Journal of Rural May 27 (Winter 2004): 95～110

Measuring Consumers' Value of Organic-Beef using Contingent valuation method

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ABSTRACT

The dichotomous-choice contingent valuation method is applied to measure consumers' value of quality-certificated organic beef. First, a logit model is estimated like previous studies. Second is a distribution-free approach. The Turnbull empirical distribution model is employed to solve negative willingness to pay and truncation problems. The result is shown that consumers are willing to pay 7,019～10,607 Won/per 600g more than the current price of regular beef for quality-certificated organic beef.

Key words : Organic-beef, logit model, Turnbull model, contingent valuation, willingness to pay

Ⅰ. INTRODUCTION

As an increase in national income and health concerns, consumer consumption patterns, and consumers' preference increasing towards the safety-guaranteed food(agricultural product). There is an increasing tendency for consumers to purchase high quality and safe agricultural products, in spite of the high price. Therefore, to meet the consumption level of domestic agricultural

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products, food safety or improvement in sorting/packing through a differentiation of quality, non-price competition factor plays a role in the agricultural product. As improving technology of production, storage, processing, packing, transportation of agricultural products continue quality differentiation of agricultural product is becoming easier than in the past.

To cope with this change, the government has implemented the agricultural product labeling and certification system[1]. The agricultural products labeling and certification system certifies quality after an established deliberation for high quality and safe products, by the National Agricultural Products Quality Management Service(NAQS) and private quality certification organizations. For successful establishment of the agricultural product labeling and certification system and the policy formulation measuring-consumers' value of quality-certificated product is required.

Several previous studies(Kim Tae Kyun · Choi Kwan, 1997; Kim Man Kyeun · Han Du Bong · Jung Bok Jo, 1998; Choi Tae Kil · Kim Tae Kyeun · Cho Chai Hwan, 2000) measuring consumer value of quality-certificated agricultural product(food safety) and GMO food(agricultural product) analyzed using the dichotomous-choice contingent valuation method. However, since these studies assume a specific function for consumers' willingness to pay(WTP), problems about estimation standards can be questioned in estimating WTP. In other words, there are two problems. to include the negative WTP assuming the standard cumulative normal distribution or the logistic distribution and to set up the range of integral area in the estimated function.

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1) In Korea, based on the law related to agricultural/fishery products, an eco-friendly agricultural product certification system has been dualized of the quality certification system and quality management and the labeling and certification system under the provision of environment agriculture promotion law. From 1 July, 2001, the dualized system of eco-friendly products is combined in the labeling and certification system, because of unnecessarily complications and has amplified confusion for both of producer and consumer.

Recently, previous studies(Heo Joo Nyoung · Kim Tae Kyun · Pyoun Sang Hee, 2000; Kim Tae Kyun · Kwak Chang Keun · Park Sung Hun · Kim Hye Young, 2002; Kwon Oh Sang, 2003) applying the dichotomous-choice contingent valuation method and Turnbull model analyzing WTP using only individual responses without defining function have yielded positive results.

The objective of this study is to measure consumers' WTP more for organic beef over regular beef. In the chapter Ⅱ the model applied for analysis is described, in the chapter Ⅲ the analysis model is estimated and consumers' WTP extra for organic beef is concluded. the general measuring estimation method and the Turnbull distribution-free model are applied for the estimation of the model. Finally, in chapter Ⅳ the analysis results is summarized and has led to the conclusion.

Ⅱ. ANALYSIS METHOD

1. PARAMETRIC METHOD

The contingent valuation(CV) method is divided into the open-ended question method and the dichotomous-choice contingent valuation(DC) method, according to the question type. In practical applications, the DC method has more merits than the open-ended question method's(Freeman, 1993). Consequently, this study is intended to measure a consumer value for organic beef using the CV method.

First of all, consumers choose between regular beef and organic beef. In this situation, consumers' indirect utility function, as following, is employed to describe the consumers' selection process(Hanemann, 1984).

$$U = V(i, BID_i, Y, A) + \varepsilon_i, \qquad i = 0, 1. \tag{1}$$

Where V(·) is an indirect utility function, i is an indicator variable. If selecting organic beef, $i=1$, otherwise

(regular beef), $i=0$. BID_i is organic beef price per unit, Y is income level, and A means individual respondents' social variables, including age and education. ε_i is independent and probability variable with distribution whose average is 0.

Regarding the individual quotation price BID_i, the probability, that utility level of respondents' selecting organic beef is higher than or equal to the utility level of selecting regular beef, is as follows(2).

$$\Pi_1 = \Pr[V(1, Y-BID, A)-V(0, Y, A) \geq \varepsilon_0-\varepsilon_1]. \quad (2)$$

With regards to the individual quotation price, the probability of a 'yes' response is Π_1 in (2). Where $\varepsilon_0-\varepsilon_1$ is defined as θ in probability function Pr, Π_1 can be the cumulative distribution function(CDF) as in formula(3).

$$\Pi_1 = F_\theta[\Delta V]. \quad (3)$$

In the formula(3), $F_\theta[\cdot]$ refer to the cumulative distribution function of θ. And ΔV indicates $V(1, Y-BID, A)-V(0, Y, A)$. The probability of selecting organic beef is influenced by property variables, such as the price gap between organic and regular beef, income level, education level and age. Thus, in formula(3), the estimation of the DC probability model can use the logit model and the probit model[2]. The logit model is commonly used in the aspects of the goodness-of-fit and easy estimation.

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2) The difference between the logit model and the probit model is that error term is assumed as standard normal distribution in the probit model, and is assumed as a standard logistic distribution in the logit model(Kim Tae Kyun, et al., 2002).

$$\Pi_1 = \frac{1}{1+\exp(-\Delta V)}, \quad (4)$$

In case of applying the logit model, the probability(Π_1) of consumers' selecting organic beef is indicated as the following formula(4). In formula(4), ΔV's function form can be assumed as the linear function and the log function and shown as the linear logit function and the log logit function by the function form. This study estimates the linear logit model and the log logit model and measures individual respondents' willingness to pay extra for organic beef using coefficient in the logit model

The additional cost for consumers(individual respondents) to purchase safety-guaranteed beef(organic beef) is measured as the maximum WTP. And various measurement values can be considered for the mean WTP. First of all, the mean of the general WTP, which is the overall mean of the WTP calculated including negative quotation price, median and truncated mean are shown as representative value(Hanemann, 1984; Johansson et al, 1989). Among these representative values, the truncated average is estimated to content with condition, such as consistency in theological limitations, and statistical efficiency on(Duffield and Patterson, 1991).

The representative value by the parametric method has different estimation results according to function form, and problems including negative quotation price area in the linear logit model. Because negative quotation price is not in respondents' real favor, the mean of the WTP can be used, which measures only the positive quotation price area without considering the negative quotation price area[3]. But this measurement value disregarding the negative quotation price area, can be a problem, because the negative quotation price area is

3) The WTP for livestock products(beef, pork) through the HACCP process shows total average as negative value in estimation(Kim Tae Kyun, Kwak Chang Keun, Park Sung Hun, Kim Hye Young, 2002).

statistical goodness-of-fit or plays an important role in function form(Kim Tae Kyun, et al., 2002).

The log logit model, where negative quotation price is not originally shown, was suggested to solve this problem(Duffield and Patterson, 1991; Cameron, 1988). Even the model without negative quotation price is problematic still regarding the integral interval size. To alleviate this problem For this, Duffield and Patterson(1991) suggest integrating the truncated mean WTP of maximum quotation price. In the model without a such negative quotation price, the right tail is estimated as being too thick. Moreover, to integrate maximum quotation price is considered to have no clear theoretical background.

2. NONPARAMETRIC METHOD

The parametric method gives a function form to utility function using the method of maximum likelihood. It is an analysis method assuming distribution for probability variable affecting to the WTP. Because of several problems with the parametric method, Turnbull estimation method doesn't assume a parametric specific function form. It is a non-parametric method using and estimating only individual responses. Because it generally applies lower-bound based on minimum values in each interval to estimate the expected value, this method is advantageous in defining the lowest value of WTP and reducing the hypothetical bias according to the hypothetical settings. In this study, it is estimated the WTP for organic beef using Turnbull distribution-free model. The Turnbull distribution-free model is an estimation method of WTP using response probability at the given quotation price and can be explained by the following process.

When organic beef price is B_j won, the number of individual respondents' facing quotation price is M. When this is expressed as j, $j=0, 1, \cdots, M$. If $j>k$, $B_j>B_k$ and B_0 is 0. Individual respondents' WTP (W) is in the interval from B_{j-1} to B_j, if the probability is p_j, can be shown as the following

formula(5).

$$p_j = P(B_{j-1} < W \leq B_j) \quad \text{for} \quad j = 1, \cdots, M+1. \tag{5}$$

The respondent responds to the each quotation price (B_j) from $j=1$ to M, and assumes $B_{M+1} = \infty$ for the price over maximum quotation price B_M. In this case, the CDF is F_j, the CDF is represented in the following formula(6).

$$F_j = P(W \leq B_j) \quad \text{for} \quad j = 1, \cdots, M+1, \quad F_{M+1} = 1. \tag{6}$$

Here, not the CDF but the probability density function (PDF), p_j in each quotation price is calculated as $F_j - F_{j-1}$, and the initial $F_0 = 0$. It's possible to estimate as cumulative distribution probability or interval probability in the Turnbull distribution-free model. Also, the calculation process of the cumulative distribution function and the probability density function is the following.[4)]

① Calculate F_j from $j=1$ to M. Here $F_j = \frac{N_j}{N_j + Y_j}$, N_j is the number of 'no' responses at the quotation price B_j. Y_j is the number of 'yes' responses.

② Beginning from $j=1$, compare the size of F_j and F_{j+1}.

③ If F_{j+1} is more than F_j, continue.

④ If F_{j+1} is less than or equal to F_j, sum j and $j+1$. Repeat to satisfy $F_{j+1} > F_j$.

⑤ Continue, until the CDF becomes a monotone increasing

4) A specific inducing process refers to Haab and McConnell(1997).

function.

⑥ Calculate the PDF using the difference of the CDF.

For measuring the expected value using CDF calculated by repeated process until CDF becomes a monotone increasing function is generally applied to the lower-bound based on the minimum value in each interval. Thus, applying the minimum value in each quotation price interval presented to respondents, the expected value of WTP, $E(LB_{WTP})$ is calculated as the following formula(7)(Habb and McConnell, 1997).

$$E(LB_{WTP}) = 0 \cdot p(0 \leq W < B_1) + B_1 \cdot p(B_1 \leq W < B_2) + \ldots + B_M \cdot p(B_M \leq W < B_{M+1}) = \sum_{j=1}^{M+1} B_{j-1} p_j . \quad (7)$$

And, in case of applying the above lower-bound, the variance of WTP is estimated by the following formula(8).

$$V\left(\sum_{j=1}^{M+1} B_{j-1} p_j\right) = \sum_{j=1}^{M+1} B_{j-1}^2 [V(F_j) + V(F_{j-1})] - 2 \sum_{j=1}^{M} B_j B_{j-1} V(F_j),$$

$$V(F_j) = \frac{F_j(1-F_j)}{N_j + Y_j} . \quad (8)$$

Ⅲ. ANALYSIS RESULTS

1. DATA

Measuring consumers value of organic beef[5] with parametric and non-parametric methods, a survey research was carried out from the beginning of September 2002 to the end of September 2002, targeting consumer(housewives) residing in Seoul and Daegu. In the total 600 response questionnaires, 521 questionnaires were used in the practical analysis, except 79 samples which has no response to the main variables necessary for measuring consumers' value.

Tabie 1. Basic Statistic

Variables	Description	Mean	Standard deviation
INCT	Monthly average income(in million won)	2.53	1.32
AGE	years	41.7	3.8
EDU	Educational level(1 = Under middle school, 2 = High school, 3 = Over college and university)	2.2	0.6

For measuring consumers' value, questioned with the DC method, 1 keun(600g) was set as the unit of regular and organic

5) According to the eco-friendly agricultural product labeling and certification system(2001.7.1), organic beef should feed cow(12 months), pig(6 months after birth) organically way after the transition period. Feed grains should be processed organically(organic grains) to ruminants over 85% and non-ruminants over 80%. The addition can be used as defined in the announcement by Ministry of Agriculture and Forestry Republic of Korea and Codex. It is identified only not to use antibiotics and growth hormone.

beef. Also, the quotation price of organic beef per unit, comparing with regular beef price, is suggested to select the price level from minimum ₩1,400, ₩2,800, ₩4,200, ₩5,600, ₩7,000, ₩8,400, and ₩9,800, up to maximum ₩11,400 price.

The basic statistic of 521 samples for measuring consumers' value of organic beef is shown as the following <Table 1>. The household monthly average income is 2.53 million won, while the average educational level is over high school, and the average age is 41 years old.

2. ANALYSIS RESULTS

To estimate this model, the method of maximum likelihood was used, the result of estimating linear logit and log logit model is summarized as the following <Table 2>. In view of the model's goodness-of-fit, there is no difference between the linear model and log model. Explanatory variables presented for measure consumers' WTP extra for organic beef are: the price gap between beef fed organically and beef fed regularly(BID); individual respondents' income level(INCT), age(AGE) and educational level(EDU). As the result of estimating linear and log model, t-values of BID, the price gap between organic and regular beef, are each -4.5 and -4.23. It is statistically significant at the 5% significance level. Income level, age and educational level were analyzed as having low statistical significance.

Table 2. Logit model estimation results

Division	Linear logit model	Log logit model
Intercept	0.24	4.08
	(0.22)	(1.01)
BID	-0.168×10-3	-0.7541
	(-4.50)*	(-4.23)*
INCT	0.1095×10-2	0.2014
	(1.35)	(1.20)
AGE	0.1064×10-1	0.4142
	(0.43)	(0.41)
EDU	0.2527	0.3704
	(1.49)	(1.14)
Model χ^2	27.9	25.7
% of Right Prediction	0.61	0.62
N	521	521

( ) indicates asymptotically t-value.
* significant at 5% significance level.

Utility function of organic beef is a decreasing function on price. In other words, the coefficient is estimated as negative. As the coefficient signs of income level, age and educational level are increasingly estimated all positive, it indicates content with the utility function property.

Utility function is a decreasing function on price. That is the higher the price gap between organic and regular beef, the less probability to select beef fed organically. In other words, as beef price guaranteeing safety goes higher, demand on safety goes lower. Also, utility function is an increasing function on income level, age and educational level. It means that as income level, age, and educational level are higher, probability to choose safety guaranteed organic beef is higher.

In the Turnbull distribution-free model, each quotation price

by level and the probability of selecting beef fed organically are used for measuring consumers' WTP extra for the safety of beef fed organically. The response results of each quotation price level for organic beef are as <Table 3>. It defines the number of 'yes' responses and 'no' responses for organic beef at the quotation price and the probability of 'no' responses at the quotation price.

Table 3. Response results by quotation price level

Quotation price	respondent.	Yes	No	Probability('no')
1,400	23	18	5	0.2174
2,800	63	48	15	0.2381
4,200	71	54	17	0.2394
5,600	110	69	41	0.3727
7,000	103	62	41	0.3981
8,400	68	32	36	0.5294
9,800	55	30	25	0.4545
11,400	28	16	12	0.4286
Total	521	329	192	

The PDF of selecting 'no' at the gap price between beef fed organically and regular beef has value p_j. When the value p_j is negative, repeatedly correct when the probability p_j of the observation point has a positive value. Thus, in this study, using the purchasing price gap between organic and regular beef as the quotation price, when the quotation price is ₩9,800 and ₩11,400, the monotonicity of CDF is not satisfied. As examined

Table 4. Calculated Estimates Turnbull Distribution

Quotation price range	Turnbull CDF	Turnbull PDF
0 ~ 1,400	0.2174	0.2174
1,400 ~ 2,800	0.2381	0.0207
2,800 ~ 4,200	0.2394	0.0013
4,200 ~ 5,600	0.3727	0.1333
5,600 ~ 7,000	0.3981	0.0254
7,000 ~ 8,400	0.5294	0.1313
8,400 ~ 9,800	pooled	pooled
9,800 ~ 11,400	pooled	pooled
11,400 ~ +	1.0000	0.4706

in the Turnbull distribution-free model, it is needed to use the cumulative distribution probability considering responses at the lower previous price level.

Defining quotation price intervals with the Turnbull cumulative distribution function, CDF(F_j) and the Turnbull probability density function, PDF(p_j) calculated as above, is summarized as <Table 4>, based on the lower-bound.

2. ANALYSIS RESULTS OF CONSUMERS' VALUE OF ORGANIC BEEF

For measuring consumers' value of organic beef, the overall mean WTP and median, mean WTP, and truncated mean WTP can be employed in the logit model assuming and estimating function form. Additionally, the mean WTP can be defined with CDF and PDF given from the individual responses for organic beef, based on the lower-bound quotation prices by each level in the Turnbull distribution-free model using the

response results of individual respondents to quotation price without assuming function form.

Table 5. WTP for organic beef

Unit: Won/600g

Division	Linear logit model	Log logit model
Total Mean(Median)	9,109	(10,607)
Mean	10,275	-
Truncated Mean	7,186	7,370

Table 6. WTP for organic beef(Turnbull model)

Unit: Won/600g

division	Estimate
Mean	7,019
Standard deviation	268.9
95% confidence interval	6,491.7～7,545.7

The results of measuring consumers' WTP extra for organic beef are summarized as the following <figure 5> and <figure 6>. As explained above, the mean WTP for organic beef, estimated in the logit model, is slightly different by various measurement value types. In the linear logit model, total average and median WTP for organic beef are ₩9,109/per 600g, average is ₩10,275 and the truncated average is ₩7,186. Also, in the logit model, median WTP for organic beef is ₩10,607 and truncated average is ₩7,370. In the Turnbull distribution-free model, mean WTP for organic beef is ₩7,019 while standard deviation is ₩269, given from individual responses. Accordingly, the 95% confidence interval is ₩6,492~₩7,546.

This is interpreted as consumers' WTP extra for organic beef. If the price gap between organic and regular beef is in the range of ₩7,019~₩10,275, consumers would purchase organic beef. In other words, individual beef consumers highly estimate the value of organic beef safety as much as ₩7,019~₩11,275 per 600g, compared with regular beef.

Among the previous studies on beef products, Kim Tae Kyun, et al.(2002) found that the WTP for HACCP processed beef safety was ₩1,953~₩2,140/per ㎏. Kim Man Keun, et al.(1998) also found that the WTP for beef safety was estimated ₩6,231~₩10,726/per ㎏ by the DC method. As Kim Tae Kyun, et al.(2002) didn't estimate the beef safety itself but the HACCP processed beef safety after slaughter, the WTP extra is less thoroughly estimated than in this study.

Ⅳ. Summary and Conclusions

The object of this study is to measure. consumers' WTP extra for organic beef compared to regular beef. For this, the dichotomous-choice contingent valuation method is adapted. Analysis models are logit model, parametric access method assuming specific function form and the Turnbull distribution-free model, non-parametric access method using the response results of individual respondents to quotation price without assuming function form.

The goodness-of-fit estimated model with the method of maximum likelihood is analyzed as no difference between the linear and log model. Also, as the result of estimating the linear and log model, the BID showing price gap between organic and regular beef is statistically significant, and utility function of organic beef is a decreasing function on price. In other words, the coefficient sign is estimated as negative. As the coefficient signs of income level, age and educational level are all estimated positive, it indicates content with the utility function property.

Utility function is decreasing function on price. That is, the higher price gap between organic and regular beef, the less probability to select beef fed organically. In other words, as beef price guaranteeing safety goes higher, demand on safety goes lower. Also, utility function is increasing on income level, age and educational level. This means that as income level, age, and educational level are higher, probability to choose safety guaranteed organic beef goes higher.

In the linear logit model, overall mean WTP for organic beef and median are ₩9,109/per 600g, while average is ₩10,275, and truncated average is ₩7,186. Also, in the logit model, median WTP for organic beef is ₩10,607 and truncated average is ₩7,370. In the Turnbull distribution-free model, mean WTP for organic beef is ₩7,019, the standard deviation is ₩269, from individual responses. Accordingly, the 95% confidence interval is ₩6,492~₩7,546/600g.

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To meet the change in consumers' food consumption patterns and the demand for safe food, food safety guarantees become a significant issue. Especially, related to livestock products, it is considered that a safety guarantee is an important issue in all the processes from production(fattening process) after slaughter to the consumer table. Consequently, the research on measuring consumers' value by range including values by individual steps (fattening process+butchery HACCP) is left for further study.

REFERENCES

Kwon, Oh-Sang, "Estimating the Willingness to Pay for the Non-GMO Agricultural Products: A Contingent Valuation Study", Korean Journal of Agricultural Economics, 44: 111-131, 2003.

Kim, Man-Keun · Han, Doo-Bong · Jong, Pok-Cho, "Estimating the Value of Food Safety in Beef Consumption", Korean Journal of Agricultural Policy, 25 : 181-196, 1998.

Kim, Tae-Kyun · Kwock, Chang-Keun · Park, Sung-Hoon · Kim, Hye-Young, "Measuring the Consumers' Value of HACCP at Slaughter Plants", Korean Journal of Agricultural Economics, 43 : 63-81, 2002.

Kim, Tae-Kyun · Choi, Kwan, "Measuring the Consumer Value of Food

Safety : Calibration of Contingent Valuation", Korean Journal of Agricultural Economics, 38 : 1-17, 1997.

Choi, Tae-Gil · Kim, Tae-Kyun · Cho, Jae-Hwan, "Measuring the Consumer's Value of Quality Certificated Farm Products", Korean Journal of Agricultural Management and Policy, 27 : 1-13, 2000.

Heo, Joo-Nyung · Kim, Tae-Kyun · Byu, Sang-Hee, "Measuring Consumers' Value of Quality-Certificated Peachesusing Logit and Turnbull Models", Korean Journal of Agricultural Management and Policy, 27 :91-102, 2000.

Cameron, T. C., "A New Paradigm for Valuing Non-Market Goods using Referendum Data: Maximum Likelihood Estimation by Censored Logistic Regression", Journal of Environmental Economics and Management 15 : 355-379, 1988.

Duffield, J. W. and D. A. Patterson, "Inference and Optimal Design for a Welfare Measure in Dichotomous-Choice Contingent Valuation", Land Economics 67 : 225-239, 1991.

Haab, T. C., and K. E. McConnell, "Referendum Models and Negative Willingness to Pay: Alternative Solutions", Journal of Environmental Economics and Management 32 : 251-270, 1997.

Hanemann, W. M., "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses", American Journal of Agriculture Economics 66 : 332-341, 1984.

Kriström, B., "A Non-Parametric Approach to the Estimation of Welfare Measures in Discrete-Response Contingent Valuation Studies", Land Economics 66: 135-139, 1990.

Kriström, B., "Spike Models in Contingent Valuation", American Journal of Agriculture Economics 79 : 1013-1023, 1997.

McFadden, D., "Contingent Valuation and Social Choice", American Journal of Agricultural Economics 76 : 689-708, 1994.

Turnbull, B., "The Empirical Distribution Function with Arbitrarily Grouped, Censored Truncated Data", J. Roy. Statist. Soc. Ser. B 38 : 290-295, 1976.