CONSUMERS' VALUATION OF RICE GRADE LABELING

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Abstract

The objectives of this study are to identify consumers' willingness to pay (WTP) for each rice grade (i.e. super, good, and normal) and to investigate consumers' valuation for a mandatory rice grading system. We utilized a non-hypothetical experimental auction (i.e. random nth price auction) to elicit consumers' valuation for rice grades and used contingent valuation method (i.e. double-bounded dichotomous choice) to obtain consumers' valuation for the mandatory rice grading system. Our results generally suggest that the provision of rice grade labeling to consumers is very important to enhance the value of domestic rice. Moreover, quality differentiation of rice is critical to receive a high price since Korean consumers have a strong preference and high valuation for 'Super' grade rice. Korean consumers also have a positive preference for the mandatory rice grading system without the 'no test' option. These results partly give an incentive to improve the current rice grading system in South Korea.

Keywords

1. Introduction

Korea opened its rice market through a minimum market access (MMA) scheme for twenty years from 1995 to 2014 as a result of the inauguration of the World Trade Organization (WTO). Korea changed its import framework of rice from the MMA to tariffication in 2015. This reform increased quantity of imported rice and caused more market competition between domestic and imported rice. Importantly, it is also worth noting that rice consumption per capita in Korea has dramatically decreased from 106.5 kg in 1995 to 65.1 kg in 2014. Both an increase in imported rice and a decrease in domestic consumption can destabilize the Korean rice industry.

Rice is the main staple food and major income source of farms in Korea[1]. A stable demand for domestic rice is thus important for food security because it will bring about the steady supply of domestic rice. To increase consumption of domestic rice, consumers should easily differentiate domestic rice from imported rice and quality of domestic rice should be satisfied by consumers. Consequently, the Korean government introduced a new domestic rice grading system in 2011. The purpose of the rice grading system is to satisfy consumers' right to know and improve the quality of domestic rice. Based on this system, domestic rice is classified into 3 grades (i.e. super, good, and normal) and 'no test' option is allowed because of the high marketing cost of grading[2].

However, the new rice grading system was not effective since both allowing "no test" option and no price differentiation of each rice grade did not give a strong incentive to rice manufacturers to follow the policy. According to the current investigation of the National Agricultural Products Quality Management Service (NAQS), about 75% of domestic rice in retail markets were labelled 'no test'. Given the high percentage of rice that has the "no test" label, it is imperative that this "no test" option in the Korean rice grading system be eliminated.

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[1] About 47 percent of the caloric intake and 70 percent of farm income come from rice in Korea (Lee et al., 2014)

[2] A "no test" label means that the rice product has not been tested for grade.

Moreover, each rice grade should be differentiated by price to induce improvement of domestic rice quality and encourage rice grading test.

To partly determine the feasibility of doing them, it is necessary to know how consumers would value each rice grade and a mandatory rice grading scheme without the 'no test' option. Thus, the objectives of this study are i) to identify consumers' willingness to pay (WTP) for each rice grade (i.e. super, good, and normal) and ii) to investigate consumers' valuation for a mandatory rice grading system. We utilize a non-hypothetical experimental auction (i.e. random nth price auction) to elicit consumers' valuation for rice grades and use contingent valuation method (i.e. double-bounded dichotomous choice) to obtain consumers' valuation for the mandatory rice grading system. We also provide different amount of information about each rice grade in the experiment to determine the efficacy of current labeling.

2. Korea Rice Grading Scheme

Rice grade labeling has been made mandatory by the Korean government since November 1, 2011. Rice grading was sub-divided into 5 ranks (from 1 to 5) and labels on non-glutinous rice product packaging was necessary, but no demands were made for glutinous rice, black rice and flavored rice. The protein content indication has also been mandatory.

A 'no test' option was allowed in the current rice grading system because rice manufacturers faced some difficulties to follow the system. First, the equipment for rice grading was so expensive and it caused cost burden to manufacturers to conduct the test. Second, if manufacturers violated the rule during the test process, they were warned or asked to temporarily cease business operations.

The Korean government thus revised the Implementing Regulations (article 7 of 3) in the Grain Management Act in 2013. First, the current rice grading scheme involved three grades (i.e. Super, Good, normal) and a 'no test' option was allowed. Second, the duty of protein

content indication was on as voluntary basis. The purpose of this revision was to increase the effectiveness of the three grade-marks by making the rice grading criteria easy to understand. Table 1 represents the current rice grade labeling.

Current rice grades are decided by using criteria that include a ratio of moisture, presence of broken rice, fracture particles, damaged grain, and heat loss grain, foreign material (piece of stone, plastic, glass, iron and whether the species grain is different from the standard). Table 2 shows the maximum percentage of each criteria.

Table 1. The current rice grading labeling on rice product packaging

Variety of rice	Chujeong	Weight	20kg
Grade (Mark "○" on related grade)	Super, Good, Normal, No test	Protein content level (voluntary label)	low, general, high, no test
		The lower protein content level, The better rice taste	
Production year	2012	Polishing date	2013. 10. 2.

Source: National Agricultural Products Quality Management Service (NAQS).

Table 2. Korea Rice Grading Criteria

Grade	Moisture	Broken rice	Fracture particle	Damaged grain	Heat loss grain	Foreign material
Super	16.0%	3.0%	2.0%	1.0%	0.0%	0.1%
Good	16.0%	7.0%	6.0%	2.0%	0.0%	0.3%
Normal	16.0%	20.0%	10.0%	4.0%	0.1%	0.6%

Note: % means the maximum percentage
Source: National Agricultural Products Quality Management Service (NAQS).

However, a recent survey conducted by the National Agricultural products Quality management service (NAQS) reported that about 75% of rice products in the retail market had the label of 'no test' (Figure 1). This suggests that the fundamental problem of the current rice grading system comes from the permission of the 'no test' option. The high percentage of rice that has 'no test' label caused a low consumer trust in domestic rice. No difference in price by

quality grade is also one of potential reasons to have high percentage of rice with 'no test' and it gave rice producers less motivation to produce good quality of rice.

Consumers should be able to purchase good quality rice by identifying information about rice grades and rice producers should also be compensated for the effort they put into ensuring good quality of rice. Therefore, it is required to get rid of the 'no test' option in the current rice grading system and differentiate rice price by quality grading to effectively implement the rice grading system.

Figure 1. The ratio of rice grade mark in Korea rice products
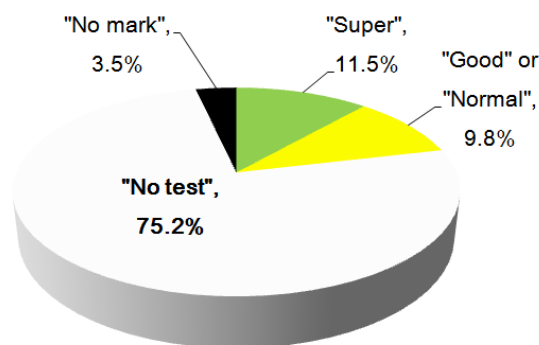
Note: Investigation period (October 15, 2014 ~ November 15, 2014), Subjects (National survey on 1,116 firms in the nation, retailer 1,036, manufacturer 80)
Source: National Agricultural Products Quality Management Service (NAQS).

3. Experimental Design

Subjects Design

The main target of our experiment are housewives between in their 20s through to 60s since they are the primary purchaser of rice. A total of 212 participants living in Seoul were recruited. Among total subjects, 103 people were recruited through a research company and the others (109 people) were directly recruited by researchers. We considered participants' age and region when recruiting them.

Figure 2 shows a map of the Seoul area in Korea[3]. The Seoul area is divided into the districts south and north of the Han River. It is also divided into east side and west side of Seoul. We recruited participants by considering the population ratio of each area in Seoul.

Table 3 shows the local and age weights of participants. About 5.11 million females were living in Seoul and about 3.77 million females were between 20s and 60s in their age according to local census in 2015. Age share between 20s and 60s of our participants were similar to local census but regional share of our participants slightly differed from the local census.

Figure 2. Map of Seoul in Korea
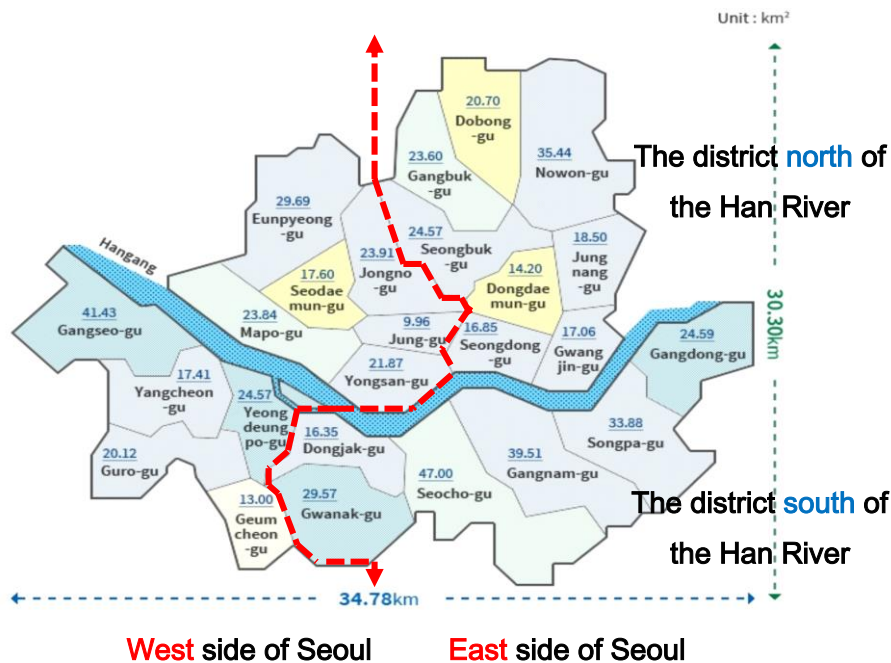
Table3. Local and age weights of participants

Categories		A component ratio	
		Participants	Women in Seoul
Local	North(West)	22%	17%
	North(East)	28%	31.5%
	South(West)	26%	21%
	South(East)	24%	30.5%
Age	20s	13%	19%
	30s	22%	22%
	40s	21%	23%
	50s	24%	22%
	60s	19%	14%

The summary statistics of participants' demographic characteristics is in table 4. Average age of subjects was 45.7 years and each age group between 20s and over 60s is distributed by 13.2%, 22.2%, 21.2%, 24.1%, and 18.9% respectively. In case of the education level, 'university graduates' was the highest proportion with 40.6%, followed by 'high school graduates' (29.7%) and 'college graduate' (19.3%). Moreover, 20.8 percent of respondents were employed, and 85.8 percent were married. The average household size was 3.3 persons and the highest proportion of the monthly household income was between 4 million ~ 4.99 with 20.8%, followed by 5 million ~ 5.99 million (17.5%) and 3 million ~ 3.99 million (15.1%).

Table 4. Participants' Socioeconomic Characteristics (N=212)

Variable	Categories	Freq. (n)	Percent (%)	Variable	Categories	Freq. (n)	Percent (%)
Age	20s	28	13.2	Family size	1	14	6.6
	30s	47	22.2		2	40	18.9
	40s	45	21.2		3	55	25.9
	50s	51	24.1		4	80	37.7
	Over 60s	40	18.9		5	16	7.5
	Non-description	1	0.5		6	5	2.4
Education	Elementary school	2	0.9		7	1	0.5
	Middle school	10	4.7		Non-description	1	0.5
	High school	63	29.7	Income (10,000 won)	Less 100	6	2.8
	College	41	19.3		100~199	9	4.2
	University.	86	40.6		200~299	21	9.9
	Master degree	10	4.7		300~399	32	15.1

Job	Have jobs	44	20.8	400~499	44	20.8
	Jobless	165	77.8	500~599	37	17.5
	Non-description	3	1.4	600~699	19	9.0
Marital status	Married	182	85.8	700~799	18	8.5
	Single	30	14.2	Over 800	23	10.8
	Non-description	0	0.0	Non-description	3	1.4

Experimental Auction

We first investigated participants' valuation for each rice grade using non-hypothetical experimental auction. We utilized the random n^{th} price mechanism which is incentive compatible and widely used by many researchers. A key characteristic of the random n^{th} price auction is that market price is endogenously determined at random (Shogren *et al*., 2001). This method potentially keeps bidders with relatively low values engaged in the auction and provides a relatively high degree of market feedback (Lusk and Shogren, 2007).

We also used the full bidding approach where participants were asked to simultaneously bid on four different rice grades (i.e. super, good, normal, and no test). The experiment was composed of three bidding rounds and each round differed in amount of information about rice grades. A binding round and binding rice product were randomly selected at the end of the experiment. The experiment was conducted from May 27 to July 8, 2015. A total of 16 sessions were conducted with each group consisting of 10 to 15 subjects. Every participant received 15,000 KRW as a participation fee in the experiment, lasting about 50 minutes.

Auctioned samples are packs of 1 kg of same brand rice produced in Hwaseong, Gyeonggi province. We got four different grades of rice with a 'Super', 'Good', 'Normal' and 'No test' by special-order[4]. The average market price of 1 kg of the rice product was about 4,000 KRW. The rice products of the four different grades were packed in a clear plastic bag and placed on

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[4] Korea rice products are commonly sold by marking only one grade per rice brand because of packing problem.

the subjects' desks.

A total of 3 bidding rounds were conducted with different amount of information about rice grades. No information was provided in the first round and subjects could only see, touch and smell each rice sample. For the second round, participants were provided simple rice-grading information (labeling of each rice grade only). They were provided detailed information about rice grades in the third round (both labeling and detailed meaning of each grade). Table 5 shows three treatments of the experiment. Specific steps of the experimental auction are as follows:

Step1: Participants arrive and are assigned their seats. They then receive their ID numbers that will be used for the entire experiment. These ID numbers will not be shared in the room of participants.

Step2: Participants are required to sign a consent form and to agree to act as subjects in the experiment. They are verbally instructed about the experimental auction. In other words, they are informed about how they should bid to buy the four different types of rice.

Step3: Before proceeding to the real auction, participants have the chance to take part in a practice auction with serial bar. It helps understand the properties of the auction and become familiar with the auction framework. Participants are then be asked a simple quiz to determine if they fully understand the auction procedures.

Step 4: After the practice auction, we conduct the random n^{th} price auction with rice products. After a blind test (i.e. visual, touch and smell test), participants submit sealed bids representing their WTPs to buy the four different types of rice products in the first round. For the second round, subjects are provided rice-grading information (i.e. labeling of each rice grade) and submit their bids for each rice product. They receive detailed information about each rice grade (i.e. both labeling and detailed meaning of each grade) and bid for each rice product in the third round.

Step 5: After all 3 rounds, a binding round and binding product are randomly selected from the envelope. A specific number is also randomly chosen from 2 to 15 (or the total number of subjects in a binding session) to determine the number of winners and market price. The N-1 highest bidders in the binding round purchase the binding product and pay the corresponding market price.

Table 5. Three Rounds of Experimental Auction

Round#	Round 1	Round 2	Round 3
	No grade information: only visual, touching and smell test	Simple grade information	Full detailed information on the meaning of each rice grade
Treatment			

Hypothetical Survey

We also conducted a hypothetical contingent valuation (CV) with same participants after finishing the auction experiment to elicit consumers' valuation for the mandatory rice grading system without the 'no test' option.

Before asking the CV questions, we provided subjects full information about each rice grade and also informed them that the Korean government would try to remove the 'no test' option on rice grading system. This revision would increase the processing cost of rice grades and it would increase rice price. Each subject was then asked the question about their additional valuation for the mandatory rice grading system.

Closed-end double-bounded dichotomous choice (DBDC) approach was used as the format of question since this method is more efficient than a single-bounded approach. Participants were asked the following question: 'The average retail price of 1kg rice in Korea is 4,000 won

(around $4). If the Korean government decides to get rid of the 'no test' option in the rice grading system, would you be willing to pay an additional (   ) won above the average price of 4,000 won/kg?' Based on their responses, participants were then asked a follow-up question. If the respondent answered 'yes' to the first question, she was then asked whether she would be willing to pay double the amount proposed in the first question. If the respondent said 'no' to the first question, she was asked whether she would be willing to pay half the amount indicated in the first question. To avoid a starting point bias, we randomly selected a price from the pre-determined price distribution (10 levels of prices from 200 won to 2,000 won) for each respondent for the first question. A cheap talk script was also read and shown to participants to minimize potential hypothetical bias (Lusk and Shogren, 2007).

Table 6. The Question Strategies of CV methods

The average price of 1kg rice in Korea is 4,000 won. If the Korean government decides to get rid of the 'no test' option, would you be willing to pay an additional _____won_____ above the average price of 4,000 won for a 1kg rice without 'no test' option in the Korea rice grading scheme?

Figure 3.The Double bounded dichotomous choice survey procedure

Price No. (randomly pick)	Initial(won)	Lower(×0.5)	Upper(×2)
1	200	100	400
2	400	200	800
3	600	300	1,200
4	800	400	1,600
5	1,000	500	2,000
6	1,200	600	2,400
7	1,400	700	2,800
8	1,600	800	3,200
9	1,800	900	3,600
10	2,000	1,000	4,000
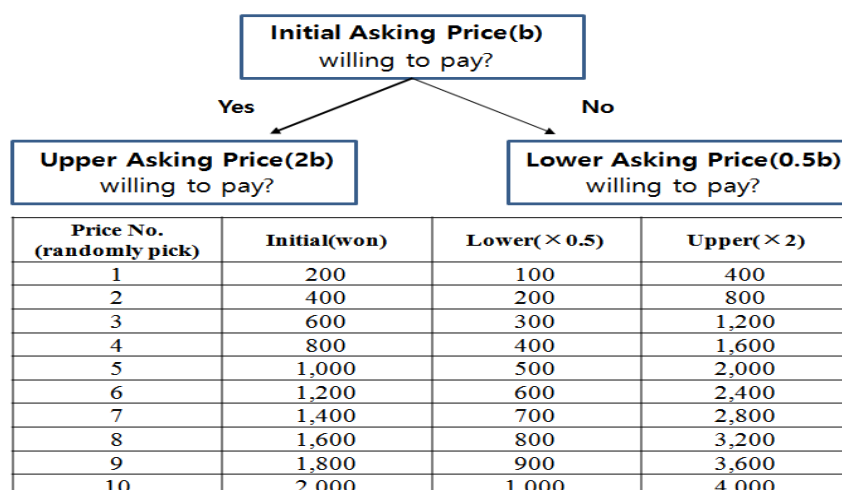
4. Empirical Results

Survey Results

We conducted a survey about awareness of rice grading. According to the survey results, participants averagely buy the rice product about 8 times a year. They usually purchased 20 kg packaging (47.6%) or 10 kg packaging (26.4%) of the rice product. In case of a purchasing place for the rice product, the response of 'Discount Mart' was more than a half of subjects (51.9%), followed by "Supermarket (19.3%)". Based on the rice price level categories, 38.2 percent of the participants purchase the price level of "42,000~51,000 won/20 kg". The level of prior information acquirement about the rice grading shows that 43.9 percent of participants acquire prior information about the grading system, followed by 'nothing at all' (33 %). Moreover, about 27 percent of participants do not check rice grade labeling when they buy the rice product. The majority of participants also think that they need the rice grade information when they purchase the rice product.

Table 7. Survey Results about Rice Grading (N=212)

Questionnaire	Respondents (Percent)					
	Frequency of purchasing Rice	Purchasing packing unit		Purchasing place		Purchase price (base on 20kg rice)	
Rice consumption propensity	Average of 8.1 times (per year)	1~8kg	28(13.3%)	Supermarket	41(19.3%)	Less than 41,000 won	65(30.6%)
		10kg	56(26.4%)	Discount Mart	110(51.9%)	42,000~51,000 won	81(38.2%)
		20kg	101(47.6)	E-Commerce	15(7.1%)	52,000~61,000 won	37(17.5%)
		Other	27(12.7%)	Other	52(21.8%)	52,000~61,000 won	29(13.7%)
Prior Information acquirement level	Nothing at all	Not much (1~2 times)		Some (3~5 times)		A great deal (more than 5times)	Not sure
	70(33.0%)	93(43.9%)		33(15.6%)		2(0.9%)	14(6.6%)
Checking Rice grading	Never	10~20%	20~40%	40~60%	60~80%	Every purchase
	57(26.9%)	29(13.7%)	39(18.4%)	21(9.9%)	30(14.1%)	36(17.0%)
Rice grading Needs	Strongly agree	Somewhat agree	Normal	Somewhat disagree	Strongly disagree	Don't Know
	70(33.0%)	103(48.6%)	29(13.7%)	6(2.8%)	1(0.5%)	3(1.4%)

Our survey results generally show that consumers rarely acquire information about the rice grading system. Moreover, they think that Korean consumers need rice grading information when they purchase the rice product. This simply implies that providing continuous rice grading information is necessary for rice consumers.

Analysis on Consumers' Value of Rice Grading

As previously mentioned, we provided three different amount of information about rice grades: no information in round 1, only rice grade labeling in round 2, and both labeling and detailed meaning of each rice grade in round 3. Table 8 illustrates mean bids from all rounds. The mean bid of super grade was the highest with 3,795 won/kg for rice product, followed by 'Good',' No test', and 'Normal' grade. In the second round, the mean bid of super grade was the highest with 4,392 won/kg for rice product, followed by 'Good', 'Normal', and 'No test'. In the third round, the mean bid of super grade was the highest with 4,338 won/kg for rice product, followed by 'Good', 'Normal', and 'No test'. The mean bids which were higher than the average price of 1 kg rice were only presented at 'super' grade in the second and third round. It shows that most consumers have a strong preference for the 'Super' grade of rice product with rice grading information.

Table 8. Mean bid across rounds (N=212)

Grade		Information Treatment		
		No Information (Round 1)	Grade only (Round 2)	Grade in detail (Round 3)
Super	Mean	3,795	4,392	4,338
	Median	3,900	4,300	4,200
	Std.dev.	842.74	939.8	962.03
Good	Mean	3,760	3,958	3,919
	Median	3,900	4,000	4,000
	Std.dev	708.04	741.09	814.47
Normal	Mean	3,660	3,548	3,521

	Median	3,800	3,800	3,700
	Std.dev	727.27	779.62	821.88
	Mean	3,700	3,209	3,160
No test	Median	3,800	3,500	3,500
	Std.dev	831.70	905.43	926.81

Figure 4. Mean bid trend in the Auction
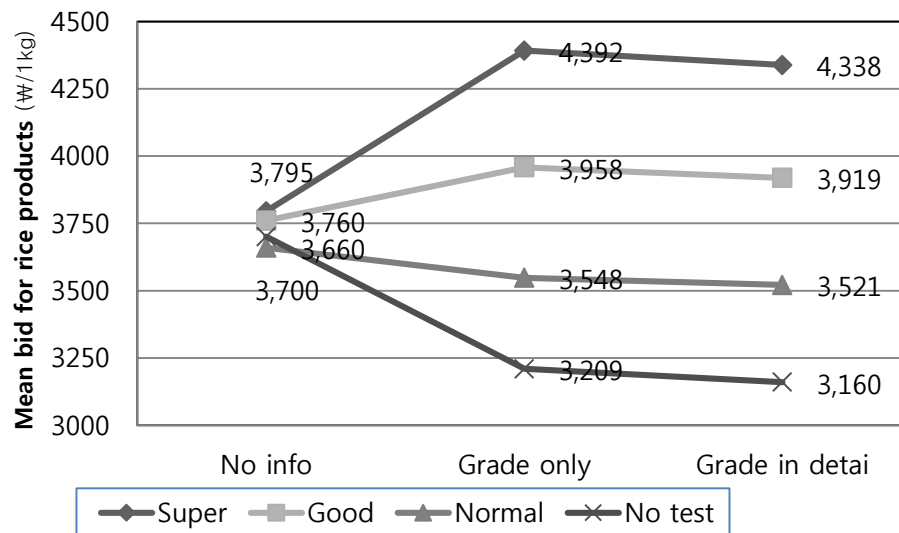
Figures 4 illustrates the trend of mean bid changes across rounds. The difference in mean bids between rice grades was quite small when participants had no information about rice grading. However, the mean differences between rice grades became bigger after participants were provided labeling information about each rice grade. Mean bids of all rice grades showed a slight decline in round 3 when participants were provided detailed information about rice grades compared to those in round 2.

The results show that rice grading information significantly change consumers' valuation for the rice product. Without labeling information, consumers could not easily distinguish four different rice products. However, they dramatically increased their values for the rice product with 'Super' grade and decreased values for the rice product with 'No test' with labeling information about rice grades. Detailed information about rice grades did not have significant impacts on consumers' valuations for the rice product. This suggests that labeling information

itself is enough to explain the quality of each rice product and rice consumers have a strong preference for grading information.

Table 9. T-test for equality of mean bid by information treatment

Grade	Treatment	Mean	Std. Error	t-value
Super	$H_0: \overline{WTP}_{No\ Info} = \overline{WTP}_{Grade}$	-596.88***	86.69	-6.88
	$H_0: \overline{WTP}_{No\ info} = \overline{WTP}_{Detail}$	-543.77***	87.83	-6.19
	$H_0: \overline{WTP}_{Grade} = \overline{WTP}_{Detail}$	53.11	92.36	0.57
Good	$H_0: \overline{WTP}_{No\ Info} = \overline{WTP}_{Grade}$	-198.01***	70.39	-2.81
	$H_0: \overline{WTP}_{No\ info} = \overline{WTP}_{Detail}$	-158.86**	74.12	-2.14
	$H_0: \overline{WTP}_{Grade} = \overline{WTP}_{Detail}$	39.15	75.62	0.51
Normal	$H_0: \overline{WTP}_{No\ Info} = \overline{WTP}_{Grade}$	112.07	73.22	1.53
	$H_0: \overline{WTP}_{No\ info} = \overline{WTP}_{Detail}$	138.86*	75.37	1.84
	$H_0: \overline{WTP}_{Grade} = \overline{WTP}_{Detail}$	26.79	77.80	0.34
No test	$H_0: \overline{WTP}_{No\ Info} = \overline{WTP}_{Grade}$	491.03***	84.43	5.81
	$H_0: \overline{WTP}_{No\ info} = \overline{WTP}_{Detail}$	540.47***	85.52	6.31
	$H_0: \overline{WTP}_{Grade} = \overline{WTP}_{Detail}$	49.43	88.98	0.55

The critical values for rejection of H_0: *** p<0.01, ** p<0.05, * p<0.1

Table 9 shows the mean equality test of bid changes by information. Both grade labeling and detailed grade information had significant effects on subjects' valuation for the rice product when we compared them with bids in round 1 (no information). However, subjects' bid changes were not significant between bids in round 2 and 3. It suggests that there is not much additional value gain from providing detailed information about rice grades to consumers.

Table 10 shows mean equality tests across rice grades. As we expected, consumers could not distinguish rice quality without rice grading information. However, consumers' bid changes were significant across rice grades when they were provided rice grading information. This implies that the provision of grading information is very important to enhance the value of domestic rice quality.

Table 10. Equality Tests of WTP Means across Rice Grades

Treatment	t-Test for equality of means		
	Mean	Std. Error	t-value
Round 1 (No information)			
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{Good}$	34.62	75.59	0.45
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{Normal}$	134.66*	76.45	1.76
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{No\ test}$	94.19	81.31	1.15
$H_0: \overline{WTP}_{Good} = \overline{WTP}_{Normal}$	100.04	69.71	1.43
$H_0: \overline{WTP}_{Good} = \overline{WTP}_{No\ test}$	59.57	75.01	0.79
$H_0: \overline{WTP}_{Normal} = \overline{WTP}_{No\ test}$	- 40.47	75.88	- 0.53
Round 2 (Grade Only)			
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{Good}$	433.49***	82.19	5.27
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{Normal}$	843.63***	83.86	10.05
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{No\ test}$	1182.12***	89.62	13.18
$H_0: \overline{WTP}_{Good} = \overline{WTP}_{Normal}$	410.14***	73.87	5.55
$H_0: \overline{WTP}_{Good} = \overline{WTP}_{No\ test}$	748.63***	80.35	9.31
$H_0: \overline{WTP}_{Normal} = \overline{WTP}_{No\ test}$	338.49***	82.06	4.12
Round 3 (Grade in detail)			
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{Good}$	419.52***	86.57	4.84
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{Normal}$	817.31***	86.90	9.40
$H_0: \overline{WTP}_{Supper} = \overline{WTP}_{No\ test}$	1178.44***	91.74	12.84
$H_0: \overline{WTP}_{Good} = \overline{WTP}_{Normal}$	397.78***	79.46	5.00
$H_0: \overline{WTP}_{Good} = \overline{WTP}_{No\ test}$	758.91***	84.74	8.95
$H_0: \overline{WTP}_{Normal} = \overline{WTP}_{No\ test}$	361.13***	85.07	4.24

The critical values for rejection of H_0: *** p<0.01, ** p<0.05, * p<0.1

We further analyzed the effect of information and other factors on consumers' valuation for each rice grade using the random effects panel model. Independent variables were composed of round effects (rice grade information treatment), frequency of checking rice grade, level of prior information acquirement about rice grading, level of needs for rice grading, frequency of purchasing rice product and participant' demographic characteristics. We withdrew 4 subjects from the regression analysis since they had some missing values in questionnaire.

$$Y_{ijt} = \alpha + \beta_1 Round2 + \beta_2 Round3 + \beta_3 Check + \beta_4 Information + \beta_5 Needs$$

$$+ \beta_6 Buy + \beta_7 Purchase\ price + \beta_8 Age + \beta_9 Education + \beta_{10} Job$$

$$+ \beta_{11} Family\ Size + \beta_{12} House\ Income + \delta\ u_{ij} + \varepsilon_{ijt}$$

$$(1)$$

where,   i = 1~208 (Participant ID),   t = 1,2,3 (Round number),

j = 1,2,3,4 ('Super', 'Good', 'Normal', 'No test' on rice grade)

Table 11. Variable Definition

Variable	Definition	Mean	Std.dev	Min	Max
Round	Grade only (1 or 0) / Grade in detail (1 or 0)	0.33	0.47	0	1
Check	When purchase rice, 1 = Every purchase check, check(60%~80%), check(40%~60%) 0 = Each time no check, check(10%~20%), check(20%~40%)	0.41	0.49	0	1
Buy _ year	Frequency of purchasing Rice (Number/Year)	8.14	6.01	0	48
Prior Information	How much would you have heard or read about **Rice grading**? 1= Some or A great deal, 0 = Nothing at all	0.60	0.48	0	1
Needs	Do you agree the need of **Rice grading** system for consumers right to know? 1= Agree(Strongly, Somewhat), 0= Disagree((Strongly, Somewhat)	0.82	0.38	0	1
Age	Age in years	45.75	13.40	0	1
Education	1 = more than College graduates, 0 = otherwise	0.45	0.49	20	69
Job	1 = have jobs, 0= housewives or jobless	0.20	0.40	0	1
Family size	Number of family members living in the household	3.30	1.16	1	7
House Income	1= ₩4,000,000 to more than ₩8,000,000 0= less ₩1,000,000 to ₩3,990,000	0.67	0.46	0	1
Obs.	208				

Table 12 represents the regression results from model (1). According to the results, rice

grading information significantly affected participants' WTPs for rice products which is

consistent with previous unconditional test results. From pooled data analysis, "grade only"

information generated a higher valuation than 'grade in detailed information', and it was

statistically significant. The mean WTP in the second round ('grade only' information) for

pooled rice grading was about 47 won/kg higher than that in the first round (no information) while the mean WTP in the third round ('grade in detail' information) was 3.7 won/kg higher than that in the first round. WTPs of subjects that frequently check the rice grade labeling were lower than WTPs of those who less check it. The level of prior information acquirement about rice grading was positively related with their WTPs. Especially, it was statistically significant on low grade of rice product. The level of needs for rice grade was positively related with their WTPs and statistically significant except 'normal' grade. In the case of demographic variables, 'education level' 'job' and 'household income' were statistically significant. The variables of 'education level' and 'job' has positively influenced their WTPs, 'household size' and 'household income' has negatively influenced their WTPs. Especially, the negative relationship between their WTPs for rice and household income reflects the current rice consumption trend. Rice consumption decreased despite the increase in national income. As a result of product dummy in the pooled model, the premiums of each grade is significantly higher than 'no test' grade. This may suggest potential possibility of price differentiation of domestic rice by grades.

Table 12. Random effect panel model estimation result

Variable	WTP_{Pooled}		WTP_{Super}		WTP_{Good}		WTP_{Normal}		$WTP_{No\ test}$	
	Coef	z-value	Coef.	z-value	Coef.	z-value	Coef.	z-value	Coef.	z-value
Intercept	3209.15***	22.22	3800.21***	12.42	3813.28***	15.02	3618.72***	14.06	3157.73***	11.09
Round2 (Grade only)	46.82*	1.89	599.23***	12.29	197.01***	5.55	-113.26***	-2.94	-495.67***	-9.56
Round3 (Grade in detail)	3.77	0.15	543.65***	11.15	157.59***	4.44	-142.50***	-3.70	-543.65***	-10.49
Check	-111.60**	-2.07	-84.07	-0.70	-122.19	- 1.23	-144.77	-1.43	-95.36	-0.86
Buy _ year	-0.65	-0.15	4.75	0.49	1.66	0.21	-1.85	-0.23	-7.15	-0.80
Needs	282.69***	4.19	426.01***	2.83	284.12**	2.27	190.43	1.50	230.23*	1.65
Prior Information	183.32***	3.39	137.16	1.14	160.42	1.60	235.66**	2.32	200.05*	1.79
Age	1.72	0.86	-4.71	-1.06	-2.74	-0.74	2.68	0.71	11.68***	2.81
Education	182.98***	3.22	63.63	0.50	207.26**	1.97	226.00**	2.12	235.03**	2.00
Job	181.26***	2.80	204.60	1.42	226.66*	1.89	228.02*	1.88	65.76	0.49
Family Size	-68.28***	-2.80	-54.91	-1.01	-71.46	-1.59	-82.50*	-1.81	-64.27	-1.28
House Income	-189.17***	-3.09	-163.81	-1.20	-180.61	-1.59	-259.66**	-2.26	-152.62*	-1.20
Super	817.16***	11.42								
Good	518.15***	7.24								
Normal	218.01***	3.05								
Observations	832		208		208		208		208	
Sigma u	668.76***		759.91***		641.73***		645.00***		690.56***	
Sigma e	505.93***		497.41***		362.18***		393.22***		528.49***	

*** p<0.01, ** p<0.05, * p<0.1

Korean Consumers' Value for Mandatory Rice Grading System

To estimate consumers' valuation for the mandatory rice grading system, we assumes that their WTPs are affected by socio demographic factors. The WTP function is specified as follows:

$$WTP_i\ (x_i, \varepsilon_i) =\ x_i\beta +\ \varepsilon_i,\ \varepsilon_i \sim N(0, \sigma^2) \tag{3}$$

where x_i is respondents' individual characteristics (demographic characteristics, the pattern of rice consumption and awareness of rice grading); β is a parameter estimates; ε_i is a random error term.

Since we have two consecutive questions with responses of 'yes' or 'no', four outcomes are possible: both are 'yes', both are 'no', 'yes' followed by 'no' and 'no' followed by 'yes'. We could set up the probability of each possible outcome[5]. With these probability functions, we could construct the likelihood function and applied full information maximum likelihood estimation to estimate this function.

Table 13 shows regression results representing relationship between individuals' characteristics and their valuation for mandatory rice grading system. The results showed that a person with a high frequency of checking grading information is more willing to pay for the mandatory rice grading system while a person who is older and more educated is less willing to pay for the grading system.

Table 14 shows the result of respondents' mean WTP for the mandatory rice grading scheme without the "no test" option. The result shows that Korean consumers are willing to pay 572.6 won/kg for the mandatory rice grading system which is about 14.3% premium compared to

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[5] Please see Lee et al (2015) for detailed derivation of the model.

average market price for rice product. This generally suggests that Korean consumers relatively

have a strong preference for the mandatory rice grading system without 'no test' option.

Table 13. CV estimation result using DBDC model

Variable	Coef.	z-value
Beta		
Intercept	1093.09***	3.60
Check	242.76**	2.01
Buy _ year	-10.45	-1.07
Information	54.87	0.45
Needs	199.91	1.27
Age	-11.75***	-2.61
Education	-251.10**	-1.96
Job	236.43*	1.64
Family Size	-45.75	-0.84
House Income	32.73	0.24
Sigma		
Intercept	729.53***	13.24
Observations	208	
Wald x^2(p>x^2)	18.90 (0.026)	
Log likelihood	-268.01	

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 14. WTP estimation of the CV

WTP	Coef.	Std. Err	z-value	[95% Conf.	Interval]
CV	**572.60***	59.34	9.65	456.28	688.92

Consumers' valuation for the mandatory rice grading system could be different between

some people who frequently check labeling of rice grades and others who less check it. Thus,

we further analyzed difference in valuation between two groups. We divided our samples into

two groups based on frequency of checking rice grade labeling. 86 respondents out of whole

samples were classified as a high checking group and 122 respondents were classified as a low

checking group. Before comparing the mean WTPs of the two groups, we checked if there is

heteroscedasticity in CV results between two groups. Table 15 shows the results of White test

for heteroscedasticity. We failed to reject the null hypothesis (Ho: homoscedasticity) at the 1% significance level in all grades. That is, there is no heteroscedasticity in variance between the two groups.

Table 15. White's test results for heterogeneity

Treatment	Super		Good		Normal		No test	
	chi2(1)	p	chi2(1)	p	chi2(1)	p	chi2(1)	p
Ho: homoscedasticity Ha: unrestricted heteroscedasticity	2.26	0.132	5.81	0.016	0.03	0.866	0.07	0.793

The mean WTP estimate results of each group are in table 16. The mean WTP for the mandatory rice grading system was 655.8 won/kg in the high frequency checking group. On the other hand, the mean WTP was 532.1 won/kg in the low frequency checking group. Table 17 shows the mean WTP difference between two groups and it shows WTPs of two groups were significantly different to each other. This result shows that the consumers' WTP for the mandatory rice grading scheme without the 'no test' option is higher in those who frequently check rice grade than those who do not.

Table 16. WTP estimation of the CV method (Label Check)

	Coef.	Std. Err	z-value	[95% Conf.	Interval]
High check (N=86)	655.88***	113.95	5.76	432.53	879.24
Low check (N=122)	532.07***	57.34	9.28	419.66	644.46

Table 17. T-test for equality of CV mean (Label Check)

Treatment	Mean	Std. Error	t-value
$H_0: \overline{WTP}_H = \overline{WTP}_L$	-123.81	12.02	-10.29***

Conclusions

Rice grading information is important to differentiate domestic rice from imported rice and improve domestic rice quality. However, current rice grading system was not effective since it allowed 'no test' option in the system and no price differentiation across rice grades. To effectively implement the rice grading system, it is imperative to eliminate 'no test' option and allow price differentiation across rice grades. This study investigated the feasibility of those changes in the current system by identifying consumers' values for each rice grades and the mandatory rice grading system without 'no test' option.

We used a non-hypothetical experimental auction (i.e. random nth price auction) to elicit consumers' valuation for each rice grade and utilized a hypothetical CV (i.e. double-bounded dichotomous choice) to estimate Korean consumers' willingness to pay for a mandatory rice grading scheme without the "no test" option.

Our results generally suggest that the provision of rice grade labeling to consumers is very important to enhance the value of domestic rice. Moreover, quality differentiation of rice is critical to receive a high price since Korean consumers have a strong preference and high valuation for 'Super' grade rice. Korean consumers also have a positive preference for the mandatory rice grading system without the 'no test' option. These results partly give an incentive to improve the current rice grading system in South Korea.

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