki	0.11	***	0.03	12	0.14	***	0.04	15
Soma	−0.11	***	0.03	−12	−0.10	***	0.04	−11
Joban	0.21	***	0.03	24	0.17	***	0.03	19
Hazaki	0.24	***	0.03	26	0.19	***	0.04	21
Shiogama	0.44	***	0.03	49	0.36	***	0.04	40
Ishinomaki	0.54	***	0.03	59	0.45	***	0.04	49
MSC	0.68	***	0.02	75	0.79	***	0.03	88
MEL	0.50	***	0.02	56	0.55	***	0.02	61
Whitebait	1.38	***	0.04	153	1.37	***	0.04	151
Cod	1.36	***	0.04	150	1.38	***	0.05	152
Interactions								
MSC × Fukushima					−0.32	***	0.05	−35
MEL × Fukushima					−0.19	***	0.05	−21
Fukushima × Soma					−0.22	***	0.07	−24
Fukushima × Joban					0.08	*	0.05	9
Miyagi × Shiogama					0.15	***	0.05	17
Miyagi × Ishinomaki					0.20	***	0.05	22
Ibaraki × Hazaki					−0.08		0.05	−9
Ibaraki × Joban					−0.34	***	0.05	−37
Fukushima × Cod					−0.10	***	0.03	−11
Likelihood	−55401				−55323			
LR chi square	10609.4				10904.0			
Prob > chi square	0.0000				0.0000			
Pseudo R^2	0.095				0.0965			

Note: The number of observations is 190,240 for both models.

that local labels have strong brand value in local areas [23]. In Japan, distant places from the investigated areas can be considered local brands compared with other large countries.

Ecolabels are also effective at improving the value of seafood from Fukushima. Although the labels were depreciated when applied to Fukushima products, the combination of ecolabel and local label was estimated to attract a positive premium for Fukushima products. Accordingly, depending upon the strategy, Iwaki and Joban products can be profitable even though they come from Fukushima Prefecture. This result supports the recovery plan of Fukushima Prefecture, which has encouraged increased use of sustainable certification [19].

The cost of MSC certification depends on the size and kinds of fisheries but ranges from approximately 2000 USD to 20,000 USD for pre-assessment, and 10,000 USD to 500,000 USD for full assessment and certification [24]. This is not a trivial cost, but a study suggests that the costs of MSC certification for a fishery in Japan would be recovered within 5 years through a 9 % price premium [25]. Fukushima Prefecture has disclosed its recovery plan and direction, which includes sustainable certification for the Fukushima fisheries [19]. Another possible approach to pay for the certification fee would be if the Fukushima fisheries could request that the Tokyo Electric Power Company (TEPCO) subsidize the MSC certification fee for fisheries to recover from the Fukushima disaster (Hirakawa N, pers. comm., 2013). Thus, public and private subsidies are both possibilities for fisheries.

The Tokyo Olympics will be held in 2020. Considering that two consecutive Olympics have used sustainable

seafood [MSC- or Aquaculture Stewardship Council (ASC)-certified], the Tokyo Organising Committee of the Olympic and Paralympic Games (TOCOG) has set MSC, ASC, MEL, and Aquaculture Eco-label Japan (AEL) as recommended sustainable seafood for use in the upcoming Olympics (TOCOG, Procurement criteria for sustainable food, web: http://www.kantei.go.jp/jp/singi/Tokyo2020_suishin_honbu/shokubunka/dai2/siryou2.pdf, 13 April 2017). Considering this trend, qualification of Fukushima fisheries as sustainable fisheries could attract the audience through their story of disaster recovery.

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Appendix

See Figs. 2 and 3.

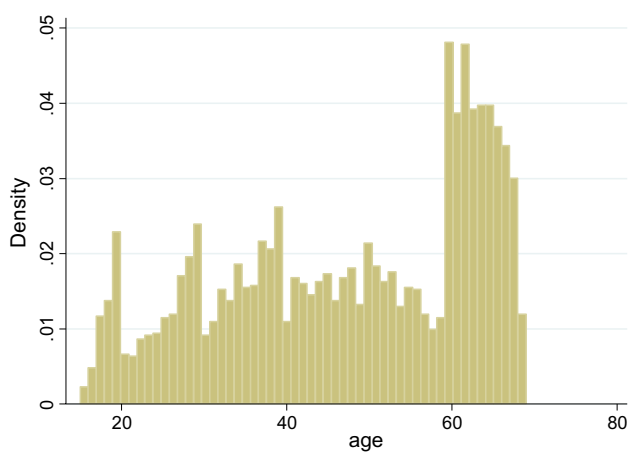

Fig. 2 Skewed samples in their sixties and seventies, obtained by the web survey in this study. We randomly removed some participants from these age groups so that the distribution of age groups was consistent with Japanese statistics

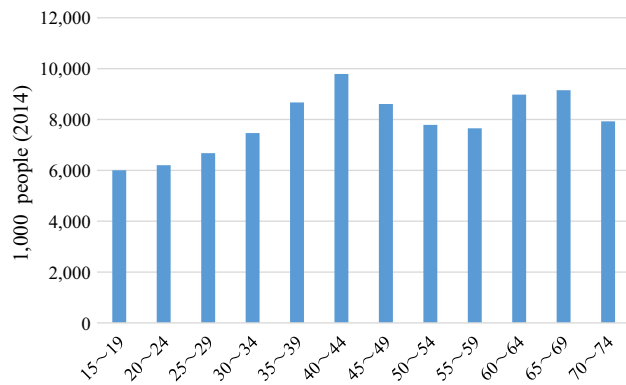

Fig. 3 Statistical distribution of age groups in Japan estimated by Ministry of Internal Affairs and Communications (http://www.e-stat.go.jp/SG1/estat/List.do?lid=000001177743, accessed 24 October 2016)

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