An Analysis of Introducing Unspawned Oysters in Japan Using a Contingent Valuation Method and Analytic Hierarchy Process

Wakamatsu, Hiroki and Miyata, Tsutom and Kamiyama, Ryutaro

National Research Institute of Fisheries Science, Fisheries Research Agency, Japan, National Research Institute of Fisheries Science, Fisheries Research Agency, Japan, National Research Institute of Fisheries Science, Fisheries Research Agency, Japan

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Hiroki Wakamatsu*
Tsutom Miyata†
Ryutaro Kamiyama††

Abstract

Demand for unshelled oysters has recently risen in Japan as oyster bars gain popularity among consumers. This study undertook consumer preference research to evaluate a new brand of unspawned oysters, "Amakoro," compared with conventional oysters. We surveyed the willingness-to-pay (WTP) for both oyster types as well as consumers' evaluation of the oysters' appearance, fragrance, taste, and texture. Based on contingent valuation method and analytic hierarchy process, we analyzed how much each factor of consumers' tastes explains WTP. The results show that Amakoro is preferred to the conventional oyster in terms of appearance, which is positively correlated to WTP, while the conventional oyster is inelastic to any kind of taste factors, but has a robust value. In addition, the results show that WTP largely depends on the characteristics of location and consumption pattern of oysters.

Keywords: AHP, Consumer Preference, CVM, Japan, Oyster, WTP
JEL Code: Q22, M31, D4

* Corresponding Author, National Research Institute of Fisheries Science, Fisheries Research Agency, Japan, 2-12-4, Fukuura, Kanazawa, Yokohama, 236-8648, Japan, phone/fax +81-45-788-7677, email: hwakamatsu@affrc.go.jp

† National Research Institute of Fisheries Science, Fisheries Research Agency, Japan, 2-12-4, Fukuura, Kanazawa, Yokohama, 236-8648, Japan, tmiyata@affrc.go.jp

†† National Research Institute of Fisheries Science, Fisheries Research Agency, Japan, 2-12-4, Fukuura, Kanazawa, Yokohama, 236-8648, Japan, rkamiyama@affrc.go.jp

1. Introduction

The Great East Japan Earthquake and collateral tsunamis caused critical damage to all aquaculture facilities for oysters, *Crassostrea gigas*, in Miyagi Prefecture. The Japanese government immediately developed a recovery plan and attempted to recover the damaged facilities, including the oyster-processing factories. However, even after the production facilities were recovered, oyster sales in Miyagi declined, reaching one-fourth of production before the earthquake, due to labor shortages and various other reasons (Tohoku Regional Agricultural Administration Office, 2014). In addition, staffing constraints and high wage rates make production of shelled oyster less profitable (Okuda, sales head in Miyagi Fisheries Cooperative, personal communication, February 2, 2014).

In order to improve profit structure, Miyagi Prefecture and Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) launched a project after the earthquake to introduce a brand new high-quality oyster. Before the earthquake, the oyster industry in Miyagi focused on shelled raw oysters. However, considering the recent increment in demand for oyster bars and restaurants in Japan, production of unshelled oysters is expected to improve profit structure.

The "Amakoro oyster" is a cultchless[1] (single-seed) unspawned[2] oyster that is characterized as smaller, sweeter, and more pure-tasting than conventional oysters (Kahoku Shinpo, 2015). It enables oyster producers to cut costs because the shells do not have to be removed and its production cycle is one year, whereas conventional oysters take more than two years. However, since demand for this new oyster type is unknown, it is necessary to ensure that it gains popularity among consumers. This study investigates consumer preference for Amakoro oyster compared with the existing brand made in Kamaishi, Japan (Kamaishi oysters).

Little literature exists on consumer preference for oysters. Grabowski, Powers, Peterson, Powers, and Green (2003) examined US consumer ratings of non-native and native oysters. They investigated whether US consumers prefer native oysters to non-native oysters with regard to taste. However, since their findings are limited to quality measures between the two oyster types, it is unclear if preference in taste is directly connected to willingness-to-pay (WTP). While WTP has been measured in many studies, there is little literature about WTP for oysters (Alfnes, Guttormsen, Steine, & Kolstad, 2006; Johnston & Roheim, 2006; Nguyen, Haider, Solgaard, Ravn-Jonsen, & Roth, 2015; Quagrainie & Engle, 2006; Wirth, Love, & Palma, 2007). Although Nguyen et al. (2015) measured WTP for oysters compared to other seafood, no researcher has decomposed the WTP into quality measure, such as tastes, appearances, flavors, and texture, for better marketing.

Will Amakoro oysters attain popularity and obtain the necessary WTP among customers? Targeting customers in oyster bars, we surveyed consumer preference for Amakoro oysters over

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[1] The single-seed oyster is separated from a hatchery, set on an oyster shell (cultch), and grown in clusters separately.

[2] Ordinary oysters are delivered after spawning season due to size limitations, but the production process of Amakoro is adjusted so that these oysters can be delivered before the spawning season.

conventional rivals at oyster bars in Japan. This study has a twofold approach. We first calibrate consumers' subjective evaluations for Amakoro and Kamaishi oysters to build quality indicators using analytic hierarchy process (AHP). Then, we adopt a contingent valuation method (CVM) to investigate how WTP is attributed to the AHP indicators and other socio-demographics.

2. Data

In order to investigate consumer preference at oyster bars, we sought the cooperation of Humanweb Inc., which is the largest oyster bar company in Japan, to implement survey research at its oyster bars. For comparison, since Amakoro oysters are distributed in summer, we use oysters from Kamaishi, which are also traded in summer. We had both Amakoro and Kamaishi oysters delivered to oyster bars, and asked Humanweb's customers to taste and compare them.

The survey was undertaken at five oyster bars around the Greater Tokyo area since most oyster bars (21 out of 30 Humanweb bars in Japan) are located there (Humanweb, October 27, 2015, www.oysterbar.co.jp/shop). The survey is available upon request. We attempted to obtain 150 to 200 samples (30 to 40 samples at each bar), but managed to obtain only 127 samples.[3] Removing irrational and invalid responses, the effective sample size was 109.

Table 1. Age and Gender of Respondents

Age/Gender	Male	Female	Total (%)
10s	0	1	1 (1)
20s	3	30	33 (30)
30s	11	18	29 (27)
40s	18	14	32 (29)
50s	6	4	10 (9)
60s	2	0	2（ 2）
70s or older	2	0	2（ 2）
Total	42	67	109（100）

Table 1 tabulates the composition of respondents in terms of age and gender. Those aged in their 20s, 30s, and 40s comprise 86% of all respondents, which indicates that oyster bars are popular among the younger age group in Tokyo, given random extraction of the sample from oyster bar consumers in Tokyo. As for gender, there are more female customers than males in the younger age groups while the proportion of males increases with customer age.

Figure 1 shows the number of visits to oyster bars per year among respondents. Most consumers visit oyster bars two to three times per year, which is once every two to four months per year. On the other hand, a few consumers visit oyster bars more than once per month (12 times/year). It follows

[3] In 2015, 1,500 Amakoro oysters were due to be delivered to Humanweb oyster bars, but due to timing delays of the harvest, only 150 Amakoro oysters ended up being delivered.

that most consumers do not visit oyster bars very often.

Table 2. Surveyed Stated Preference

	Mean	Std. Dev.	Min. Price	Max. Price
Amakoro	411.8	160.2	100	950
Kamaishi	470.7	136.4	150	880
Difference	-58.9	114.4	-400	300

Table 2 shows the summary statistics of responders' WTP for Amakoro and Kamaishi oysters, evaluated in yen. Both standard deviations are small and the variance of these preferences is relatively small. However, the standard deviation of price difference between Amakoro and Kamaishi oysters (Difference = Amakoro – Kamaishi) is larger than the mean value. This study utilized these preferences and using CVM, estimated WTP for both oysters.

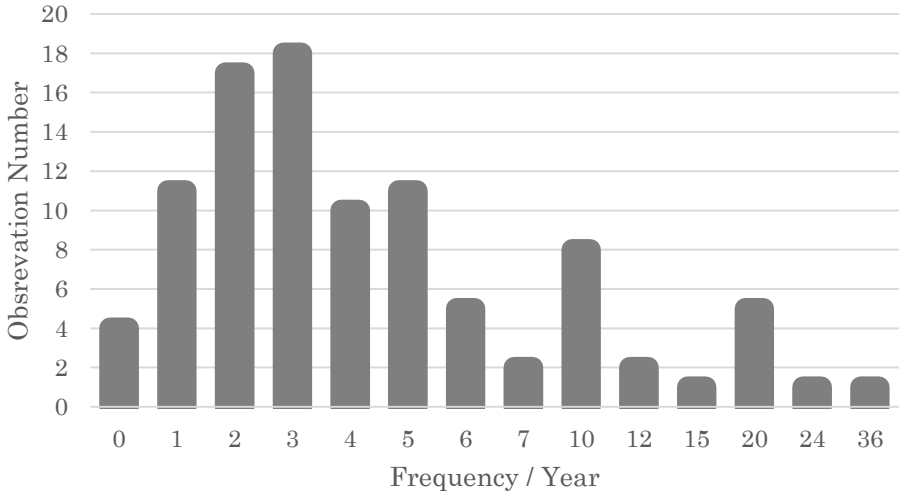

Figure 1. Frequency of Oyster Bar Visits

3. Material and Method

We first calibrate consumers' evaluation of both oysters by AHP, and then, we analyze their WTP, including AHP indicators, other control variables, and dummy variables in CVM. Accordingly, we first explain AHP theoretically and practically, followed by CVM.

3.1. Analytic Hierarchy Process

AHP was developed by Saaty in the 1970s in order to quantify various choices to set priorities. (Saaty, 1977). AHP is applied to a variety of fields since it enables researchers to quantify any kind of comparable targets by a pairwise comparison method. We need to set a goal and targets for evaluation,

such as Amakoro and Kamaishi oysters, to determine priorities based on evaluation criteria, and then, to judge the targets. Figure 2 shows this study's AHP structure.

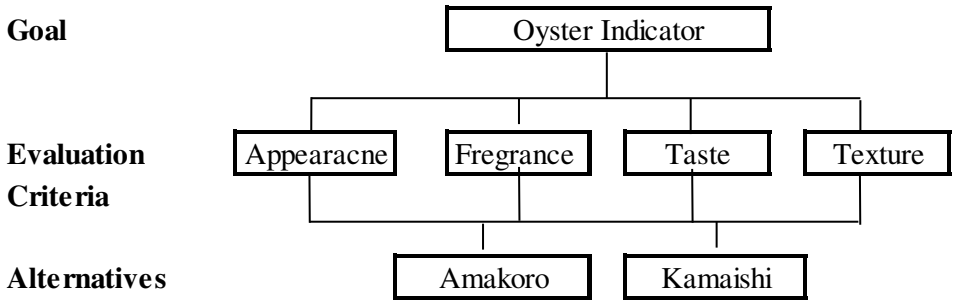

Figure 2. AHP Hierarchical Structure

The weighted evaluation for each criteria is calculated using either geometric mean or Eigen value. Although the Eigen value method is more accurate, the objective of using AHP was to obtain a regressor in the main analysis. In addition, the objective of using AHP in our study was to obtain regression variables for CVM analysis. Thus, for both reasons, we adopted geometric mean method.

Table 3. Pairwise Comparison for Evaluation Criteria and Alternatives

Criteria	Appearance	Fragrance	Taste	Texture
Appearance	a_{11}	a_{12}	a_{13}	a_{14}
Fragrance	$1/a_{12}$	a_{22}	a_{23}	a_{24}
Taste	$1/a_{13}$	$1/a_{23}$	a_{33}	a_{34}
Texture	$1/a_{14}$	$1/a_{24}$	$1/a_{34}$	a_{44}

Panel A: Evaluation Criteria

Alternatives	Amakoro	Kamaishi
Amakoro	b_{11}	b_{12}
Kamaishi	$1/b_{12}$	b_{22}

Panel B: Alternatives

The left panel of Table 3 shows a pairwise comparison for the evaluation criteria and the right panel shows a pairwise comparison for alternative choices. a_{ij} and b_{ij} denote sets of evaluations: $a \in 1, 3, 5, 7$ and $b \in 1, 3$, respectively. The weights are the values of the geometric mean of each row divided by their sum, $\frac{\sqrt[n]{\prod_j a_{ij}}}{\sum_i \sqrt[n]{\prod_j a_{ij}}}$, where n is the number of variables in the row. We obtained four weights in the evaluation criteria table, and two weights in the alternative table. In addition, we obtained the weighted values for each alternative by multiplying each weight of alternative by each weight of evaluation criteria. The sum of the weighted values was the general AHP value for each alternative. In addition,

we used a consistency index (CI) to check if the values of the AHP indicator were consistent. The CI was calculated by taking the geometric mean of the product of each row in the evaluation criteria table, as shown in the following equation (Saaty, 1988).

$$CI = \frac{1}{n}\sum_j \frac{\sqrt[n]{\prod_j a_{ij}}}{\sum_i \sqrt[n]{\prod_j a_{ij}}}$$

3.2. Contingent Valuation Method Analysis

We develop a model for estimation of WTP for Amakoro and Kamaishi oysters based on surveyed stated preferences. The CVM method is utilized in various fields, including environmental evaluation and marketing of a new commodity (Carson, Flores, & Meade, 2001; Johnston & Roheim, 2006; Loureiro & Lotade, 2005; Loureiro, McCluskey, & Mittelhammer, 2002; Lusk & Schroeder, 2004; Murphy, Allen, Stevens, & Weatherhead, 2005). In CVM, consumers are asked to state their preference for target, which sometimes creates bias due to lack of payment obligation (Murphy et al., 2005; Nape, Frykblom, Harrison, & Lesley, 2003; Tanner, Lusk, & List, 2005). Kallas and Gil (2012) used a payment-card format method to obtain the WTP of respondents in their study, where the combination of AHP and CVM was first applied to agro-food products. However, it is possible that WTP in this method is biased by the range of product prices that researchers arbitrarily set (Freeman, 2003). Because it is considered difficult to estimate the price of a brand-new product, we decided to choose another method.

This study collected consumer preference by an open-ended question. The open-ended question generates strong bias when respondents are unfamiliar with the evaluation target and do not have a base price (homegrown value) in mind (Cummings, Harrison, & Rutstrom, 1995; Rutström, 1998). In shopping, consumers face choices among many aspects of commodities, including price, quantity, quality, and competition. Thus, consumers are not used to open-ended pricing without any alternatives (Freeman, 2003). However, this study surveyed customers in oyster bars by asking them to consume both oyster types for free and to state their WTP. In this way, customers were already in the oyster bar, and had already made their choices from the menu. In addition, most customers visited the oyster bar more than once, according to Figure 1. Therefore, we assumed that our samples have a homegrown value in mind, which avoids the bias described above.

4. Econometric Model

We developed our econometric model for stated preference for oysters within a CVM framework. The responses in value are obtained by the open-ended question method, which can simply be interpreted as WTP or compensating surplus (Freeman, 2003). The following linear model is developed accordingly.

$$WTP_i = \boldsymbol{q_i}\boldsymbol{\beta} + \boldsymbol{z_i}\boldsymbol{\gamma} + \varepsilon_i$$

where $\boldsymbol{q}$ is a vector of quality variables, including AHP indexes (appearance, fragrance, taste, and texture), types of oysters (Kamaishi as a reference), and interaction terms between AHP indexes and

the dummy of Amakoro oysters. z is a vector of dummy variables, including gender (female), age (young and old age groups), and bar locations, as control variables (Yokohama, Futakotamagawa, and Ikebukuro), which is shown in Table 4.

Table 4. Variables for Regression

Variables	Description
Kamaishi	1 if the oyster is from Kamaishi, 0 otherwise
Quality Criteria	
Appearance	Weighted AHP index for appearance
Fragrance	Weighted AHP index for fragrance
Taste	Weighted AHP index for taste
Texture	Weighted AHP index for texture
Interaction	
Amakoro×Appearance	Appearance if Kamaishi =1, 0 otherwise
Amakoro×Fragrance	Fragrance if Kamaishi =1, 0 otherwise
Amakoro×Taste	Taste if Kamaishi =1, 0 otherwise
Amakoro×Texture	Texture if Kamaishi =1, 0 otherwise
Socio-demographics	
Female	1 if the respondent is female, 0 otherwise
Youth (39 years or less)	1 if the respondent is under 39 years, 0 otherwise
Elder (60 years or more)	1 if the respondent is 60 years or more, 0 otherwise
Consumption Pattern	
Frequency of visit	The number of visiting oyster bars per year
Location dummy	
Ikebukuro	1 if the respondent is surveyed in Ikebukuro, 0 otherwise
Futakotamagawa	1 if the respondent is surveyed in Futakotamagawa, 0 otherwise
Yokohama	1 if the respondent is surveyed in Yokohama, 0 otherwise

We pooled the WTP of both Amakoro and Kamaishi oysters and treated it as panel data, by regarding Amakoro and Kamaishi as the same oyster belonging to *Crassostrea gigas*. Thus, the panel data consist of two dimensions: individuals and species. This is not ordinary cross-sectional and time-point panel data, but we apply panel data analysis, which is developed to keep a random-sampling assumption for repeated samples (Baltagi, 1995). This study adopted the random-effect model, since the fixed effect model drops invariant socio-demographic variables across the type of oysters due to a collinearity problem (Greene, 2003). The Hausman test was not effective since the chi-square value becomes negative, probably because lack of samples made the variance in regression large. However, heteroskedasticity did not exist, according to the result of the Breusch–Pagan test, and no disparity

was found across ordinary standard errors, robust standard errors, and bootstrapped standard errors. Consequently, the estimation result was not robust because of insufficient sample size, and not because of the data.

5. Results

5.1. Analytic Hierarchy Process

Values of AHP indicators for each evaluation criteria are shown in Figure 3. The appearance of Amakoro is highly evaluated compared with that of Kamaishi. Otherwise, they have almost the same value as each other, although the fragrance of Amakoro is slightly higher than that of Kamaishi, while the other criteria are slightly less than those of Kamaishi. The aggregated AHP indicator is higher for Amakoro by 0.044 points. As for the Consistency Indicator (CI), 0.15 is the threshold of inconsistency (Saaty, 1988), but 45% of AHP were more than 0.15 and judged as inconsistent. The CI becomes higher as the frequency of visits declines. Thus, customers do not visit oyster bars often enough to be able to evaluate oysters using these criteria. The CI explains the rationality for each AHP criterion, and thus, a lower value of CI would be a problem when AHP makes the best decision among the alternatives. However, the objective of this study is to regress WTP with AHP indicators, and thus, precision is not as important as in other AHP studies, unless inconsistency affects our regression results. Therefore, we probed the consistency of the regression results, regardless of whether inconsistency of the AHP indicators generated bias in the regression results.

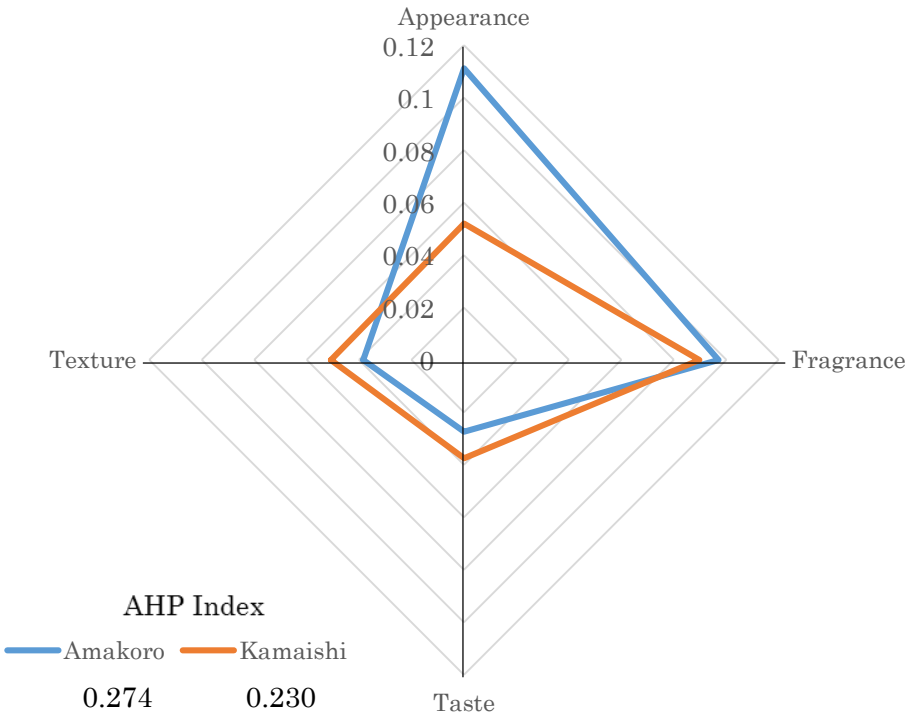

Figure 3. AHP Indexes by Each Factor of Amakoro and Kamaishi

5.2. Contingent Valuation Method

Table 5 illustrates the results of the random-effect model, which contrasts Amakoro and Kamaishi oysters. Generally, the results indicate that WTP for Amakoro is largely dependent upon quality measures while that for Kamaishi has an invariant value to quality measures. The constant term is insignificant, which means there is no base price for both oyster types. However, the Kamaishi dummy was significant, and instead plays a role in the base price only for Kamaishi oysters.

Table 5. Estimation Results of Random-Effect Model

Variables	Estimates		Std. Err.
Kamaishi	375.33	**	152.5
Quality Criteria			
Appearance	-376.82		339.9
Fragrance	-252.69		263.4
Taste	212.35		408.2
Texture	-774.73		368.9
Interaction			
Amakoro×Appearance	1211.39	**	581.4
Amakoro×Fragrance	1066.88		582.6
Amakoro×Taste	992.38		877.1
Amakoro×Texture	1633.91	**	802.4
Socio-demographics			
Female	49.12		26.1
Youth (39 years or less)	-23.06		26.7
Elder (60 years or more)	5.80		30.8
Consumption Pattern			
Frequency of visit	5.63	**	2.3
Location dummy			
Ikebukuro	131.83	***	36.5
Futakotamagawa	21.92		44.4
Yokohama	-44.54		30.9
Coefficient	96.13		108.9
R^2	0.35		

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

In addition, Kamaishi has no significant quality variables. It follows that the evaluation of Kamaishi oysters is relatively invariant to oyster quality. While consistency of the AHP indexes is a concern, the analysis is robust because the result does not change, even when we remove samples that show a CI of more than 0.15. Accordingly, in spite of the quality evaluation, consumers have a constant WTP for Kamaishi oysters.

In contrast, for the Amakoro results, an insignificant coefficient and many significant interaction variables of quality make the WTP for Amakoro dependent on quality measures. In addition, the estimated magnitude in the quality criteria is large. While the Kamaishi dummy determined 80% of the values of Kamaishi oysters, quality determined nearly 60% of the value of Amakoro oysters.

In addition, this study introduced dummy variables to treat heterogeneity of location, considering a variety of customers' characteristics and prices of oyster bars. These variables became significant and controlled heterogeneity across oyster bars. We set the base as Ginza and Hamamatsucho areas, since their locations are close to each other and both their targets are business people. The result shows that Ikebukuro is substantially higher than the other restaurants. Age dummies were not found to have significant relationships to WTP, but the frequency of visits had a significant correlation to WTP; the WTP for oysters increased as customers visited oyster bars more frequently. The predicted values are 406 yen per Amakoro oyster and 471 yen per Kamaishi oyster.

6. Discussion

In order to answer the research question described in the introduction, we investigated whether consumers would accept a new brand, Amakoro oysters, at oyster bars. According to the results, we found that the evaluation of Amakoro oysters depends on their quality while Kamaishi oysters were invariant to the quality measure. One of the reasons is the difference in size. In the estimation, a Kamaishi oyster was evaluated 60 yen higher than an Amakoro oyster, although the size of the Kamaishi oyster is two to three times larger than that of the Amakoro oyster, as shown in Figure 4. Thus, consumers who found value in the qualities of the Amakoro oyster might have shown higher WTP for the Amakoro oyster, while the Kamaishi oyster was superior to the Amakoro oyster, at least in terms of size. Even if the qualities of the Kamaishi oyster were not as satisfactory as those of the Amakoro oyster, consumers might have had a constant WTP for Kamaishi oysters.

Figure 4. Amakoro Oysters (Left Side of Plate) and Kamaishi Oysters (Right Side of Plate)

However, Amakoro oysters have a cost advantage. As Kamaishi oysters are spawned and commonly take 2 to 3 years to produce, which means the cost is larger than that of Amakoro oysters. In that sense, the evaluation of Amakoro oysters could have been better than what this study found. However, in order to integrate cost into our analysis, we need to integrate oyster famers' production function, and this will be a future research topic.

Are consumers willing to pay for Amakoro oysters at the commercial level? According to our result, the answer is affirmative, if 406 yen makes commercial sense. The WTP for Kamaishi oysters is estimated at 470 yen in this study yet they are sold for around 550 yen in the oyster bars. Accordingly, 406 yen for Amakoro oysters seems a reasonable price.

In addition to pricing, two aspects are important to consider the success of the Amakoro oyster brand project: consolidation of brand image and timing of shipment. Amakoro oysters were evaluated higher than Kamaishi oysters in terms of quality; however, brand equity is not stable yet because the former is a new brand. Brand equity is consolidated by repetitive consumption by consumers, and the more frequent consumption is, the greater is consolidation of brand equity (Keller, 1993). Consequently, producers need to increase production and product distribution. At the moment, production of Amakoro oysters is limited because Miyagi Prefecture asks only some oyster farmers to produce Amakoro oysters, resulting in 5,000 oysters produced per year. Although we have yet to grasp the big picture of market size, according to Humanweb Inc., there is demand for as many as 70,000 to 80,000 oysters per year (Yusuke Tobiki, Personal communication, May 14, 2015). Thus, it is possible for oyster farmers to produce more Amakoro oysters to enlarge its market share and build brand equity.

The other aspect is timing of shipments. When we researched this study, producers started shipment of Amakoro oysters in late July, because weather conditions were not good enough to increase production of Amakoro oysters to commercial levels. This is too late for Amakoro oysters because considerable oysters were spawned after shipment, and became useless. Few oysters

survived due to difficulties of survival in summer. Thus, oyster bars could not obtain stock of Amakoro oysters in 2015. Producers would have been able to avoid these problems and make more shipments of Amakoro oysters if they had shipped between May and early July. However, shipment in late July has the advantage of producers facing less competition, since most oysters are not shipped in summer, except in Hokkaido and Northern Tohoku. Limited supply causes excess demand, increased price, and greater profit. Thus, producers have to decide whether to ship when prices are higher with less competition, or to ship when they face fewer risks but lower prices. Such analysis is not the scope of this study, and requires further research.

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