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Consumer Preference for Cultchless Unspawned Oysters in Japan Using a Contingent Valuation Method and Analytic Hierarchy Process

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【abstract】
Demand for oysters has seen a significant rise in oyster bars in Japan, which have recently gained popularity among consumers. This study undertakes a consumer preference study to compare a new brand of cultchless unspawned oysters, "Amakoro," with conventional oysters. We survey the willingness to pay (WTP) for both oyster types as well as consumers' evaluation of the oysters' appearance, flavor, taste, and texture. Based on a contingent valuation method and analytic hierarchy process, we analyze the extent to which each factor of consumers' tastes explains WTP. The results show that in terms of appearance, Amakoro is preferred over the conventional oyster, which is positively correlated to WTP. The conventional oyster is inelastic to any type of taste factor but has a robust value. In addition, the results show that WTP largely depends on the characteristics of location and frequency of visits to oyster bars.

【keywords】
AHP, consumer preference, CVM, Japan, oyster

1. Introduction

The Great East Japan Earthquake and collateral tsunamis inflicted critical damage to all aquaculture facilities for oysters, *Crassostrea gigas*, in Miyagi Prefecture. The Japanese government immediately initiated a plan to recover the damaged facilities, including the oyster-processing factories. However, even after the production facilities were recovered, oyster sales in Miyagi declined and their production reached one-fourth of that before the earthquake, owing to labor shortage and other reasons (Tohoku Regional Agricultural Administration Office (2014)). In addition, the production of shelled oysters requires cumbersome shell-shucking labor. Thus, staffing constraint and high wage rates make the production of shelled oysters less profitable (Yoshio

Okuda, sales head in Miyagi Fisheries Cooperative, personal communication, February 2, 2014). However, the production of unshelled oysters can circumvent this shucking process, thereby possibly saving labor power and cost, while increasing profitability (Kamiyama and Miyata (2021)).

To improve profit structure, Miyagi Prefecture and Japan's Ministry of Agriculture, Forestry and Fisheries 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 increased demand for oysters in oyster bars and restaurants in Japan, the production of unshelled oysters is expected to improve the profit structure.

The "Amakoro oyster" is a new oyster brand with new properties of being cultchless(1) and unspawned(2). This oyster is smaller, sweeter, and more pure-tasting than conventional oysters(3). While conventional oysters are produced in two or three years, Amakaro oysters are produced within one year. Consequently, the Amakoro producers can save one- or two-year running cost for production. In addition, cultchless type of products cut costs for oyster producers because the shells do not have to be removed to ship out the oysters to the market. Conventional oysters are cultured as an agglomeration, similar to a big ball, and they need to be separated into individual oysters during harvesting. Amakoro oysters are separated before they are cultured, which makes the shape of the oyster shell balanced compared with the cultch oyster. Estimation of the added value of cultchless unspawned oysters helps the oyster industry to develop a variety of oysters in the future. A marketer should understand the purchasing factors preferred by consumers, to anticipate an effective promotion for restaurants, such as oyster bars.

Literature exists on consumer preference for conventional oysters (Cheng and Capps (1988)), but it is limited to home consumption. No study has targeted consumption in the dining industry. However, as demand for this new oyster type is not addressed in the literature, it is necessary to analyze the estimation not only for the industry but also toward its academic contribution. Grabowski *et al.* (2003) examined whether US consumers prefer the taste of native oysters or the non-native ones. However, as their findings were 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, the literature on WTP for oysters is limited (Alfnes *et al.* (2006), Johnston and Roheim (2006), Nguyen *et al.* (2015), Quagrainie and Engle (2006), Wirth *et al.* (2007)). Although Nguyen *et al.* (2015) measured WTP for oysters

compared to other seafood, the contingent valuation method (CVM) cannot decompose the total value into the WTP of purchasing factors or quality measures, such as taste, appearance, flavor, and texture. To estimate marginal WTP, each evaluation parameter needs to be collected separately by survey and considered in the regression analysis.

The discrete choice experiment (DCE) is a popular method to estimate consumers' WTP by decomposing purchasing factors. Since the DCE approach requires the setting of attributes and levels in its experimental design, it is unsuitable for this study because it is difficult for consumers to understand levels of an oyster's quality measure.

Moreover, people's sensory evaluation of food is generally difficult to apply in quantitative research because the evaluation consists of several sensory factors, such as taste, appearance, flavor, and texture. Even though the evaluation can be quantified (such as using a 5-point Likert scale), the importance/priority across factors is difficult to weigh. We employ an analytic hierarchy process (AHP) in this study to obtain people's evaluation, which can quantify consumers' evaluation while considering the weights of purchasing factors (Saaty (1977)).

We targeted customers in oyster bars and surveyed consumer preference for cultchless unspawned oysters over their conventional rivals at oyster bars in Japan. We used Amakoro oysters as an example of new cultchless unspawned oysters. This study has a twofold approach: we first calibrate consumers' subjective evaluations for Amakoro and Kamaishi oysters (as control) to build quality indicators using an AHP. Thereafter, we adopt a CVM to investigate how WTP is attributed to the AHP indicators and other socio-demographics.

2. Data

To investigate consumer preference in oyster bars, we conducted survey research at the oyster bars of Humanweb Inc.—the largest oyster bar company in Japan. For comparison, as Amakoro oysters are distributed in summer, we used oysters from Kamaishi, which are a major oyster brand 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 as most oyster bars (21 out of 30 Humanweb bars in Japan) are located in the region (Humanweb, October 27, 2015, www.oysterbar.co.jp/shop). The survey is attached in Appendix B. We surveyed 150-200 respondents (30-40 at each bar) but managed to

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)

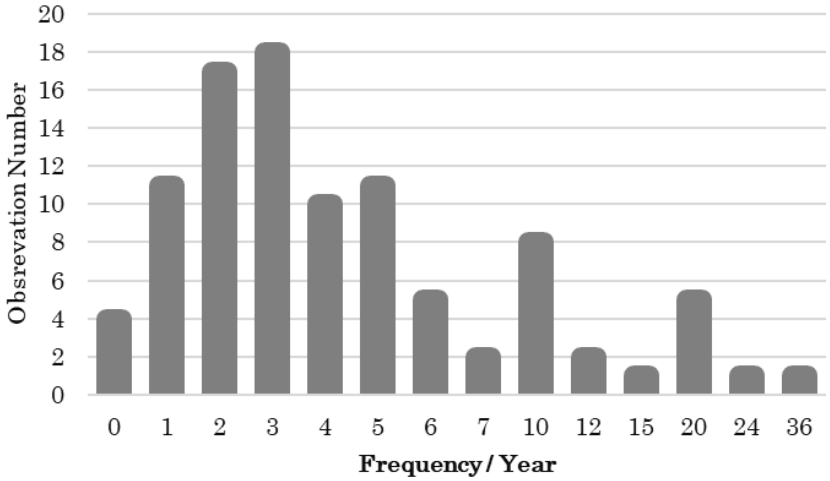

Figure 1 Frequency of Oyster Bar Visits Per Year

obtain only 127 respondents(4). Upon filtering irrational and invalid responses, the effective sample size was 109.

Table 1 tabulates the composition of respondents in terms of age and gender. Based on random extraction of the sample from oyster bars in Tokyo, it is evident that those aged in their 20s, 30s, and 40s comprise 86% of all the respondents, which indicates that oyster bars are popular among the younger age group. Regarding gender, there are more female customers than males in the younger age groups, while the proportion of males increases with customers' age.

Figure 1 shows the number of visits made by the respondents to oyster bars per year. Most consumers visit oyster bars once every two to four months. On the other hand, a few consumers visit oyster bars more than once per month (12 times/year). It follows that most consumers do not visit oyster bars very often.

3. Method

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

3-1. Analytic Hierarchy Process

The AHP was developed by Saaty in the 1970s to quantify various choices to set priorities (Saaty (1977)). It is applied in a variety of fields as it enables researchers to quantify any type of comparable target via a pairwise comparison method. A goal and targets for evaluation have to be set, such as Amakoro and Kamaishi oysters, to determine priorities based on evaluation criteria, and subsequently, to judge the targets. Figure 2 outlines this study's AHP structure.

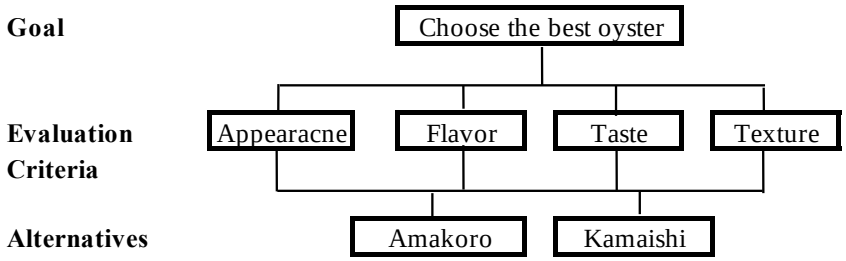

Figure 2 AHP Hierarchical Structure

Table 2 Importance of Evaluation Criteria

	Appearance	Flavor	Tasete	Texture	Geometric Means		Importance
Appearance	1	a_{12}	a_{13}	a_{14}	$\sqrt[4]{1\times a_{12}\times a_{13}\times a_{14}}$	(1)	(1)/(5)
Flavor	$1/a_{12}$	1	a_{23}	a_{24}	$\sqrt[4]{1/a_{12}\times 1\times a_{23}\times a_{24}}$	(2)	(2)/(5)
Taste	$1/a_{13}$	$1/a_{23}$	1	a_{34}	$\sqrt[4]{1/a_{13}\times 1/a_{23}\times 1\times a_{34}}$	(3)	(3)/(5)
Texture	$1/a_{14}$	$1/a_{24}$	$1/a_{34}$	1	$\sqrt[4]{1/a_{14}\times 1/a_{24}\times 1/a_{24}\times 1}$	(4)	(4)/(5)
				Total	Sum of Geomtric Means	(5)	1.000

Table 3 Importance of Alternatives

	Amakoro	Kamaishi	Geometric Means		Importance
Amakoro	1	b	$\sqrt[2]{1\times b}$	(1)	(1)/(3)
Kamaishi	1/b	1	$\sqrt[2]{1/b\times 1}$	(2)	(2)/(3)
		Total	Sum of Geomtric Means	(3)	1.000

The weighted evaluation for each criterion is calculated using either the geometric mean or eigenvector approach. We employed the geometric mean method because it is easier to calculate and generates consistent results if the number of factors is less than five (Manabe (2000)). This study uses four factors for the evaluation. Although the eigenvector method is more accurate, pairwise comparisons are assumed to be consistent (Saaty (1988)). The eigenvector method has larger errors while those of the geometric mean method are relatively small and have an invariant property in pairwise comparison (Dijkstra (2013)).

Following Saaty (1988), we designed pairwise comparisons for both the evaluation criteria (Table 2) and alternative choices (Table 3). The actual design is attached in Appendix B, and the survey is written in Japanese (please contact the author for the English version). Let a and b denote sets of evaluations: a ={1, 3, 5, 7} and b = {1, 3}. 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 the alternative by each weight of the evaluation criteria. The sum of the weighted values was the general AHP value for each alternative.

3-2. Contingent Valuation Method

We developed a WTP estimation model for Amakoro and Kamaishi oysters based on survey-stated preferences. The CVM is utilized in various fields, including environmental evaluation and marketing of a new commodity (Carson *et al.* (2001), Johnston and Roheim (2006), Loureiro and Lotade (2005), Loureiro *et al.* (2002), Lusk and Schroeder (2004), Murphy *et al.* (2005)). In the CVM, consumers are asked to state their preference for the target, which sometimes creates bias due to the lack of a payment obligation (Murphy *et al.* (2005), Nape *et al.* (2003), Ehmke *et al.* (2008)). 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, the WTP in this method may be biased by the range of product prices that researchers arbitrarily set (Freeman (2003)). Because estimating the price of a brand-new product is considered difficult, we decided to choose another method.

In this study, we collected consumer preference using an open-ended question approach, which generates strong bias when respondents are unfamiliar with the evaluation target and do not have a base price (homegrown value) in mind (Cummings *et al.* (1995), Rutström (1998)). For shopping, consumers are confronted with choices across many aspects of commodities, including price, quantity, quality, and competition. Thus, consumers are not used to open-ended pricing without alternatives (Freeman (2003)). In the CVM, private goods that are familiar to consumers generate relatively less hypothetical bias (Murphy *et al.* (2005)). This study surveyed customers in oyster bars by asking them to consume both oyster types for free and state their WTP. In this way, the customers were already in the oyster bar and had already made their choices from the menu, it more or less reduced hypothesis bias while we did not verify if every single customer checked the menu and price before they responded to our survey. In addition, most customers visited the oyster bar more than once, according to Figure 1. Thus, we tried to reduce hypothetical bias; however, we could not eliminate it. Therefore, the estimated WTP for oysters may be affected by some hypothetical bias, and we focused on the difference in the WTP for Kamaishi and Amakoro oysters and estimated all the factors, except for the base price (constant). To get more truthful values, an incentive-compatible method, such as the auction method or market data, is desirable.

4. Econometric Model

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

$$WTP_i = \boldsymbol{q_i}\boldsymbol{\beta} + \boldsymbol{z_i}\boldsymbol{\gamma} + \varepsilon_i \quad (1)$$

where $\boldsymbol{q}$ is a vector of quality variables, including AHP indexes (appearance, flavor, taste, and texture), types of oysters (Kamaishi as a reference), and interaction terms between AHP indexes and the dummy of Amakoro oysters; and $\boldsymbol{z}$ is a vector of dummy variables, including gender (female), age (young and old age groups), and bar locations; Yokohama, Futakotamagawa, and Ikebukuro, as control variables, as shown in Table 4.

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

Table 4 Variables for Regression

Variables	Description	Mean (Std. Dev)
Kamaishi	1 if the oyster is from Kamaishi, 0 otherwise	0.50 (0.50)
Quality Criteria		
Appearance	Weighted AHP index for appearance	0.08 (0.07)
Flavor	Weighted AHP index for flavor	0.08 (0.09)
Taste	Weighted AHP index for taste	0.03 (0.03)
Texture	Weighted AHP index for texture	0.04 (0.03)
Interaction		
Amakoro×Appearance	Appearance if Kamaishi =0, 0 otherwise	0.06 (0.08)
Amakoro×Flavor	Flavor if Kamaishi =0, 0 otherwise	0.05 (0.07)
Amakoro×Taste	Taste if Kamaishi =0, 0 otherwise	0.01 (0.03)
Amakoro×Texture	Texture if Kamaishi =0, 0 otherwise	0.02 (0.03)
Socio-demographics		
Female	1 if the respondent is female, 0 otherwise	0.61 (0.49)
Youth (39 years or less)	1 if the respondent is under 39 years, 0 otherwise	0.13 (0.34)
Elder (60 years or more)	1 if the respondent is 60 years or more, 0 otherwise	0.58 (0.50)
Consumption Pattern		
Frequency of visit	The number of oyster bar visits per year	5.35 (5.94)
Location dummy		
Ikebukuro	1 if the respondent is surveyed in Ikebukuro, 0 otherwise	0.23 (0.42)
Futakotamagawa	1 if the respondent is surveyed in Futakotamagawa, 0 otherwise	0.11 (0.31)
Yokohama	1 if the respondent is surveyed in Yokohama, 0 otherwise	0.22 (0.42)

* The number of observations is 218.

analysis, which is developed to keep a random-sampling assumption for repeated samples (Baltagi (1995), p191). This study adopts the random effects model, as the fixed effect model drops invariant sociodemographic variables across the type of oysters due to a collinearity problem (Greene (2003), p118). To choose the model, the Lagrange multiplier (LM) test is conducted and rejected, and thus a random effects model is

adopted(5). However, heteroskedasticity did not exist, according to the result of the Breusch–Pagan test, and no disparity was found across ordinary, robust, and bootstrapped standard errors. Consequently, the estimation result was not robust because of the insufficient sample size, rather than because of the data measurement error.

5. Results

5-1. Analytic Hierarchy Process

The values of the AHP indicators for each evaluation criterion are shown in Figure 3. The appearance of the Amakoro oysters is highly evaluated compared with that of Kamaishi. This is probably because Amakoro oysters have relatively deep-cupped shells, while Kamaishi oysters have barely cupped and flattened shells. This makes Amakoro oysters puffed, whereas Kamaishi oysters are flat. Respondents prefer puffed oyster to flattened ones. Other than appearance, they have almost the same value as the other, although the flavor of Amakoro oysters is slightly stronger than that of Kamaishi, while the other criteria are slightly lesser than those of Kamaishi oysters. The aggregated AHP indicator is higher for Amakoro by 0.044 points. In the AHP, inconsistency is discussed because it affects decision-making. However, in regression analysis, as inconsistency is treated as an error term, unbiased estimates will be obtained unless a sufficient sample size is collected. We probed the consistency of the regression results, regardless of whether the inconsistency of the AHP indicators generated bias in the regression results.

5-2. Contingent Valuation Method

Table 5 presents the result of the open-ended CVM, as well as 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 the price difference between Amakoro and Kamaishi oysters (Difference = Amakoro – Kamaishi) is larger than the mean value. As mentioned above, the listed price for Kamaishi oysters is approximately 550 yen, which is 80 yen below the CVM result. There is always a problem of hypothetical bias in CVM studies; however, by employing real customers of oyster bars as participants in this study, we successfully reduced overall hypothetical bias because the stated average price is lower than the listed price.

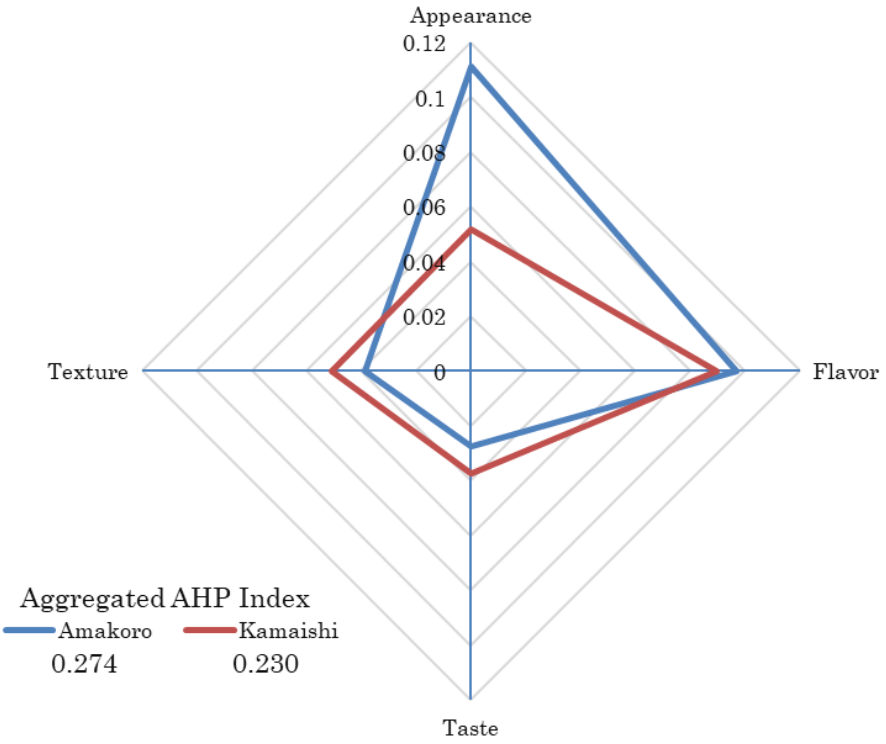

Figure 3　AHP Indexes by Each Factor of Amakoro and Kamaishi

Note: Summed values of respective indexes are shown as Aggregated AHP index. Respective quality criteria are the broken values of AHP Indexes range between 0.03 to 0.11. The broken values of Amakoro (Kamaishi) are, 0.11 (0.05) in appearance, 0.1 (0.09) in flavor, 0.03 (0.04) in taste, and 0.04 (0.05) in texture.

Table 5　Surveyed Open-ended Stated Preference (WTP)

	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

Figure 4 presents the histograms for prices of Kamaishi and Amakoro oysters. Some participants bid 600 yen or more for the Kamaishi oysters, which may be a hypothetical bias but is negligible when averaged.

5-3. Regression Analysis

Table 6 presents the results of the ordinary least squares and random effects model estimation. The LM test for random effects rejected the null hypothesis that the

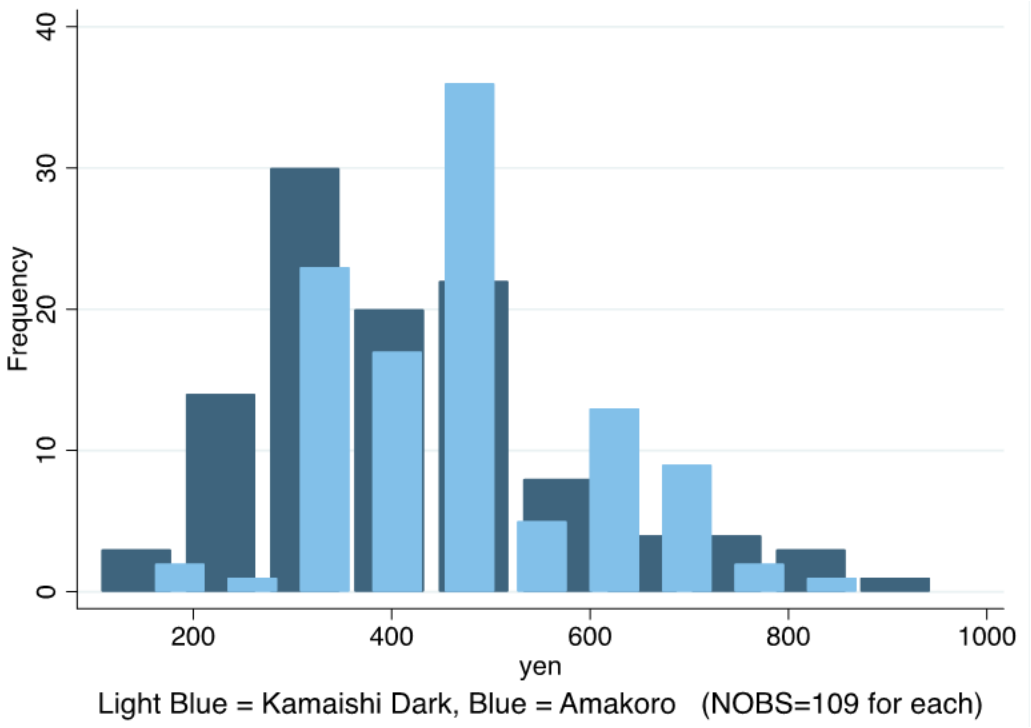

Figure 4 Histograms of WTP for Kamaishi and Amakoro oysters

variance across entities is zero, and we adopted the random effects model. The results indicate that the WTP for Amakoro oysters is attributable to appearance and texture, while that for Kamaishi has an invariant value to quality measures because the coefficients of quality in the main effects (for Kamaishi) are insignificant. However, the Kamaishi dummy is significant, and instead, it plays a role in the base price only for Kamaishi oysters. Accordingly, regardless of the quality evaluation, consumers have a constant WTP for Kamaishi oysters. While the consistency of the AHP indexes (C.I.) indicates that some participants' AHP index was inconsistent, we conducted a robustness check and found that inconsistent indexes did not affect our results (See Appendix A).

Conversely, 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.

Moreover, in this study, we introduced dummy variables to treat the heterogeneity of the location of restaurants, considering a variety of customers' characteristics and oyster prices in oyster bars. The variable became significant and controlled for heterogeneity across oyster bars. We set the base as the Ginza and Hamamatsucho areas, since they are located close to each other and their target clientele are business

people. The post-estimation equality tests between the WTP of Ikebukuro and those of other locations show a significant difference. Age dummies were not found to have significant relationships with 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 averages of the predicted values ($\hat{y}=\boldsymbol{Xb}$) of all the participants are 406 yen per Amakoro oyster and 471 yen per Kamaishi oyster.

Table 6 Estimation Results of the Ordinary Least Squares (OLS) and Random-Effect Model

	OLS			Random Effects		
Variables	Estimates		Std. Err.	Estimates		Std. Err.
Kamaishi	380.78	***	124.6	375.33	**	152.5
Quality Criteria						
Appearance	-234.70		477.6	-376.82		339.9
Flavor	-269.84		329.1	-252.69		263.4
Taste	407.42		499.3	212.35		408.2
Texture	-978.33	**	477.3	-774.73		368.9
Interaction						
Amakoro×Appearance	1075.96		567.3	1211.39	**	581.4
Amakoro×Flavor	1148.56	**	505.7	1066.88		582.6
Amakoro×Taste	918.74		729.8	992.38		877.1
Amakoro×Texture	1802.55	**	823.5	1633.91	**	802.4
Socio-demographics						
Female	47.83	**	24.0	49.12		26.1
Youth (age 39 or less)	-25.13		23.8	-23.06		26.7
Elder age 60 or older	3.00		31.6	5.80		30.8
Consumption Pattern						
Frequency of visit	5.47	***	1.8	5.63	**	2.3
Location dummy						
Ikebukuro	133.25		28.5	131.83	***	36.5
Futagotamagawa	22.20		36.5	21.92		44.4
Yokohama	-41.57		28.4	-44.54		30.9
Constant	89.43		97.8	96.13		108.9
Adjusted R-squared	0.28			0.28		

Note: This study regards statistical significance level at 5% or more, and excludes the 10% level from the result. ** and *** denote significance levels at 5% and 1%, respectively. The four quality criteria are the AHP index values that range from 0.03 to 0.11, as shown in Figure 3.

Amakoro's AHP indexes for quality criteria range from 0.07 to 0.63 (appearance), 0.08 to 0.56 (flavor), and 0.08 to 0.45 (texture). Thus, upon multiplying the respective significant estimates, the ranges of Amakoro's estimated WTP for the respective criteria are 84.8-736.1 yen (appearance), 85.4-597.5 yen (flavor), and 130-735.3 yen (texture).(6)

6. Discussion

This study adds a new finding to existing literature that has not evaluated oysters with respect to price and the quantified quality measure. Both aspects have been considered in this study. The quality measure in price provides stakeholders with more useful marketing and production strategies.

To answer the research question posed in the Introduction section, we investigated whether consumers would accept the new cultchless unspawned oysters at oyster bars. We found that the consumer preference for the Amakoro oysters was attributed to some of the quality measures, while Kamaishi oysters were invariant to the quality measure. Thus, consumers who found value in the qualities of the Amakoro oysters might have shown higher WTP for them, despite the Kamaishi oysters being superior to the Amakoro oysters at least in terms of size (Figure 5). Thus, despite the qualities of the Kamaishi oysters not being as satisfactory as those of the Amakoro oysters, consumers might have had a solid WTP for Kamaishi oysters.

However, Amakoro oysters have a cost advantage. As Kamaishi oysters are spawned and commonly take two to three years to produce, they cost more than Amakoro oysters. For future research, a benefit–cost analysis is necessary if cultchless unspawned oyster is more profitable than the conventional 2-3-year oysters.

Figure 5　Amakoro Oysters (Left-hand Side of Plate) and Kamaishi Oysters (Right-hand Side of Plate)

Are consumers willing to pay for Amakoro oysters at the commercial level? According to our result, the answer is in the affirmative, if 412 yen makes commercial sense. The WTP for Kamaishi oysters is estimated at 470 yen in this study, but they are sold for approximately 550 yen in oyster bars. Accordingly, paying 412 yen for Amakoro oysters seems acceptable, especially considering that the price of oysters is approximately 500 yen (Yusuke Tobiki, Personal communication, May 14, 2015).

According to the regression analysis results, while no sociodemographic factors, such as gender or age correlate with the WTP, customers who frequent oyster bars tend to be willing to pay more for oysters as their frequency of visits increases. The estimation result shows that one visit results in an increase of 5.6 yen per oyster, and the mean visit frequency is 5 times per year. Thus, 25 yen per oyster can be added for repeat customers. However, customers who visit less frequently prefer cheaper oysters. Thus, discount coupons for less-frequent customers may be a strategy to make them consume more oysters. The results also indicate that the appearance and texture of the Amakoro oyster attract customers. Although texture cannot be detected unless the oysters are consumed, appearance is an easy way to differentiate and promote Amakoro oysters. A new cultchless unspawned oyster is evaluated 58 yen lower than conventional famous oysters. Therefore, besides the appearance, tasting service is desirable for such new oysters to survive as a fixed menu in the bar, as their texture can be differentiated from conventional oysters.

Since this study aimed to compare a specific brand with another, the result and its interpretation is limited only to the specific brands. For a more general implication, it is necessary to compare the relationship between cultchless unspawned and ordinary oysters. Thus, further studies would provide a more general interpretation for Japan's oyster industry.

One of the limitations of this study is the size difference. The size of the Kamaishi oyster is two to three times larger than that of the Amakoro oyster; however, we did not include oyster sizes in our AHP design, which may not typify consumer preference if the size is an important purchasing factor.

Note

(1) The cultchless oyster, which is also called 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 oysters is adjusted so that they can be delivered before

the spawning season.

(3) Kahoku Shinpo. (2015) "Debut of "Amakoro oyster", symbol of recovery," *Kahoku Sinpo*, Kahoku Sinpo Publishing, Miyagi, July 14, 2015 (in Japanese).

(4) In 2015, 1,500 Amakoro oysters were due to be delivered to Humanweb oyster bars, but owing to timing delays during the harvest, only 150 were delivered.

(5) The Hausman test was not effective, as the chi-square value became negative, probably because the lack of samples enlarged the variance in the regression.

(6) Significance levels above 5% are considered in this discussion. The linear combination of the main effect and Amakoro interaction terms are tested, and the chi-square test significant probabilities are 0.3% for appearance, 2% for flavor, 1% for taste, and 12% for texture.

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