A Comparison of Auction and Choice Experiment:
An Application to Consumer Willingness to Pay for Rice with Improved Storage Management

Lianfan Su[1], Brian Adam[1], Jayson Lusk[1], and Frank Arthur[2]

[1]Department of Agricultural Economics
Oklahoma State University
413AGH, Stillwater, OK
Email: Lianfan.Su@okstate.edu
Email: Brian.Adam@okstate.edu
Email: Jayson.Lusk@okstate.edu

and

[2] Stored Product Insect Research Unit
Center for Grain & Animal Health Research
Manhattan, KS
Email: Frank.Arthur@ars.usda.gov

Selected Paper Prepared for Presentation at the 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011

A Comparison of Auction and Choice Experiment:
An Application to Consumer Willingness to Pay for Rice with Improved Storage Management

Abstract

Experimental auction and discrete choice experiment are two popular value elicitation methods. Theoretically they should yield the same results but empirical results have been mixed (e.g., Lusk and Schroeder 2004, 2006; Corrigan et al. 2010.) This study uses both methods to determine consumers' willingness to pay (WTP) for rice with improved insect control and for rice stored using Integrated Pest Management (IPM).

This study investigates two potential reasons – anchoring and information – for why some studies have found apparent inconsistencies between auction and choice experiment results.

Results indicate that consumers' WTP derived in the auction and choice experiments are significantly different. Consumers' average bids in the auction are higher than their willingness to pay calculated from the choice experiments. Further, anchoring in the choice experiment appears to be an explanation for the discrepancy. Providing consumers with more product information help consumers behave more consistent in terms of having same preference ranking for different rice samples in the auction and the choice experiments, but their average does not substantially affect the discrepancy.

Key words: *2nd price auction, choice experiment, price level, information.*

Introduction

Experimental auctions and discrete choice experiment are widely used in consumers' preference studies. Several studies have used them, hypothetically or non-hypothetically, to elicit consumers' WTP (willingness to pay) for certain attributes of various agricultural products (Bryan et al. 1996; Melton et al. 1996; Lusk et al. 2001; Feuz et al. 2004; Jaeger et al. 2004;

Feldkmap, Schroeder, and Lusk, 2005; Alfnes et al. 2006). Some studies have discussed the incentive compatibility and limitations of both methods (Lusk, and Schroeder 2004; Umberger, and Feuz 2004; Alfnes et al. 2005; Corrigan et al. 2010). Experimental auctions yield point estimates of WTP directly, but in order to truly reveal consumer value the auction has to be incentive compatible which requires an auction format (such as n^{th}-price auction) that may not be familiar to participants. Discrete choice experiments are easy to implement, and more closely replicate consumers' real shopping experiences, but reveal WTP only indirectly and requires assumptions about the form of the consumers' utility functions.

Comparisons of empirical WTPs derived from auction and choice experiments have been mixed (Lusk and Schroeder 2004, 2006; Kimenju, Morawetz, and Groote 2005, 2006). Factors that affect consumers' behavior in auction and choice experiments may include different auction mechanisms (Lusk and Schroeder, 2004, 2006), different response formats, and various experimental designs used in choice studies (Boyle, Holmes, Teisl, and Roe, 2000; Lusk and Norwood, 2005). However no studies go further to discuss how the changes in mechanism design affect the empirical differences between auction and choice. In this study we use both auction and choice experiment to determine the value consumers place on rice with varying insect infestation levels and storage methods, compare the estimated results empirically and investigate whether changes in experimental design can reduce differences in WTP estimates between the two methods.

In hypothetical settings, consumers tend to overstate or misrepresent the value they place on the products (Lusk and Schroeder, 2004; Lusk and Coble, 2005; Yue, Alfnes, and Jensen, 2006). To reduce this hypothetical bias, this study compared participant behavior in non-hypothetical auction and choice experiments.

Background

Rice is one of the main crops in United States. Batres-Marquez et al. (2010) stated that more than 63% of U.S. domestic rice consumption is used directly without further processing. Thus physical attributes of rice, such as appearance, texture, and color, are very important to consumers. Insect infestation can affect these physical attributes during storage, reducing the quality of rice and thus its economic value.

Lesser grain borer (*Rhyzopertha dominica)* is one of the common pests of stored grains and perhaps the most potentially destructive insect that infects stored rice (Luh 1980). Their larvae feed inside the kernel until they mature into adults and burrow out of the kernel, damaging the kernels. This may reduce milling yield and the proportion of whole rice kernels. In addition, the insects' contact with the rice kernels may cause a displeasing odor, particularly if the insect population is large. Thus, both quantity and quality of rice may be reduced by these insects.

Current insect control methods during rice storage can be categorized into 1) conventional chemical-based pest management, and 2) integrated pest management (IPM), which is a balanced use of multiple control tactics – biological, chemical, and cultural – as is most appropriate for a particular situation in light of careful study of all factors involved. There are potential benefits of IPM associated with environment and human health, but few, if any, studies have empirically evaluated its value to consumers of stored products.

The rice samples we used in our study are milled long grain rice provided by Riceland Foods, Inc. These samples were split into a control group plus two treatments of insect infestation with lesser grain borer (LGB). One treatment used a low level of initial insect infestation (20 adult LGB/kg), and the second used a high level (200 adult LGB/kg). The control

group had zero adult insects. After eight weeks, the rice samples were frozen to kill any internal infestation. Then the rice was milled so that the final product was suitable for human consumption.

Conceptual Framework

This study determines whether consumer WTP (willingness to pay) elicited from experimental auction and discrete choice experiments are equal, and determines if and how price used in the discrete choice experiment and information provided to participants affects the difference between these two methods. The null hypotheses are:

1) $WTP^{AUCTION} = WTP^{CHOICE}$. Here $WTP^{AUCTION}$ is the mean WTP derived from auction data and WTP^{CHOICE} is the mean WTP derived from discrete choice experiment data. If we reject the null hypothesis, we conclude that the WTP derived from the auction and the choice experiment are not equivalent.

2) An increase in price level used in the choice experiment does not affect the difference in WTP derived from auction and choice experiments: $D = D^{HP}$. Here D is the difference in WTP derived from auction and choice experiments, $D = WTP^{AUCTION} - WTP^{CHOICE}$ and D^{HP} is the difference in WTP derived from the auction and choice experiments with a higher initial price level, where $D^{HP} = WTP^{AUCTION} - WTP^{CHOICE, HP}$. If we reject this null hypothesis, we conclude that initial price level used in the choice experiment is associated with differences in WTP derived from auction and choice experiments. Hypothesis 2 is, in essence, a test of whether anchoring affects WTP estimates in a choice experiment.

3) Providing participants more products information does not affect the difference in WTP derived from auction and choice experiments: $D^{INFO} = D$. Here D^{INFO} is the difference in

WTP derived from auction and choice experiment when participants are provided extra product information, $D^{INFO} = WTP^{AUCTION,INFO} - WTP^{CHOICE,\ INFO}$. If we reject this null hypothesis, we conclude that the amount of information provided is associated with differences in WTP derived from auction and choice experiments.

To test the hypothesis, both a non-hypothetical auction and choice experiments are conducted to reveal consumer WTP for several rice products. Consumers' WTP derived from both methods are compared to test hypothesis one. Hypothesis two is tested by comparing both a low-initial-price choice experiment and a high-initial-price choice experiment with an auction to determine if price level of the choice experiment affects the difference in price between an auction and choice experiment. The last hypothesis is tested by comparing both a low-initial-price choice experiment and a high-initial-price choice experiment with an auction, when participants are given more information about the product on which they are bidding or choosing.

Experimental Design and Procedures

We recruited participants through in-person and email invitations, offering $20 compensation for approximately one hour's participation. Before the experiment, the participants tasted and evaluated three rice samples using a sensory taste panel format. Prior to milling for human consumption, one of the samples had been infested with 200 adult LGB/kg, one had been infested with 20 adult LGB/kg, and one had not been infested. The rice samples were cooked and served following the procedures described in a sensory analysis for cooked long-grain rice conducted by Meullenet et al. (2000). Participants rated the samples using a 9-point scale where 1= extremely undesirable and 9 = extremely desirable. The serving orders of rice were

completely randomized over participants by using a counterbalanced design to reduce the order effects.

Then, the participants were given $2 in coins and informed that they would have the opportunity to purchase one of the rice samples through auctions or choice experiments. We also informed them that they could choose to buy rice that was the same in all respects as the rice they had tasted, but that was stored using an integrated pest management (IPM) approach. Thus, with three possible levels of pre-milling insect infestation, and two storage methods – IPM and non-IPM – the participants could choose from among six rice products.

For both the auction and the choice experiment, the participants were informed that although they had been given $2 in coins with which to purchase rice they had "won," if any, they were free to bid more than that amount if they wished, but that if they won the bid and the price was more than $2, they would be obligated to use money they had brought with them. Conversely, they were informed that if they did not win a bid in a binding round, the $2 was theirs to take home with them.

We conducted four rounds of 2nd price auction and one round of choice experiment to determine consumers' preferences for alternative rice products, based on their prior taste evaluation. Then, we conducted another round of auction and choice experiment after providing participants objective information about the quality of each rice sample. Specifically, we told them which rice sample that they ate was good quality (the one with high pre-milling insect infestation), which one was high quality (the one with low insect infestation), and which one was superior quality (the one with zero insect infestation.) The same procedures were repeated with another group of participants, changing only the price level used in the choice experiment. Figure 1 illustrates the experimental design.

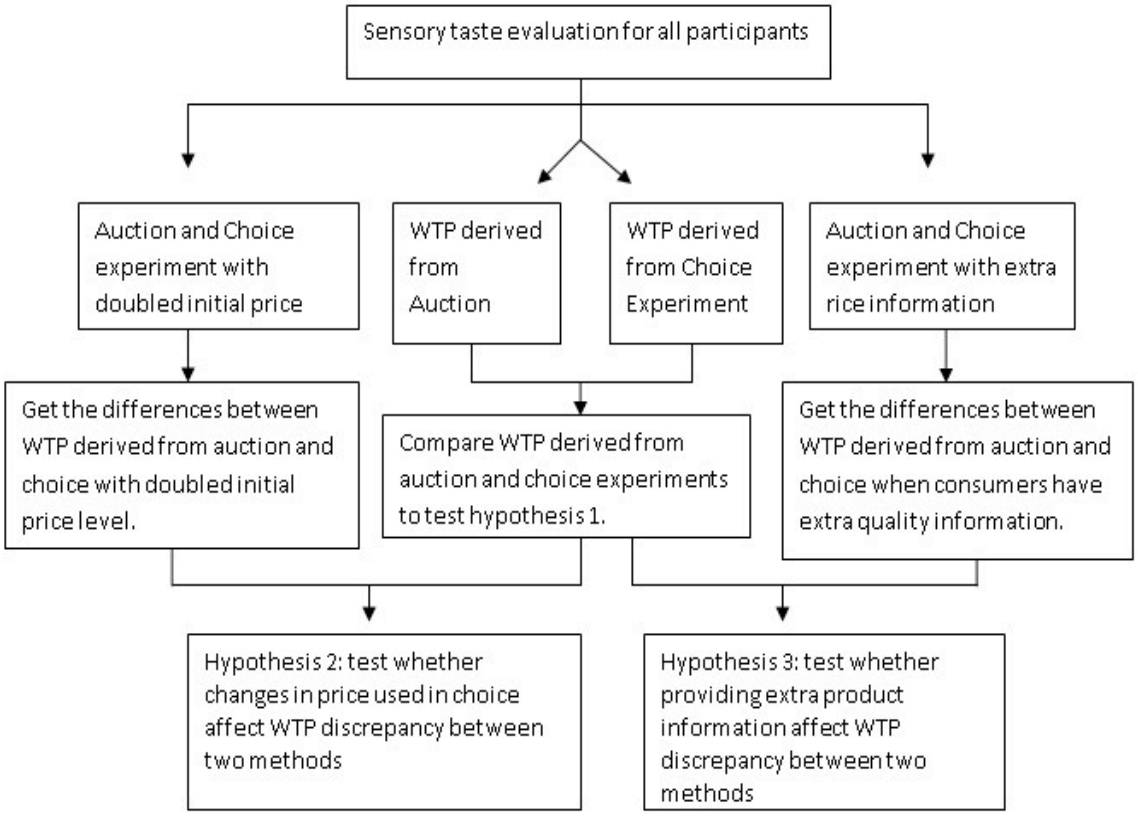

Figure 1. Outline of experimental procedure

Before bidding began, we provided participants a brief written statement on the difference between IPM and conventional pest management methods, and read the statement aloud to them. Participants retained the sheet on which they had recorded their evaluation of the rice samples. In explaining the procedures for the 2nd price auction to the participants, we emphasized that they should bid exactly the amount they believed the product was worth to them, and that if they were to "win" a binding auction, they would be obligated to purchase the rice at the winning price, the second highest bid. Participants were then given bid sheets and asked to submit sealed bids for each of the six rice products simultaneously.

Participants indicated their bid for each rice product on a bid sheet labeled with the participants' and products' unique identification numbers. We conducted four rounds of

auctions. After each round, for each of the six rice products the winner's identification number and the winning price (the second highest bid) were displayed for all participants to see.

After four rounds of auctions, we conducted the choice experiment. The same six rice samples were used in the choice experiment. Some groups of participants chose from prices scaled at a lower level, and some groups chose from prices scaled at double that level. In explaining the procedures for the choice experiment, we emphasized to participants that they should truthfully indicate which rice/price combination (or none) they would like to choose, because if their identification number was selected at the end, they would be obligated to purchase the rice/price combination they had selected in the randomly-selected binding scenario. After participants finished four rounds of auctions and one round of choice experiment, we gave them the objective quality levels of each rice samples and they completed one more round of both the auction and the choice experiment based on the information they received.

At the end of the entire experiment, we drew a number between one and five to determine the binding auction round, and a number between one and six to determine the binding rice product. The participant bidding the highest price for this rice sample in this auction round paid the second highest price bid for this rice sample in this round and received one pound of that rice, while the other participants paid nothing and got no rice.

Then we randomly drew a number between one and two to determine the binding choice experiments and a number between one and eight to determine the binding scenario. Then one participant's identification number was randomly selected (we took out the auction winner's identification number to make sure one participant did not purchase more than one pound of rice.) The selected participant purchased the rice that he chose in that binding round and binding

scenario at the price listed. Finally, participants were asked to complete a short survey on their demographic information and their rice purchasing habits before they left.

Economic Models

To test the first hypothesis, that auction and choice experiment WTP are not equal, we compared the estimated WTP from both the auction and the choice experiment for each rice sample. In the auction, consumers' bids for each rice sample can be directly interpreted as their WTP. We used three sets of variables to explain the variation in auction WTP: (1) variables explaining variation in rice attributes, including insect infestation level (zero insect infestation, medium insect infestation and high insect infestation) and storage management method (IPM vs. non-IPM); (2) variables for participants' socio-demographics and their attitudes towards environmental, pesticide resistance and worker safety issues; and (3) whether or not the participants had been provided with extra quality information. We used the following econometric model to explain consumers' WTP for the rice in the auction:

1) $$WTP^*_{ij} = BID_{ij} = \alpha X_j + \beta Y_i - \gamma Z_{ij} + \eta_i + \varepsilon_{ij}$$

where WTP^*_{ij} is individual *i*'s WTP for product *j*, and BID_{ij} is individual *i*'s bid for product *j*. In auction, participants cannot bid below zero, thus this WTP* is a latent variable censored from below zero. $\boldsymbol{X}_j$ is a vector of product quality attributes for product *j*, including objective insect infestation levels HI_j and MI_j and the storage method IPM_j. HI_j and MI_j are indicator variables for rice with high (H) or medium (M) insect infestation level; IPM_j is 1 if rice *j* is maintained with IPM methods and 0 otherwise. $\boldsymbol{Y}_i$ is a vector of individual *i*'s socio-demographic information, including gender, race, age, income, how often they eat rice and their attitudes towards the environment, worker health and safety issues, and pesticide resistance

issues and their taste evaluation of the j^{th} rice sample. $\mathbf{Z}_{ij}$ is a vector of design variable information and the interaction between information and quality attributes. $\mathbf{Z}_{ij}$ includes $INFO_{i,j}$, which is 1 if extra information is provided and 0 otherwise, and $INFOLI_{i,j}$ and $INFOMI_{i,j}$ are interaction terms between INFO and insect levels HI_j and MI_j. $\eta_i \sim N(0, \sigma_\eta^2)$ is the random individual effect for the i^{th} participant that captures the correlation between the bids made by the same participant, and $\epsilon_{ij} \sim N(0, \sigma_\epsilon^2)$ is the residual error term. In our auction experiments, since participants cannot bid negative values and we observed many zero bids, which implies our data are left censored. Thus, a left-censored Tobit model is used to estimate the parameters.

In the choice experiment, instead of bidding directly how much they valued each rice product, participants had to choose among alternative rice/price combinations. Their willingness to buy the six price products is expressed in two categories, willing to buy and unwilling to buy. Because the respondent variables do not directly reflect consumers' WTP, a random utility model was used to derive consumers' WTP. Suppose a consumers' utility function can be expressed as:

2) $U_{ij} = V_{ij} + \epsilon_{ij}$

where U_{ij} is participant i's utility from choosing the j^{th} rice product, V_{ij} is the systematic portion of the utility function determined by the rice attributes and ϵ_{ij} is a stochastic element.

The systematic portion of consumer i's utility of choosing rice product j is:

3) $V_{ij} = \beta_1 HI_j + \beta_2 MI_j + \beta_3 ZI_j + \beta_4 HIIPM_j + \beta_5 MIIPM_j + \beta_6 ZIIPM_j + \beta_7 Price_{ij} + \xi_{ij}$

where $Price_{ij}$ is price faced by consumer i for rice product j, and the dummy variables HI_j, MI_j, ZI_j, $HIIPM_j$, $MIIPM_j$ and $ZIIPM_j$ are dummy variables which denote, respectively, the jth rice product is of high insect level, medium insect level, zero insect level, high insect level and stored with IPM method, medium insect level stored with IPM method, and zero insect level stored with IPM method, and ξ_{ij} is the error term. The coefficients β_1 to β_6 represent the utility of having the corresponding characteristics compared to not having them.

The parameters β in equation (6) can be estimated by maximizing the log-likelihood functions:

4) $$LLF = \sum_{i=1}^{N \cdot 8} \left(C_{ij} \times ln\left(\sum_{j=1}^{7} Prob_{ij} \right) \right)$$

where $C_{ij} = 1$ if rice product j is chosen by consumer i and 0 otherwise, and $Prob_{ij}$ is the probability of rice product j being chosen.

Consumers' marginal WTP for each rice product j can be calculated as $\hat{\beta}_j / \hat{\beta}_{price}$, where $\hat{\beta}_j$ and $\hat{\beta}_{price}$ are corresponding estimated coefficients for rice product j and price.

The WTP from the auction are the direct bids while the WTP estimates from the choice experiment are the calculated results. To make the two WTP measures more comparable, we estimated both auction and choice models considering participants' demographic information, and compared the predicted individual's WTP from each model.

To predict each individual's WTP from choice model, we extended model (4) to model (6) by adding all interaction terms between rice products and consumers demographic information.

5) $$V_{ij} = \beta_1 (HI)_{ij} - \beta_2 (MI)_{ij} + \beta_3 (ZI)_{ij} + \beta_4 (HIIPM)_{ij} + \beta_5 (MIIPM)_{ij} - \beta_6 (ZIIPM)_{ij} - \beta_7 (Price)_{ij} - \gamma_{ij} R_i Y_i - \xi_{ij}$$

Where, $\boldsymbol{R_j}$ is the vector of all six rice products and $\boldsymbol{Y_i}$ is as defined as in model (2). $\boldsymbol{R_j Y_i}$ are interaction terms between participants' demographics (gender, ethnic, education, age, rice eating habits and attitudes towards environmental, pesticide resistance and worker safety issues) and all six rice products (*HI, MI, ZI, HIIPM, MIIPM,* and *ZIIPM*).

Paired t-tests were conducted to compare the predicted average WTP from auction and choice models for each rice product. We assumed possible reasons for differences in the estimated WTP are the different initial price levels used in the choice experiment and the amount of information participants have. Two sample t-tests were used here to compare the difference between predicted WTP from the auction and choice experiments with different initial price levels and under conditions of providing extra product information. We also used a random effect model to test the effects of initial price levels and information on the differences between WTP predicted from auction and choice data.

6) $D_{ij} = \alpha_0 + \alpha_1 PL_i + \alpha_2 Info_i + \beta Y_i + \gamma_j + \omega_{ij}$

where D_{ij} is the difference between consumer *i*'s predicted WTP from auction and choice experiment for rice product *j*, PL_i is the price level consumer *i* faced in choice experiment (PL_i = 1 when they faced a higher initial price level in choice experiment, 0 otherwise), $Info_i$ = 1 when consumer *i* was provided with extra rice quality information in the auction and choice experiment, 0 otherwise, Y_i are as defined before, $\gamma_j \sim N(0, \sigma_j^2)$ is the random effect with respect to different rice products, $\omega_{ij} \sim N(0, \sigma_\omega^2)$ is pure random error term, and γ_j and ω_{ij} are independent of each other.

Results

A total of 112 participants were recruited on and off Oklahoma State University campus though emails and flyers. Summary statistics in Table 1 shows that 57% of participants were female;

40% were Asian, and since most participants are from university, our participants had a younger age and higher educational level. Fifty-six percent of the participants were aged 20 to 30, and 77% of the participants had bachelor's degrees or higher. The average annual household

Table 1. Variable Definitions and Summary Statistics

Variable	Definition	Average
Ethnic	1 if Asian; 0 if others	0.41 (0.49)
Gender	1 if Female; 0 if Male	0.57 (0.50)
Education	Education level of respondent 1=high school or below; 2=associate degree; 3=bachelor's; 4=master's; 5=doctor's degree or higher	3.17 (1.28)
Income	Household income level 1=less than $20,000; 2=$20,000 to $39,000; 3=$40,000 to $59,999; 4=$60,000 to $79,999; 5=$80,000 to $99,999; 6=$100,000 or more	2.26 (1.59)
Age	1=20-30; 2=31-40; 3=41-50; 4=51-60; 5=above 60	1.94 (1.26)
Rice eat	How often does respondent eat rice 1=never; 2=once a year; 3=few times a year; 4=once a month; 5=every two weeks; 6=more than once a week	4.87 (1.43)
Environment	Respondent's level of concern level about environmental issues 1= not concerned; 2=somewhat concerned; 3=very concerned	2.41 (0.66)
Safety	Respondent's level of concern about worker safety issues 1= not concerned; 2=somewhat concerned; 3=very concerned	2.47 (0.59)
Resistance	Respondent's level of concern about pesticide resistance issues 1= not concerned; 2=somewhat concerned; 3=very concerned	2.52 (0.58)

Note: numbers in parentheses are standard deviations.

income of all participants is between $20,000 and $40,000. The sample represents a wide range of demographics, with age ranging from 20 to above 60, education ranging from high school to PhD degree, income ranging from below $20,000 to above $100,000, and rice consumption and purchase ranging from zero times per year to once a week. The majority of the participants were rice eaters, eating rice an average of once every two weeks. The participants also answered

questions related to the strength of concerns about the environment, worker health and pesticide resistance problem, and on average they showed a high level of concern about these problems.

Comparison of WTP derived from auction and choice experiments

Unlike the results of Lusk and Schroeder (2006), our results (table 2) show that average bids from auctions are higher than the WTP derived from choice data for all six rice samples. We rejected the first null hypothesis and conclude that the WTP derived from the auction and the choice experiment are not equivalent, but that WTP from the auction are larger than WTP derived from the choice experiment.

Table 2. Comparison of Average Willingness to Pay ($/pound) for Six Rice Products Derived from Auction and Choice Data

Different Rice Products	$WTP^{AUCTION}$ [a]	WTP^{CHOICE} [a]	Difference	Test
High Insect	1.03	0.59	0.44	<0.0001[c]
	(0.31)[b]	(0.20)	(0.30)	
Low Insect	1.03	-0.19	1.21	<0.0001
	(0.28)	(0.64)	(0.77)	
Zero Insect	1.03	0.06	0.97	<0.0001
	(0.29)	(0.54)	(0.74)	
High Insect	1.09	0.65	0.44	<0.0001
IPM	(0.31)	(0.38)	(0.34)	
Low Insect	1.09	0.67	0.42	<0.0001
IPM	(0.31)	(0.35)	(0.45)	
Zero Insect	1.09	0.81	0.28	<0.0001
IPM	(0.29)	(0.24)	(0.37)	

[a] $WTP^{AUCTION}$ and WTP^{CHOICE} are point predicted consumers' WTP from auction and choice models.
[b] Standard deviations are in parentheses.
[c] p-value for the two-tailed t-test of H_0: $WTP^{AUCTION} = WTP^{CHOICE}$.

Effects of initial price level in choice experiment on difference in WTP between auction and choice experiment

The results in table 2 mask the variation in WTP estimates that result from providing additional information about rice quality to participants, and from doubling the initial level of prices used in the choice experiment. However, when we doubled the price level used in the choice experiment, the WTP for the rice products increased substantially, greatly reducing the

differences in WTP between the two methods. For example, table 3 indicates that for the Auction without information the WTP for Zero Insects rice was $0.80 while the low price choice experiment without information (CE – LP without information) WTP for Zero Insects rice was $0.54, a difference of $0.26. However, doubling the price level in the choice experiment (CE – HP without information) resulted in a WTP estimate of $0.80, or no difference between the auction and choice experiment WTP measures.

Table 3. Comparison of Consumers' WTP ($/Pound) for Six Rice Products Derived from Auction and Low- and High-Price Choice Experiment, with and without Information

WTP	Auction without information	Auction with information	CE-LP[a] Without information	CE-LP with information	CE-HP[b] without information	CE-HP with information
High Insect	0.75 (0.74)	0.68 (0.61)	0.50 (0.02)	0.30 (0.02)	0.76 (0.03)	0.58 (0.03)
Medium Insect	0.77 (0.65)	0.87 (0.71)	0.20 (0.01)	0.46 (0.03)	0.77 (0.03)	0.83 (0.03)
Zero Insect	0.80 (0.73)[a]	1.07 (0.94)*	0.40 (0.02)**	0.54 (0.03)	0.80 (0.03) **	1.01 (0.04)
High Insect IPM	0.82 (0.80)	0.76 (0.66)	0.82 (0.05)	0.67 (0.04)	1.14 (0.04)	1.06 (0.04)
Medium Insect IPM	0.87 (0.72)	0.99 (0.74)	0.82 (0.04)	0.86 (0.06)	1.10 (0.04)	1.14 (0.04)
Zero Insect IPM	0.95 (0.71)	1.22 (0.93)	0.89 (0.04)	0.99 (0.06)	1.26 (0.05)	1.55 (0.06)

[a] CE-LP stands for choice experiment with lower initial price level.
[b] CE-HP stands for choice experiment with higher initial price level.
[c] Standard errors are in parentheses.
*Standard errors are calculated in the conventional manner.
**Standard errors are calculated by delta methods.

To further test this, we conducted two sets of choice experiments with different initial price levels, and applied an in-sample likelihood ratio test to test whether a different price level used in choice experiment affects consumers' WTP measures. The restricted model is model 4) with pooled data from the choice experiment with both higher and lower initial price levels, while the unrestricted models are separate models from the choice experiment, one with higher

initial price level and one with lower initial price level. Table 4 shows the estimated coefficients of the unrestricted and restricted models. The null hypothesis that estimated rice product parameters are equivalent across the three models: H_0: $\beta_1^{HP} = \beta_1^{LP}, \ldots, \beta_6^{HP} = \beta_6^{LP}$.

Table 4. Multinomial Logit Estimates for Choice Experiment with Higher Price Level (HP) and Lower Price Level (LP).

Rice Attributes	Model 1(HP)	Model 2(LP)	Model 3 (Pooled)
Price	-2.66	-3.66	-2.10
Zero Insect	2.20	1.47	1.76
Medium Insect	2.11	0.72	1.15
High Insect	2.09	1.82	1.62
Zero Insect IPM	3.36	3.26	2.94
Medium Insect IPM	2.82	3.00	2.51
High Insect IPM	3.04	2.97	1.62
LL	-1265.86	-522.076	-1958.53
#Obs	4818	3026	7842

The test statistic is 222 (2*(1958.53-1787.94)), and the critical chi-square value with four degree of freedom at 99% confidence level is 13.3. Comparing the test statistics with the critical chi-square value, we reject the null hypothesis and conclude that WTP estimates change when different initial price levels are used in choice experiments.

Then we conducted another two sample t-tests to compare differences between predicted WTP from auction and predicted WTP from the choice experiment with different initial price levels. The differences in table 5 are calculated as predicted WTP from auction minus predicted WTP from choice: $Diff = WTP^{AUCTION} - WTP^{CHOICE}$; $Diff^{HP} = WTP^{AUCTION,HP} - WTP^{CHOICE,HP}$. The results indicate that doubling the initial price level in the choice experiment reduces the difference in WTP between the two methods. The reductions in WTP differences are significant for all rice products except for rice that with zero insect level stored under conventional methods.

Table 5. Effects of Using Higher Initial Price in Choice Experiment on the Difference between Predicted Consumers' Willingness to Pay ($/pound) for All Rice Products Derived from Auction and Choice Data

Different Rice Products	$DIFF^{HP}$	DIFF	Difference[a]	Test
Zero Insect Level	0.42	0.44	-0.02	0.8748[c]
	(0.50)[b]	(0.30)	(0.44)	
Medium Insect Level	0.40	1.21	-0.81	<0.0001
	(0.43)	(0.78)	(0.58)	
High Insect Level	0.27	0.97	-0.70	<0.0001
	(0.34)	(0.73)	(0.52)	
Zero Insect Level IPM	-0.04	0.43	-0.48	<0.0001
	(0.33)	(0.29)	(0.36)	
Medium Insect Level IPM	0.001	0.42	-0.42	<0.0001
	(0.53)	(0.45)	(0.50)	
High Insect Level IPM	-0.03	0.28	-0.30	<0.0001
	(0.36)	(0.35)	(0.36)	
Pooled All Rice Products	0.17	0.62	-0.45	<0.0001
	(0.47)	(0.63)	(0.53)	

[a] Difference is difference between differences of predicted consumers' willingness to pay from auction and choice models with different initial price levels: $Difference=DIFF^{HP}-DIFF$.

[b] Standard deviations are in the parenthesis.

[c] p-value for the two sample t-test of H_0: $DIFF^{HP}=DIFF^{LP}$.

Effects of amount of information on difference in WTP between auction and choice experiments

When we doubled the amount of information provided to consumers, their WTP for all rice products from both auction and choice experiments changed. Table 3 shows consumers' WTP for rice products in auction and choice experiments with and without additional information. Providing additional information has a similar effect on both auction and choice experiment: with objective rice quality information, participants' WTP for rice with zero and medium insect infestation levels increases, while their WTP for rice with high insect infestation level decreases.

To determine how the WTP difference is affected by the amount of information participants have, we also conducted a two sample t-tests to compare differences between predicted WTPs from auction and predicted WTPs from choice with and without extra information. The differences in table 6 are defined as: $Diff^{INFO} = WTP^{AUCTION,INFO}$ -

$WTP^{CHOICE,INFO}$; $Diff^{NOINFO} = WTP^{AUCTION,NOINFO} - WTP^{CHOICE,NOINFO}$. Table 7 indicates that the effect of providing more information varies across the six rice products. For rice with medium

Table 6. Effects of Extra Information on the Difference between Auction and Choice Experiment in Consumers' Willingness to Pay ($/pound) for All Rice Products

Different Rice Products	$DIFF^{INFO}$	$DIFF^{NOINFO}$	Difference	Test
Zero Insect Level	0.71	0.45	0.26	0.0002[c]
	(0.58)[b]	(0.44)	(0.52)	
Medium Insect	0.60	0.72	-0.12	0.1221
Level	(0.39)	(0.71)	(0.57)	
High Insect Level	0.61	0.55	0.06	0.4537
	(0.51)	(0.63)	(0.57)	
Zero Insect Level	0.30	0.13	0.16	0.0306
IPM	(0.68)	(0.43)	(0.57)	
Medium Insect	0.27	0.13	0.14	0.0427
Level IPM	(0.48)	(0.54)	(0.51)	
High Insect Level	0.09	0.06	0.03	0.5381
IPM	(0.39)	(0.40)	(0.39)	
Pooled All Rice	0.43	0.34	0.09	0.0044
Products	(0.56)	(0.60)	(0.58)	

[a] Difference is difference between differences of predicted consumers' willingness to pay from auction and choice models with and without extra information: Difference=$DIFF^{INFO}$-DIFF.
[b] Standard deviations are in the parenthesis.
[c] p-value for the two sample t-test of H_0: $DIFF^{HP}=DIFF^{LP}$.

and high insect levels and stored using conventional methods, and for rice with high insect levels stored using IPM methods, providing participants more information did not affect the difference in WTP between auction and choice experiments, but for the other rice products and for all rice products pooled together, providing extra information increased the discrepancy.

A fixed effects model was used to test the effects of initial price used in choice experiment and amount of information provided on the difference in WTP, while holding other factors constant. In table 7, the estimated intercept is 0.49, which indicates that with a low initial price level in the choice experiments, consumers' WTP from auction bids for one pound of rice is $0.49 higher than their predicted WTP from the choice experiment. With a higher initial price level, though, the difference in WTP is reduced by $0.44, leaving a net difference of $0.05.

Table 7. Effects of Initial Price Levels Used in Choice Experiment on Difference between Predicted Consumers' WTP from Auction and Choice Data

Independent variable	Coefficient and standard error	p-value
Intercept	0.4469**	0.0079
	(0.1046)[a]	
Price Level	-0.4424**	<0.0001
	(0.0245)	
Info	0.0942	<0.0001
	(0.0231)	
Race	-0.1816**	<0.0001
	(0.0285)	
Gender	-0.0756**	0.0020
	(0.0244)	
Education	-0.0137	0.1953
	(0.0106)	
Income	0.0366**	0.0002
	(0.0099)	
Age	0.1282**	<0.0001
	(0.0122)	
Variance of Rice Products Random Effect	0.056	

**statistical significance at the 0.05 level or lower.

[a] Standard errors are in the parenthesis.

Thus, with a higher initial price level, the WTP derived from auction and choice experiments were more consistent.

We also considered the effect of demographic information on consumers' behavior in auction and choice experiments. Except for education level, most of the demographic factors were related to their behavior. Compared to male participants, females behave more consistently between auction and choice experiment. To the extent that females are the main food purchasers, they may be more familiar with the price of rice. Similarly, the predicted WTP for Asian participants are more consistent between auction and choice than are those of non-Asian participants. Asian participants may have had a better understanding of rice products compared with non-Asian consumers. More Asian than non-Asian participants were regular rice eaters, and may have had a better understanding of how much the rice products were worth to them so that their WTP was not influenced as much by the different value eliciting mechanisms.

People with lower income levels exhibited smaller difference in WTP between auction and choice experiments. Low income consumers may have been more price-conscious and more cautious when they placed the value on the rice products. Older participants exhibited a larger difference in WTP than younger participants, possibly because they found the experimental procedures more difficult to understand.

Conclusion

In this study, we conducted non-hypothetical 2nd price experimental auction and discrete choice experiments to determine consumers' WTP for rice products with varying insect infestation levels and insect control methods, and compared the elicited WTP measures derived from both mechanisms. To make the WTP derived from both mechanisms comparable, we used a censored Tobit model for the auction bids and an indirect utility model for the choice experiment results. Individual's WTP predicted from both models were compared to test whether the two elicitation mechanisms yielded equivalent results. Our study shows that consumers' WTP in 2nd price auction were significantly higher than their corresponding WTP predicted from the choice utility model.

This study also investigated potential reasons for the WTP inconsistency between auction and choice experiments. Results show that when participants faced different price levels in choice experiments, or when they were provided additional information about the rice products, their behavior changed. Increasing the price level used in the choice experiment substantially reduced the discrepancy in WTP between the two mechanisms. Providing additional information had a smaller effect on the discrepancy but leas to same preference orders of all products.

Differences in participant demographics were associated with differences in behavior in these experiments. In general, participants who are more familiar with the products behaved

more consistent in both mechanisms. In our case, the WTP discrepancies were smaller for female and Asian participants.

Since our results indicate that WTP differences between auction and choice depend on several factors, we cannot draw a general conclusion that one method is better than the other. However our findings suggest that the both WTP estimates derived from choice experiments and the preference rankings vary with price level used and amount of information provided. Thus consumers' behaviors are more vulnerable to mechanism design in choice experiment. Further studies should be cautious in selecting a price range when using choice experiments and should provide consumers more product information to help them have better product valuation. Also, since participants' demographic background affects how they behave in the experiments, recruiting participants who are familiar with the interested products and who are able to learn the mechanisms quickly may provide more reliable results regardless of the value-eliciting mechanisms used.

References:

Batres-Marques, S. Patricia, Helen H. Jensen, and J.L. Upton. 2009. "Rice Consumption in the United States: Evidence from Food Consumption Surveys." *Journal of the American Dietetics Association* 109(10):1717-1727.

Brooks, Kathleen, and Jayson L. Lusk 2010. "Stated and Reveled Preference of Organic and Cloned Milk: Combining Choice Experiment and Scanner Data." *American Journal of Agricultural Economics* 92(4):1229-1241.

Melton, Bryan E., Wallace E. Huffman, Jason F. Shogren, and John A. Fox. 1996. "Consumer Preference for Fresh Food Items with Multiply Quality Attributes: Evidence from an Experimental Auction of Pork Chops." *American Journal of Agricultural Economics, Vol. 78, No.4* (Nov.): 916-923.

Corrigan, J.R., D.P.T. Depositario, R. M. Nayga, Jr., X. Wu, and T.P. Laude. 2009. "Comparing Open-ended Choice Experiments and Experimental Auctions: An Application to Golden Rice." *American Journal of Agricultural Economics* 91(3): 837–853.

F. Alfnes, A.G. Guttormsen, G. Steine and K. Kolstad, 2006. "Consumers' Willingness to Pay for the Color of Salmon: A Choice Experiment with Real Economic Incentives." *American Journal of Agricultural Economics* **88** (4):1050–1061.

Feldkamp T. J., T.C. Schroeder, and J.L. Lusk. 2005. "Determining Consumer Valuation of Differentiated Beef Steak Quality Attributes." *Journal of Muscle Foods* 16: 1-15.

Feuz Dillion M., Wendy J. Umberger, Chris R. Calkins, and Bethany Sitz. 2004. "U.S. Consumers' Willingness to Pay for Flavor and Tenderness in Steaks as Determined with an Experimental Auction." *Journal of Agricultural and Resource Economics* 29(3): 501-516.

Kevin J. Boyle, Thomas P. Holmes, Mario F. Teisl, and Brian Roe. 2001. "A Comparison of Conjoint Analysis Response Formats." *American Journal of Agricultural Economics* 83(2) (May 2001):441-454.

Kimenju S.C., U. B. Morawetz,, and H. De Groote. 2005. "Comparing Contingent Valuation Methods, Choice Experiments and Experimental Auctions in soliciting Consumer Preference for Maize in Western Kenya: Preliminary Results.*"* Paper prepared for presentation at the African Econometric Society 10th Annual Conference on Econometric Modeling in Africa, Nairobi, Kenya.

Kole A.P.W., Altintzoglou T., Schelvis-Smit R. A.A.M., and Luten J. B.. 2009. "The Effects of Different Types of Product Information on the Consumer Product Evaluation for Fresh Cod in Real Life Settings." *Food Quality and Preference 20 (2009) 187-194.*

Magnusson, Erik and J.A.L. Cranfield. 2005. "Consumer Demand for Pesticide Free Food Products in Canada: A Probit Analysis." *Canadian Journal of Agricultural Economics* 53: 67-81.

Mario F. Teisl, Sara B. Fein, and Alan S. Levy. 2009. "Information Effects on Consumer Attitudes Toward Three Food Technologies: Organic Production, Biotechnology, and Irradiation." *Food Quality and Preference 20 (2009) 586-596.*

Melton, B. E., W. E. Huffman, J. F. Shogren, and J. A. Fox.1996. "Consumer Preferences for Fresh Food Items with Multiple Quality Attributes: Evidence from an Experimental Auction of Pork Chops." *American Journal of Agricultural Economics* 78(November 1996):916-23.

Meullent, J. F., B. P. Marks, J. A. Hankins, V. K. Griffin, and M. J. Daniels. 2000. "Sensory Quality of Cooked Long-grain Rice as Affected by Rough rice Moisture Content, Storage Temperature, and Storage Duration." *Cereal Chemistry* 77:259-263.

Luh, BS, Editor. 1980. Rice Production and Utilization. AVI Publishing Co., Westport, CT.

Lusk, J. L., and Keith H. Coble. 2005. "Risk Perceptions, Risk Preference, and Acceptance of Risky Food." *American Journal of Agricultural Economics* 87(2):393-405.

Lusk J. L., Ty Feldkamp Ty, and Ted C. Schroeder. 2004. "Experimental Auction Procedure: Impact on Valuation of Quality Differentiated Goods." *American Journal of Agricultural Economics* 86(2):389-405.

Lusk, J. L., John A. Fox, T.C. Schroeder, James Mintert, and Mohammad Koohmaraie.2001."In-Store Valuation of Steak Tenderness". *American Journal of Agricultural Economics* 83(3) (August 2001):539-550.

Lusk, J. L., and J. Shogren. 2007. Experimental Auctions: Methods & Applications in Economics & Marketing Research. Cambridge, UK: Cambridge University Press.

Lusk, J.L., and F. B. Norwood. 2005. "Effect of Experimental Design on Choice-Based Conjoint Valuation Estimates." *American Journal of Agricultural Economics* 87 (3) (August 2005):771-785.

Lusk, J.L., and T.C. Schroeder. 2004. "Are Choice Experiments Incentive Compatible? A Test with Quality Differentiated Steaks." *American Journal of Agricultural Economics* 86:467-82.

____. 2006. "Auction Bids and Shopping Choices." *Advances in Economics Analysis and Policy* 6:1-37.

Lusk, J.L., Lisa O. House, Carlotta Valli, Sara R. Jaeger, Melissa Moore, J.L. Morrow, and W. Bruce Traill. 2004. "Effects of Information about Benefits of Biotechnology on Consumer Acceptance of Genetically Modified Food: Evidence from Experimental Auctions in The United States, England, and France." *European Review of Agricultural Economics Vol. 31 (2) (2004) 179-204.*

Jaeger, Sara R., Jayson L. Lusk, Lisa O. House, Carlotta Valli, Melissa Moore, Bert Morrow, and W. Bruce Traill. 2004. "The Use of Non-hypothetical Experimental Markets for Measuring the Acceptance of Genetically Modified Foods." *Food Quality and Preference 15(2004) 701-714.*

Mueller, Simone C., and Wendy J. Umberger. 2010. "Are Consumers Indeed Misled? Congruency in Consumers' Attitudes towards Wine Labeling Information versus Revealed Preference from a Choice Experiment." Selected Paper prepared for presentation at the Agricultural and Applied Economics Association 2010 AAEA,CAES & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010.

Umberger, Wendy J. and Dillon M. Feuz. 2004. "The Usefulness of Experimental Auctions in Determining Consumers' Willingness-to-Pay for Quality-Differentiated Products." *Review of Agricultural Economics, volume 26:170-185.*

Yue, Chengyan, Frode Alfnes, and Helen H. Jensen. 2006. "Discounting Spotted Apples: Investigating Consumers' Willingness to Accept Cosmetic Damage in an Organic Product." Working Paper, Center for Agricultural and Rural Development, Iowa State University.