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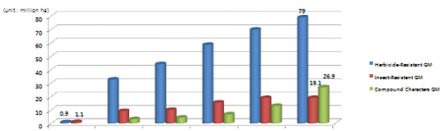
Measuring Willingness to Accept(WTA) for GM food by Characteristics : Hypothetical Bias in Choice Experiments

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I. Introduction

- Rapid increase in the acreage and market size of genetically modified(GM) agricultural products.
- The cultivation area of stacked GM crops, which consist of two or three compound characters, is increasing recently.
- Despite the rapid growth of GM food market, there has not been any research on consumers' willingness to accept for GM food of different technological characteristics.
- The study of consumers' preference of GM food by technological characteristics is important in that it provides the economic rationality to develop GM food.
- However, as there is the hypothetical bias problem in a choice experiment. It is necessary to conduct an empirical study to determine the rational behind the use of the valuation method for non-market goods.



<Figure 1> Acreage of GM Crops by Characteristics

II. Objectives

Questions to Address

1. How strong is consumers' willingness to accept for GM food of different characteristics?
2. Will there be a hypothetical bias in a choice experiment?
 - Is it rational to use the valuation method of non-market goods?

Purpose of Research

1. Estimate consumers' willingness to accept (WTA) for GM food by characteristics.
 - Estimate the WTA of GM rice of various types with a different technological characteristic, such as herbicide-resistant GM rice, insect-resistant GM rice, and functionality-enhanced GM rice.
2. Empirical analysis of hypothetical bias in choice experiments.
 - Verify the difference in WTA between real situation and hypothetical situation.

III. Methods

Methods : Conduct choice experiment under real situation and hypothetical situation.

- All conditions are same except the actual payment in real situation.

Experiment item : Rice (1 kg)

- Herbicide-resistant GM rice, Insect-resistant GM rice, Functionality-Enhanced GM rice (golden rice), Non-GM rice.
- All other characteristics such as weight, color, freshness, and packaging are identical.
- To perform a choice experiment under real situation, the survey participants were informed that the product in the choice experiment is a specially ordered (produced) product, even though a product of same quality was produced in the experiment.
- To improve the reliability of the product, a newly created brand tag was attached to the product.



- Composition of a questionnaire choice set related to technological and price characteristics of GM rice.
- Present the following 5 alternative choices: non-GM rice, herbicide-resistant rice, insect-resistant rice, functionality-enhanced rice (golden rice), and none of the above.
- Set the price range of rice from 1,500(\$1.17) to 6,500(\$5.08) (base exchange rate of \$1=1,280 in the period of August 17 ~ 19, 2009).
- Sixteen profiles of maximum efficiency were drawn and grouped into four sets of profiles, with each set containing four profiles.

<Figure 2> GM Rice by Characteristics

<Table 1> Example of questions for the real and hypothetical choices

Q. 1	Non-GM Rice (1kg) 3,900won(\$3.05)	Herbicide-Resistant GM Rice(1kg) 3,500won(\$2.73)	Insect-Resistant GM Rice (1kg) 1,500won(\$1.17)	Functionality-Enhanced GM Rice(Golden Rice) (1kg) 5,000won(\$3.91)	None 0 won
Choose One	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Setting the experimental conditions for real value evaluation

- Real value evaluation: as in the purchase of general items, the survey participants have the obligation to purchase the item of his or her choice and actual payment is made.
- A total of 86 survey participants were selected in consideration of consistency and population traits such as age and gender.
- An experiment allowance of 40,000won(\$31.25) was provided to each panelist.
- Explain positive and negative aspects of GM food and technologically different types of GM rice before the experiment.
- Let each survey panelist answer the four questions (Q1-Q4) after letting her or him observe the 4 kinds of rice on experiment.
- Pick questions (Q1-Q4) randomly and make each panelist actually pay the price of rice he or she selected.



<Figure 3> Experiment participants

Setting the experiment conditions for hypothetical value evaluation

- Hypothetical value evaluation: no actual payment is made.
- A survey method identical to one in real value evaluation was used except that no actual payment is made for alternative choices.
- Consumers who live in the Daegu region and who are of more than 20 years of age were the target of survey, and a total of 220 samples were collected.

IV. Results & Discussion

- The WTA payments for GM rice of different characteristics were estimated.
- The base group is set at consumers of non-GM rice. Therefore, WTA means minimum amount of compensation for giving up the consumption of non-GM rice in place of GM rice.
- The amounts of WTA under real situation and hypothetical situation were compared and estimated, and a multinomial logit model was applied.

Multinomial Logit Model

- In the actual and hypothetical value evaluations, all attribute variables are significant at 1% level.
- In comparison to the estimates of non-GM rice and functionality-enhanced GM rice, the estimate coefficient of other GM (that is, GM rice with the exception of functionality-enhanced GM rice) was shown to be smaller.
- Therefore, one can see that, relatively speaking, consumers don't prefer GM rice with the exception of functionality-enhanced rice (golden rice).
- The coefficients of price are estimated to be negative(-).

<Table2> Estimated result of multinomial logit model

Parameter	Real Situation		Hypothetical Situation	
	Estimate	Standard Error	Estimate	Standard Error
Non-GM Rice	3.6458*	0.3017	3.7888*	0.2299
Herbicide resistant-GM Rice	1.4131*	0.3376	1.3476*	0.2585
Insect-resistant-GM Rice	1.8986*	0.3127	1.5248*	0.2509
Golden-GM Rice	3.4538*	0.3253	3.3029*	0.2452
Price	-0.00045*	5.37E-05	-0.00025*	3.28E-05
Number of Cases	1,720		4,400	
Likelihood Ratio	-404.91		-960.37	
AIC	819.82		1931	

[None asterisk(*) denotes values that are statistically significant at the 0.01 level.

- The WTA (percentage of non-GM rice price) in real situation : herbicide-resistant rice 53.5%, insect-resistant rice 41.9%, functionality-enhanced rice 4.6%
- The WTA in hypothetical situation : herbicide-resistant rice 47.1%, insect-resistant rice 43.6%, functionality-enhanced rice 9.3%
- In both real and hypothetical situations, consumers showed positive acceptance to functionality-enhanced rice (nutrition-wise).
- In the real situation where one has to make real payment, consumers are found to be sensitive to the price.

<Table3> WTA for GM Rice by Characteristics

Willingness to Accept for	Real Situation	Hypothetical Situation
	Amount(won'100)	Amount(won'100)
Herbicide resistant-GM Rice	4,966(53.5%)	9,720(47.1%)
Insect-resistant-GM Rice	3,888(41.9%)	9,015(43.6%)
Golden-GM Rice	427(4.6%)	1,925(9.3%)

- Bootstrapping was used to explain the gap in the willingness to accept for GM rice of different technological characteristics.
- Re-sampling through bootstrapping was repeated 1,000 times, and the 95 percentage confidence intervals of WTA are shown in Table 4.

<Table4> WTA Confidence Interval Estimation

Commodities	95% Confidence Intervals of Consumers' WTA			
	Real Situation		Hypothetical Situation	
	lower bound(won'100)	upper bound(won'100)	lower bound(won'100)	upper bound(won'100)
Herbicide resistant-GM Rice	4,966 (61.2%)	5,036 (61.5%)	9,766 (64.5%)	9,859 (64.6%)
Insect-resistant-GM Rice	3,888 (47.9%)	3,941 (48.1%)	9,044 (59.7%)	9,168 (59.8%)
Golden-GM Rice	408 (5.0%)	438 (5.4%)	1,933 (12.8%)	1,977 (12.9%)

Hypothetical Bias Test

- For the same presented amount, the WTA under hypothetical situation is higher than the WTA under real situation.
- Hypothetical bias test using the non-parametric Wilcoxon test
- Confirm the presence of hypothetical bias between two value measures at 1% significance level.
- In hypothetical situation, consumers ignored the fulfillment of the compensation for consuming GM rice.
- The risk that can serve as a factor threatening the reliability of hypothetical value estimation

<Table 5> Nonparametric Wilcoxon test

Variables	Mean		Wilcoxon Rank Sum Z(p-value)
	Real Situation(won'100)	Hypothetical Situation(won'100)	
Herbicide resistant-GM Rice	5,002	9,833	-38.7201* (<0.0001)
Insect-resistant-GM Rice	3,915	9,106	
Golden-GM Rice	423	1,956	

[1] one asterisk(*) denotes values that are statistically significant at the 0.01 level.

V. Conclusions

- Amid continued social debate over positive potential and negative risks of GM foods, the consumer recognition and acceptance of GM foods are relatively low.
- However, since consumers show positive attitude toward functionality-enhanced GM food (ex: golden rice).
- The analysis result of consumers' willingness to accept (WTA) for GM rice of different characteristics reveals that consumers' preference differs depending on the type of GMO with different technological characteristics.
- The functionality-enhanced GM rice gives substantial benefits to consumers and its WTA, rather than the WTA of GM rice with strong agronomic traits, is analyzed to be the lowest.
- It is predicted that GM food, especially functional GM food, can be marketable if various technologies related to health are applied and if there is a modest decrease in production cost.
- In the meantime, a gap occurred in the WTA under the experimental situation (real and hypothetical) of a choice experiment.
- This confirms that a choice experiment under a hypothetical situation can generate hypothetical bias by overestimating the WTA.
- Therefore, it is necessary to conduct a follow-up study on the methodology of solving the hypothetical bias problem in future choice experiments.