Res. Bull. Obihiro Univ. 30 : 44～52 (2009)

Measuring Japanese consumers' evaluation of beef derived from cattle fed in accordance with improved food safety measures

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(Received:30 April, 2009) (Accepted:15 May, 2009)

食品安全性に配慮して生産された牛肉の消費者評価

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Abstract

The purpose of this paper was to verify the stability of consumers' evaluations of food safety by conducting the identical choice experiments questionnaire survey at the same site two different times. The two surveys, measuring the consumers' evaluations of beef derived from cattle fed in accordance with improved food safety measures were conducted in January 2003 (n = 83) and March 2004 (n = 369) in Kiyota ward of Sapporo city in Hokkaido, Japan. A comparison of the results of the two surveys suggests that social issues related to the choice experiment questions can significantly influence the consumers' inferred values for food safety on the basis of the questions.

Key words: beef, food safety, consumers' evaluation, stated preference methods, choice experiments

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Introduction

Increasing public attention has been paid focused on food safety issues, and this has increased studies on Japanese consumers' evaluation of food safety through stated preference methods (e.g., Aizaki et al. 2004, 2006, 2007, 2008; Hosono 2004; Iwamoto et al. 2004; Managi et al. 2008; Otani et al. 2004; Sato et al. 2001; Sawada et al. 2008; Peterson et al. 2004). With the exception of some studies (e.g., Iwamoto et al. 2004; Peterson et al. 2004; Aizaki et al. 2008), almost all the studies have focused on consumers located in a single site and at a specific time. Therefore, the stability of the consumers' evaluations that were measured has not yet been discussed. In order to examine this issue, this paper compares data collected at the same site in 2003 (Aizaki et al. 2004) and 2004. A comparison of the results revealed that consumers' evaluations of beef derived from cattle fed in accordance with improved food safety measures were stable.

MATERIALS AND METHODS

Data

In January 2003 (Aizaki et al. 2004) and March 2004, two surveys for measuring consumers' evaluations of beef derived from cattle fed in accordance with improved food safety measures were conducted in Kiyota ward in the city of Sapporo in Hokkaido, Japan. In March 2004, the questionnaire survey was mailed to 1,000 households that were randomly selected from a list of registered voters in Kiyota ward. Of these, 384 households returned the survey by mail. Since the responses of 15 households were incomplete, a sample size of 369 households was finally considered valid for analysis. Although the aim of this paper is to compare the data collected in 2004 with that collected in 2003 by Aizaki et al. (2004), the latter includes sample households randomly selected from the list of register of voters in Kiyota ward (of the 300 households that were mailed the survey, 83 were valid samples) and the city of Obihiro in Hokkaido (of the 300 households that were mailed the survey, 82 were valid samples). In order to match the conditions as best as possible when comparing the two results, households from Kiyota ward were extracted from the data collected by Aizaki et al. (2004) and re-analyzed using an empirical discrete choice model, which is described later in this paper.

Choice experiment questions for evaluating beef

The two surveys conducted in 2003 and 2004 used identical choice experiment questions asking the respondents to choose their most preferred alternative from among four beef products; a "none of these" option was also provided (Fig. 1). Each beef alternative had three attributes: type of beef (country of origin), type of feeding, and price per 100g. The type of beef (country of origin) attribute was given as an alternative specific attribute; the four beef alternatives were "domestic Wagyu beef," "domestic dairy beef," "Australian beef," and "US beef" in the same order from left to right in each choice experiment question. The type of feeding had two levels: "Conventional" and "Safe." The former implies that the beef is derived from cattle fed conventionally and, of course, is safe for consumption as per the Japanese food safety regulations at the time the surveys were conducted. The latter implies that the beef is assumed to be derived from cattle fed in accordance with the newly introduced food safety measures; it is hereafter called "S beef" (Fig. 2). Although S beef is a hypothetical type of beef, each of the conditions that the beef needs to satisfy in order to be certified as S beef(Fig. 2), has been implemented in Japan.

Table 1 shows the choice sets, except for the "none of these" option, used in the questionnaire conducted in 2004; each respondent was asked ten choice experiment questions. On the other hand, each respondent was asked

eight choice experiment questions in the 2003 survey (see Aizaki et al. 2004 for details). The choice sets used in 2003 and 2004 were created using the Microsoft Excel macro program (Sato et al. 2001) with a design method based on the *D*-efficiency criterion (Zwerina et al. 1996).

Empirical discrete choice model

According to the random utility theory, respondent n is assumed to select the alternative that provides the greatest utility from among five alternatives — the domestic Wagyu beef, domestic dairy beef, Australian beef, US beef, and "none of these" options in the choice experiment questions. The systematic component of the

Please circle one of four types of beef for *yakiniku* listed below that you would like to purchase.

Circle one →	1	2	3	4	5
Type of beef	Domestic	Domestic	Australian	US	None
(Country of origin)	Wagyu beef	dairy beef	beef	beef	of
Type of feeding	Conventional	Safety	Conventional	Safety	these
Price per 100g	398 yen	348 yen	178 yen	148 yen	

Fig. 1. An example of choice experiment questions

A retail store that you trust is assumed to have begun purchasing from a specific beef producer. The beef is assumed to be produced under the following guidelines.

1) The beef is derived from cattle at a cattle ranch operated directly by the beef producer, where hygiene management is well implemented, medicines such as antibiotics are used as little as possible and safe fodder is given to the cattle. (Safe fodder is fodder that does not contain any meat bone meal and genetically modified crops at all and is derived from crops grown without agricultural chemicals in the field or postharvest.)
2) The history of the cattle, from its birth place to the slaughterhouse, and the course of the beef from the slaughterhouse to the retail store is recorded and can be traced.
3) Information for the individual identification of cattle, information about the feeds and pharmaceutical use, and the result of the BSE test are open to public inspection either at a retail shop or via the Internet.
4) It is guaranteed, through a DNA test or the attestation of a third party organization, that the disclosed information is true.

The beef is called "S beef" as follows. The price of S beef is assumed to be higher than that of non-S beef (conventional beef) since the measures to guarantee the safety of S beef is costly.

Fig. 2. Explanation of beef derived from cattle fed according to improved food safety (S beef) measures

Table 1. Choice sets of the survey, excluding the "none of these" option

Question	Type of beef	Type of feeding*	Price per 100g	Question	Type of beef	Type of feeding*	Price per 100g
1	1	0	398 yen	6	1	0	598 yen
1	2	1	348 yen	6	2	1	398 yen
1	3	0	178 yen	6	3	1	98 yen
1	4	1	148 yen	6	4	0	78 yen
2	1	1	498 yen	7	1	1	348 yen
2	2	0	398 yen	7	2	0	248 yen
2	3	0	178 yen	7	3	0	98 yen
2	4	1	148 yen	7	4	0	178 yen
3	1	0	298 yen	8	1	0	448 yen
3	2	1	198 yen	8	2	0	148 yen
3	3	0	148 yen	8	3	0	178 yen
3	4	0	98 yen	8	4	1	98 yen
4	1	1	298 yen	9	1	0	398 yen
4	2	0	198 yen	9	2	0	198 yen
4	3	1	98 yen	9	3	1	248 yen
4	4	0	158 yen	9	4	1	178 yen
5	1	0	598 yen	10	1	0	398 yen
5	2	0	178 yen	10	2	0	178 yen
5	3	1	128 yen	10	3	1	198 yen
5	4	1	98 yen	10	4	0	178 yen

*0 and 1 denote "conventional" and "safety," respectively.

utility of respondent n for choosing beef i is as follows (the systematic component of the utility for the "none of these" option is normalized to zero):

$$V_{in} = ASC_i + bS_i\ SAFETY_{in} + bP_i\ PRICE_{in}$$

where i denotes the type of beef (1 = domestic Wagyu beef, 2 = domestic dairy beef, 3 = Australian beef, 4 = US beef); ASC_i represents an alternative-specific constant for each type of beef i relative to the "none of these" option; bS_i is a coefficient of $SAFETY_{in}$ that takes the value of 1 if beef i is derived from the cattle fed in accordance with improved food safety measures (S-beef) and otherwise takes the value of 0; and bP_i is a coefficient of $PRICE_{in}$, which is the price of beef i.

In this paper, a random parameters logit (RPL) model (Train 2003) based on the aforementioned systematic component of utility was applied. The reason for using this model was that it is able to estimate the distribution of coefficient (mean and standard deviation [s.d.]) and provide individual (respondent) specific parameter estimates.; therefore, it was able to capture the differences in the respondents' evaluation of beef attributes. Each coefficient of attributes including ASC_i was assumed to be normally distributed. Further, the reason why the coefficient $PRICE_{in}$ was also randomly distributed was that there was the possibility of US beef being rejected — no matter how cheap it may be, I do not want to purchase US beef attitude — since a bovine spongiform encephalopathy (BSE) − positive cow in the United States was first discovered in December 2003, and consequently, Japan suspended the import of US beef (Aizaki et al. 2006).

The empirical discrete choice model was estimated using a simulated maximum likelihood estimation method included in NLOGIT Version 3.0, by Econometric Software, Inc.

Scales of consumers' evaluation of beef and beef attributes

The following two values were measured as the consumers' evaluations of beef and beef attributes.

Willingness-to-pay (WTP) for beef i derived from cattle fed conventionally (WTP of conventional beef) = $-ASC_i / b_{Pi}$

Marginal willingness-to-pay (MWTP) of S beef = $-bS_i / b_{Pi}$

The former is calculated based on the assumption that all the five alternatives including the "none of these" option have the same magnitude of the systematic component of utility, that is, the choice probability of each alternative is the same. However, since the share of each alternative in the actual beef market is not the same, the WTP for ASC_i may differ from the price of beef i in the real market. The latter shows the consumers' added value of S beef i as compared to conventional beef i when the other conditions were constant. These (M)WTPs for a representative individual are calculated using mean parameter estimates. Similarly, (M)WTPs for respondent n can be calculated using individual-specific (respondent) parameter estimates.

RESULTS AND DISCUSSION

Table 2 indicates the random parameters logit model estimates. Coefficients that were not significantly different from zero at the 10% level were as follows: in 2003, the mean of ASC for US beef (ASC4), the mean of S beef for domestic Wagyu beef (SAFETY1), the standard deviation (s.d.) of S beef for Australian beef (SAFETY3), and the mean price of Australian beef (PRICE3); in 2004, the mean and s.d. of ASC for US beef (ASC4) and the mean of S beef for US beef (SAFETY4). Since individual-specific parameter estimates may be significant even if the mean and s.d. corresponding to them are not significant, a specification of the empirical mode was not modified.

Table 3 shows a representative individual's WTP of conventional beef and the MWTP of S beef. Since the mean price of Australian beef was not significant in 2003, the (M)WTPs for Australian beef in 2003 were unstable (the 90% confidence intervals for Australian beef were relatively larger than those for the other types of beefs). One of the main features of (M)WTPs was that the WTPs of conventional US beef in both 2003 and 2004 were relatively lower than those of conventional beef for the other types of beef. Another feature was that the MWTP for S beef of domestic Wagyu beef in 2004 was significant, while this was not the case in 2003; MWTP for S beef of US beef in 2004 was not significant, although it was significant in 2003.

Table 4 displays the classification of respondents based on the sign condition of each of the individual parameter estimates. Changes from the results in 2003 to the results in 2004 are summarized as follows: the ratio of the respondents who had a negative ASC for US beef (ASC4) increased from 13.3% to 89.2%; the ratio of the respondents who had a positive coefficient of SAFETY for domestic Wagyu beef (bS1) increased from 38.6% to 86.7%; the ratio of the respondents who had a negative coefficient of SAFETY for US beef (bS4) increased from 9.6% to 68.0%. A similar trend was observed in the percentiles of the individual (M)WTPs (Table 5).

One of the factors that had a great impact on the estimates of the present study, during the two questionnaire survey periods (from January 2003 to March 2004), seems to be the suspension of imports of US beef in December 2003 when a BSE-positive cow was first discovered in the United States. Our results suggest that this issue caused Japanese consumers to express a strong anxiety about the safety of US beef and to evaluate the hypothetical measures for producing safe beef (S beef), which are also assumed to have been taken in Japan and Australia, very poorly. This study implies Japanese consumers are relatively aversive to risks related to the safety of beef (Schroeder et al. 2007; Sawada et al. 2008) and have the tendency to adopt the attitude that domestic foods are safer than imported foods

Table 2. Random parameters logit estimates

Independent variables		2003			2004		
		Estimate	S.E.	*p*	Estimate	S.E.	*p*
ASC1	mean	16.8829	2.4835	0	10.5073	0.633	0
	s.d.	1.7714	0.5028	0	1.286	0.1872	0
ASC2	mean	6.7462	0.744	0	4.4472	0.2529	0
	s.d.	3.6312	0.4309	0	2.4191	0.1448	0
ASC3	mean	1.6373	0.9195	0.08	1.8196	0.264	0
	s.d.	2.7236	0.379	0	2.5405	0.2108	0
ASC4	mean	0.8444	0.9893	0.39	-0.0982	0.3868	0.8
	s.d.	1.8364	0.434	0	0.1302	0.2336	0.58
SAFETY1	mean	-1.2324	0.8137	0.13	1.8713	0.2485	0
	s.d.	5.9499	1.0524	0	2.5462	0.2707	0
SAFETY2	mean	5.3165	0.8545	0	2.4849	0.2365	0
	s.d.	4.2784	0.6976	0	4.2556	0.2551	0
SAFETY3	mean	1.6766	0.3661	0	1.041	0.1497	0
	s.d.	0.566	0.5419	0.3	1.3729	0.1961	0
SAFETY4	mean	1.372	0.4564	0	-0.3868	0.4611	0.4
	s.d.	2.3503	0.6258	0	4.8114	0.4803	0
PRICE1	mean	-0.0436	0.0066	0	-0.0349	0.002	0
	s.d.	0.0209	0.003	0	0.0143	0.0008	0
PRICE2	mean	-0.0228	0.0029	0	-0.0115	0.001	0
	s.d.	0.014	0.0025	0	0.0085	0.0006	0
PRICE3	mean	-0.0069	0.0047	0.14	-0.0141	0.0016	0
	s.d.	0.016	0.0027	0	0.0121	0.0014	0
PRICE4	mean	-0.0227	0.0062	0	-0.0149	0.0031	0
	s.d.	0.0197	0.0032	0	0.0129	0.0016	0
Log likelihood at zero				-1,068.667			-5,938.826
Log likelihood at convergence				-653.548			-3,502.721
McFadden's R-square				0.366			0.406
Number of respondents				83			369
Number of observations				664			3,690

(Aizaki et al. 2004; Sato et al. 2005). This tendency might be one of the factors that influenced Japanese consumers' severe evaluations of US beef after the discovery of the BSE-positive cow in the United States.

In addition, our results indicate there is the possibility that social issues related to the choice experiment questions significantly influenced consumers' evaluations of food safety on the basis of the questions. Information on the consumers' evaluations of food safety through the choice experiment questionnaire surveys under various social conditions is very important for the implementation of a cost-benefit analysis of measures related to food safety. The variation of consumers' evaluations of food safety in relation to social situations should be highlighted as a future research topic.

Table 3. Representative individuals' (M)WTPs of beef and beef attributes

	2003	2004
WTP of conventional beef		
Domestic Wagyu beef***	387	301
	[365, 414]	[289, 314]
Domestic dairy beef***	296	386
	[265, 332]	[352, 427]
Australian beef*	236	129
	[17, 553]	[111, 147]
US beef	37	-7
	[-51, 85]	[-67, 28]
MWTP of S beef		
Domestic Wagyu beef***	-28	54
	[-61, 2]	[41, 66]
Domestic dairy beef	233	216
	[177, 302]	[187, 250]
Australian beef*	241	74
	[-688, 1,491]	[53, 100]
US beef**	60	-26
	[24, 130]	[-83, 25]

***, **, * denote that the difference between the values in 2003 and 2004 is significant from zero at the 1%, 5%, and 10% levels, respectively (Poe et al. 2005).
Figures in parentheses are the lower and upper 90% confidence intervals of the (M)WTP estimated from a bootstrap sample size of 2,000 (Krinsky et al. 1986).

Table 4. Number of respondents classified by the sign condition of individual specific parameter estimates

Year	Sign		ASCi				bSi				bPi			
			i = 1	i = 2	i = 3	i = 4	i = 1	i = 2	i = 3	i = 4	i = 1	i = 2	i = 3	i = 4
2003	Positive	(N)	83	83	67	72	32	71	83	75	0	0	14	3
		(%)	100	100	80.7	86.7	38.6	85.5	100	90.4	0	0	16.9	3.6
	Negative	(N)	0	0	16	11	51	12	0	8	83	83	69	80
		(%)	0	0	19.3	13.3	61.4	14.5	0	9.6	100	100	83.1	96.4
2004	Positive	(N)	369	363	314	40	320	285	326	118	0	11	14	17
		(%)	100	98.4	85.1	10.8	86.7	77.2	88.3	32.0	0	3.0	3.8	4.6
	Negative	(N)	0	6	55	329	49	84	43	251	369	358	355	352
		(%)	0	1.6	14.9	89.2	13.3	22.8	11.7	68.0	100	97.0	96.2	95.4

Table 5. Percentiles of each (M)WTP

Percent point*	WTP of conventional domestic Wagyu beef		WTP of conventional domestic dairy beef		WTP of conventional Australian beef		WTP of conventional US beef	
	2003	2004	2003	2004	2003	2004	2003	2004
Min	212	172	57	−13,378	−2,716	−6,736	−425	−1,288
1%	226	186	85	−4,742	−2,245	−688	−247	−355
10%	252	222	119	79	−339	−69	−8	−26
50%	325	311	328	301	74	116	28	−6
90%	686	951	768	1,534	345	463	386	−1
99%	1,905	1,810	1,555	6,557	1,199	1,927	4,767	35
Max	2,017	1,996	2,438	11,090	1,401	8,569	12,360	174
	MWTP of S beef for domestic Wagyu beef		MWTP of S beef for domestic dairy beef		MWTP of S beef for Australian beef		MWTP of S beef for US beef	
	2003	2004	2003	2004	2003	2004	2003	2004
Min	−489	−703	−939	−9,796	−3,146	−9,546	−3,745	−5,829
1%	−341	−507	−719	−198	−1,636	−716	−874	−1,177
10%	−199	−4	−32	−49	−278	−24	−4	−316
50%	−25	40	144	167	85	59	58	−98
90%	121	198	590	1,235	255	307	575	548
99%	241	328	1,216	7,095	993	1,930	2,615	2,553
Max	298	448	2,363	8,468	1,714	5,990	7,795	23,658

* Each of the individual-specific (M)WTPs are permuted in ascending order, and each value located in each percent point is indicated.

Acknowledgement

This work was supported by Grant-in-Aid for Scientific Research (15580185) of Japan Society for the Promotion of Science (JSPS), Japan.

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摘要

本稿の目的は，同一の選択実験を同一地域の異なる２時点で行い，食品安全性に関する消費者評価の安定性を検討することである。北海道札幌市清田区の住民を対象に，食品安全性に配慮して生産された牛肉の消費者評価を求める調査を2003年(n=83)と2004年(n=369)に実施した。両調査データを分析したところ，選択実験の質問に関連する社会事象の発生が，選択実験による食品安全性の消費者評価に影響を与えることが示唆された。

キーワード：牛肉，食品安全性，消費者評価，表明選好法，選択実験