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On the Use of Valuation Mechanisms to Measure Consumers' Willingness to Pay for Novel Products: A Comparison of Hypothetical and Non-Hypothetical Values[1]

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Abstract

Willingness to pay (WTP) estimates for novel products are needed to assess consumers' valuation of these products as well as for product adoption and optimal pricing strategies. Using experiments in a retail setting, we compare hypothetical and non-hypothetical WTP values between a Becker-DeGroot-Marshak (BDM) auction mechanism and conjoint analysis. Our results suggest that the auction WTP values are higher than conjoint analysis WTP values. Moreover, the hypothetical WTP values are higher than the non-hypothetical WTP values in both elicitation mechanisms.

Keywords: Conjoint analysis, willingness-to-pay, auction, hypothetical, non-hypothetical

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Introduction

Every year thousands of new products are introduced into the marketplace with a low success rate. Due to the high failure rate, accurate marketing research procedures are critical to increasing the chance for a successful product (Lusk, Feldkamp, and Schroeder, 2004). Many of these novel products include new attributes or an innovative combination of preexisting attributes such as convenience, product form, new safety assurance levels, new technology or functional property. For any new product, food and agribusiness companies need to know how consumers would value these products and decide on an introductory price that reflects consumers' willingness to pay for the novel product. Commonly, the price is assessed based on a "relative" close substitute that has similar attributes. However, this strategy may not yield optimal pricing, since the initial price does not directly take into account how much consumers actually value the innovative product.

The objective of our study is to assess and compare consumers' willingness to pay (WTP) for novel products using two elicitation mechanisms: Becker-DeGroot-Marshak mechanism (BDM) auction and conjoint analysis. In addition, we also want to examine differences in WTP values from these two elicitation mechanisms using hypothetical and non-hypothetical experiments. Hypothetical experiments are normally used when the actual product to be evaluated is not yet available. A potential issue, however, that comes up when using hypothetical experiments is hypothetical bias in the WTP values. Consequently, non-hypothetical or incentive compatible mechanisms have been recently introduced in the marketing field as an alternative to traditional hypothetical valuation. Therefore, one of our goals is to specifically assess the sensitivity of experimental marketing results based on the following WTP elicitation mechanisms: hypothetical conjoint, hypothetical auction, incentive aligned/non-hypothetical conjoint and incentive compatible/non-hypothetical BDM auction. Food/agribusiness managers and researchers can use the results of our study to better understand how choice of WTP elicitation mechanisms can significantly influence WTP estimates, which can then be used to make informed product adoption and optimal pricing decisions. After discussion of the advantages/disadvantages of each technique, an illustrative example is given that compares the differences between the WTP elicitation techniques.

Methodology

Experimental Auction

In an effort to determine potential profitability of selling new goods or modifying existing products, economists and market researchers are increasingly using experimental auctions as opposed to other experimental mechanisms (Depositario, Nayga, and Wu, 2007; Lusk et al., 2006; Shaw, Nayga, and Silva, 2006; Corrigan

and Rousu, 2006; Umberger and Feuz, 2004; Wertenbroch and Skiera, 2002; Hoffman et al., 1993). Experimental auction procedures have especially become a popular method for eliciting WTP values for new product attributes, and for examining several aspects of economic theory (Shogren et al., 1994; Melton, Huffman, and Shogren, 1996). Hoffman et al. (1993) discusses in detail the advantages of including experimental auctions in a pretest market research program. Particularly in the last two decades, auctions have been widely used to test economic theory in a lab setting and less frequently in a retail setting (see Wertenbroch and Skiera, 2002).

In experimental auctions, subjects are normally assigned to a specific group (also called treatment) or a control group. The various treatments can be generated by using different types of subjects, settings, information, endowment levels, or elicitation mechanisms (e.g. Voelckner, 2006). In an experimental auction, subjects submit a bid (otherwise referred to as the subject's WTP) to get a product with the understanding that they may have to actually purchase the product at the conclusion of the study, and the market-clearing price is then determined. One of the most popular elicitation mechanisms is the sealed-second-price auction, in which the highest bidder is the winner and has to pay the second highest price from the group of participants. However, studies conducted in a retail environment typically entail a researcher asking a consumer a set of questions, which rules out the use of the sealed-second-price auction as an elicitation mechanism since there is no second highest bid. Consequently, we used the Becker-DeGroot-Marshak (BDM) mechanism. For a review of some advantages and disadvantages of auction procedures, check Lusk and Hudson (2004).

Commonly used experimental auction procedures are conducted in one of two ways: (i) subjects receive an endowed good (typically a pre-existing substitute) and then are asked to bid to exchange their endowed good for the good of interest, or (ii) subjects can bid directly on several competing goods and a random drawing can be used to determine which good is binding (must be purchased), so that demand for a single unit can be elicited. Experiments involving a transaction of goods or cash are non-hypothetical. In this study, we use the BDM mechanism to elicit our subjects' WTP values for a product.

Conjoint Analysis

Conjoint analysis has been widely applied to evaluate consumers' willingness to pay for various products. According to Green, Kreiger, and Wind (2001), conjoint analysis is "by far, the most used marketing research tool for analyzing consumer tradeoffs." This technique mimics a real buying decision by allowing subjects to choose between a set of product profiles with various combinations of predetermined attribute levels. By evaluating several products with various attribute combinations, it is possible to estimate the WTP for each attribute and its levels. A

key benefit of conjoint designs is their ease of use. However, conjoint designs have typically been hypothetical (i.e., no transaction takes place), in nature. Based on prior research, subjects facing a hypothetical buying decision tend to behave differently than subjects in a real buying situation, leading to biased WTP estimates.

Recently, some modified versions of conjoint analysis have been developed that maintain ease of use, while reducing hypothetical bias. Ding (2005) and Voelckner (2006) have published applications of incentive aligned conjoint analysis. This technique takes advantage of the incentive compatibility of experimental auctions and the availability of substitutes in conjoint analysis. In other words, conjoint designs are transformed from hypothetical transactions to "real life" transactions where the respondent may have to purchase a product that they are evaluating. By including the incentive modification to traditional conjoint analysis, the decision-making environment becomes even more realistic, while maintaining the ease of application that managers and researchers desire when conducting an experiment in a retail setting. Consequently, subjects may generate more accurate information and allow for improved applicability for agribusiness decision-making. However, introduction of a transaction into the experiment does come at a cost since the product chosen for purchase must be provided, which may cause problems if the product is only in the developmental or prototype stages. To our knowledge, prior work utilizing the incentive aligned conjoint approach has not been evaluated against auctions in a retail setting/field experiment.

Model

After conducting the study either through the auction or conjoint analysis format, calculation and comparison of WTP estimates is the next critical step. Calculation of the WTP of a product, for both the hypothetical and non-hypothetical auction experiments, usually involve running a regression to test the significance of both treatment effects and other explanatory variables, such as demographics. With regards to hypothetical and non-hypothetical conjoint analysis, when a rating scale is used, the ratings are regressed on the product profiles to obtain part worth estimates. Next, a transformation is needed to move from utility space to a monetary price space. Voelckner's (2006) transformation utilizes a limit-card to make the conversion from utility to price and is briefly described below. First, the part-worths are estimated for each attribute level for each respondent using ordinary least squares. Second the utility is calculated for each product using all part-worths except those associated with price. Third, the utility for those products the respondent is willing to buy and the minimum or limit utility are calculated. Fourth, the price that equates the limit utility with the utility value in step two is then the monetary WTP.

After obtaining all the WTP for every treatment, a random effects single limit (censored at 0) tobit model was used to assess both attribute and treatment effects on WTP. A random effects tobit model was used due to the panel like structure of our data when all treatments were merged together.

Application

We conducted a field experiment, utilizing both conjoint analysis and auction mechanisms, at selected grocery stores in College Station, Texas in February 2007. Adult shoppers (at least 18 years old) were intercepted while exiting the store and asked to participate in the study. The study was designed to last no longer than ten minutes to reduce respondent fatigue. Using grapefruit as the product of interest, our subjects completed both a demographic and consumption questionnaire about their fresh fruit purchasing. We used value-added products with attributes consisting of type of cut (segmented or cubed) and preservatives (with or without) in our WTP experiments. The attributes of interest (i.e., segment/cube and with/without preservatives) were identified during our pre-tests as the most important attributes that consumers consider in purchasing value-added grapefruit products. In addition to these attributes, the conjoint experiments also involved a price attribute ($0.5, $2.50, or $4.00 per half-pound). These price levels were also obtained from the pretest results of the survey. Our auction experiments did not have a specified price since respondents were required to give their own WTP. A total of 245 subjects participated in our experiments[2] which involved four treatments: hypothetical conjoint, incentive aligned/non-hypothetical conjoint, hypothetical auction, or incentive compatible/non-hypothetical BDM auction (see Table 1).

Table 1: Experimental Treatment Groups

Group	Subject Task	Sample Size
A-Nonhypothetical Auction	Write down WTP; product to purchase was randomly chosen.	44
B-Hypothetical Auction	Write down WTP on rating scale; no transaction occurred.	64
C-Nonhypothetical Conjoint	Rate pictures; Product to purchase was randomly chosen.	59
D-Hypothetical Conjoint	Rank pictures; no transaction occurred.	78

Subjects in the hypothetical conjoint treatment were asked to evaluate twelve pictures consisting of various combinations of product attributes and rate their intention to buy on a 1 to 7 scale. A transformation given by Voelckner (2006), discussed in the model section of this paper, was used to transform the rating scale values to monetary WTP estimates.

[2] The study script and questionnaires are available from the authors upon request.

In the hypothetical auction treatment, subjects were free to write down any number to express their WTP. Participants were explicitly told that they could assess a WTP of zero dollars if they did not want the product. The products were presented in a set of four pictures and every picture was titled with the attributes they represented. Since price was not given, as was the case with conjoint, only four pictures were needed, representing all combinations of the attributes presented above. Considering that this treatment was hypothetical, no transactions took place.

The only difference between the hypothetical and non-hypothetical treatments was that the respondents had the chance of purchasing one of the products in the non-hypothetical treatments. In the non-hypothetical auction treatment, a random product and price (i.e. market price) was chosen after giving their WTP for each picture. The subject had to purchase the randomly selected product if their stated price was equal to or higher than the market price. In the non-hypothetical conjoint treatment, a product was randomly chosen and the respondent had to purchase the product only if their rating was four or greater. If their rating was less than four then another product was randomly drawn. This procedure continued until a transaction occurred or three products had been drawn randomly. Up to three products were chosen so as to maintain the same chance of "winning" as the non-hypothetical BDM auction, given that the subject had a favorable rating for the product. Based on the incentive aligned literature, this can be thought of as a modified version of the work done by Ding (2005) and Voelckner (2006).
Our subjects each received $4 for participating in our experiments. This participation fee may be considered as an endowment that could be spent totally or partially in the study. If a subject purchased a product, then they received the product plus the $4 minus the price paid for the product. The giving of endowments may bias WTP estimates for the good in question (Harrison, 1989), which is called an endowment effect. Loureiro, Umberger, and Hine (2003) design an experiment to test if three levels of monetary endowments would cause significant different bids. The authors conclude that an endowment close to the value of the auctioned good should not have a significant impact in the experimental design. Consequently, since the four dollars was close to the expected WTP values based on a pretest of the survey, we do not expect a significant endowment effect in the WTP estimates.

Results and Discussion

The first step in the analysis was to calculate the WTP values for each treatment using the simple averages (see Table 2). Results show that the auction WTP means are higher than the conjoint WTP means, in both the hypothetical and non-hypothetical experiments. Also, in both auction and conjoint treatments, the hypothetical WTP mean is higher than the respective non-hypothetical treatment mean.

Table 2: Mean Willingness to Pay Values by Group*

Group	Cubes NoPreservatives	Cubes Preservatives	Segments No Preservatives	Segments Preservatives
A-Nonhypothetical Auction	$1.50 C	$1.35 B,D	$1.59 B,C,D	$1.32 B
B-Hypothetical Auction	$1.83 D,C	$1.56 A,C,D	$1.87 A,C,D	$1.67 A,C,D
C-Nonhypothetical Conjoint	$1.40 A,B	$0.73 B	$1.54 A,B,D	$0.84 B,D
D-Hypothetical Conjoint	$1.53 B	$0.79 A,B	$1.99 A,B,C	$1.18 B,C

(*) The simple averages represent the average WTP for that product.
Note: Significance is tested pair-wise using the Kolmogorov-Smirnov test. For example, a superscript of BD in Nonhypothetical auction means that Treatment A (non-hypothetical auction) is significantly different from treatments B (hypothetical auction) and D (hypothetical conjoint).

Table 3 formally shows the differences between the hypothetical and non-hypothetical BDM auction and the hypothetical and non-hypothetical conjoint. Statistical tests of the differences between treatments were calculated using the Kolmogorov-Smirnov test for equality of distribution functions since normality of the WTP distributions was rejected. Results generally indicate that, with the exception of two cases, the hypothetical WTP values are significantly higher than the non-hypothetical WTP values.

Table 3: Differences of Willingness to Pay Means

Group	Cubes NoPreservatives	Cubes Preservatives	Segments No Preservatives	Segments Preservatives
Auction (hypothetical – nonhypothetical)	$0.33**	$0.21*	$0.28*	$0.35*
Conjoint (hypothetical – nonhypothetical)	$0.13	$0.06	$0.45*	$0.34*

(*) Statistically significant at the 0.10 level using Kolmogorov-Smirnov test
(**) This difference has a p-value of 0.154

The descriptive statistics of all the variables in the model are presented in Table 4. The mean WTP results suggest that our subjects value segmented products without preservatives the most with average WTP of $1.78, followed by cubed products without preservatives, segmented products with preservatives, and then cubed products with preservatives.

Table 4: Descriptive Statistics of the Variables

	Median	Mean	Std. Dev.	Max	N.	Min
Willingness to Pay						
Cubes with preservatives	1.00	1.08	0.94	5.00	223	0
Cubes without preservatives	1.50	1.58	1.09	4.42	223	0
Segment with preservatives	1.08	1.25	1.03	5.67	223	0
Segments without preservatives	1.50	1.78	1.19	5.00	223	0
Treatment Indicators						
Treatment A (non-hypothetical auction)	0	0.18	0.39	1	223	0
Treatment B (hypothetical auction)	0	0.26	0.44	1	223	0
Treatment C (non-hypothetical conjoint)	0	0.22	0.42	1	223	0
Treatment D (hypothetical conjoint)	0	0.33	0.47	1	223	0
Income Indicators						
$19,000 or less	0	0.43	0.50	1	223	0
$20,000 - $39,999	0	0.22	0.42	1	223	0
$40,000 - $59,000	0	0.11	0.32	1	223	0
$60,000 - $79,999	0	0.08	0.27	1	223	0
$80,000 - $99,999	0	0.06	0.24	1	223	0
More than $100,000	0	0.09	0.29	1	223	0
Marital Status Indicators						
Single	1	0.51	0.50	1	223	0
Married	0	0.46	0.50	1	223	0
Other (widows and divorced)	0	0.04	0.19	1	223	0
Educational Indicators						
Less than 12 years	0	0.04	0.21	1	223	0
12 years (graduated from high school)	0	0.21	0.41	1	223	0
More than 12 and less than 16 years	0	0.29	0.46	1	223	0
16 years (graduated from college)	0	0.30	0.46	1	223	0
More than 16 years	0	0.16	0. 37	1	223	0
Situational Indicator						
Hungry and thirsty	0	0.28	0.45	1	223	0

To definitively assess the product and treatment effects on WTP, we ran a single limit random effects tobit model. The marginal effects and standard errors of the To definitively assess the product and treatment effects on WTP, we ran a single limit random effects tobit model. The marginal effects and standard errors of the random effects Tobit model are exhibited in Table 5, *see Appendix.* All the product and treatment effects are statistically significant at the 0.05 level. Specifically, consistent with the descriptive WTP means, our model results indicate that segmented products without preservatives are valued about $0.83 more than cubed products with preservatives (base product), *ceteris paribus*. Cubed products without

preservatives and segmented products with preservatives are valued about $0.61 and $0.23 more than cubed products with preservatives. In terms of the treatments, consistent with the descriptive analysis, results suggest that the auction treatments have generally higher estimates than the conjoint WTP values. Specifically, the results show that the non-hypothetical BDM auction ($0.43), the hypothetical auction ($0.76) and hypothetical conjoint ($0.37) treatments have significantly higher WTP values than the non-hypothetical conjoint[3]. The non-hypothetical conjoint treatment has the lowest WTP values while the hypothetical auction treatment has the highest WTP values. Also, as evidence of the expected existence of hypothetical bias in hypothetical valuation experiments, the hypothetical treatments have significantly higher WTP values than the non-hypothetical treatments. Specifically, the marginal effects suggest that the WTP values in hypothetical auction are $0.33 higher than the non-hypothetical BDM auction and the WTP values from the hypothetical conjoint are $0.37 higher than the non-hypothetical conjoint. In summary, we find that the non-hypothetical valuation mechanisms offered a significant reduction of the possible hypothetical bias. This finding is consistent with the findings of Lusk, Feldkamp, and Schroeder (2004). Using a sample of 104 subjects in a lab setting, they found that WTP for hypothetical treatments was 1.2 times the size of the non-hypothetical treatments. In contrast, Voelckner (2006) could not definitively find a significant reduction in hypothetical bias with the use of incentive aligned mechanisms. A key difference between our study and the Voelckner (2006) and Lusk, Feldkamp, and Schroeder (2004) studies is that their studies were conducted in a lab setting as opposed to a retail/field environment.

In terms of the other variables, marital status, education level and a situational variable (hungriness and thirstiness at the time of the experiments) are statistically significant. Specifically, single and married subjects have higher WTP values than other individuals (i.e., widows and divorced). As expected, subjects who indicated that they felt hungry and thirsty during the experiments have higher WTP values ($0.36 more) than those who were not hungry/thirsty. Ethnicity, household age composition, principal shopper condition, purchase location, frequency of purchasing and complexity of the task were originally included in the model but were excluded in the final model because they were not close to being statistically significant. Similarly, with respect to experimental design, we also did not find any significant store, time of the day, day of the week and interviewer effects.
To better understand the complexity of the treatment for each subject, a question was included asking each respondent to rate the degree of complication of the

[3] In addition, we compared groups A and C (non-hypothetical treatments) and B and D (hypothetical treatments). We found that the non-hypothetical conjoint was a significant $ 0.46 less than the non-hypothetical auction. Using the same procedure for the hypothetical groups, we found that hypothetical conjoint estimation was a significant $ 0.47 less than the hypothetical auction estimation. We do not include these outputs in the paper but are available from the authors upon request.

experiments (Table 6). As expected the hypothetical groups have a lower complexity index than the non-hypothetical groups. The hypothetical groups required little training to complete their task while the non-hypothetical groups required more respondent effort to understand the experimental and survey process. Further analysis reveals that the hypothetical conjoint (most popular approach) had the lowest complexity score, while the non-hypothetical or incentive aligned conjoint had the highest. In addition, the random effects model shows that the complexity variable was not significant. Considering the level of complexity expressed by the subjects overall and since it is not statistically significant, we do not believe that the complexity of the treatments played a significant role in their WTP estimates or can explain some of the WTP variation.

Table 6: Level of Complexity of the Task

Group	Complexity Level
A-Nonhypothetical Auction	2.83
B-Hypothetical Auction	2.51
C-Nonhypothetical Conjoint	3.04
D-Hypothetical Conjoint	2.31

Note: The subject classifies the task from 1 (very easy) to 10 (very hard)

Concluding Remarks and Managerial Implications

Food and agribusiness managers continue to introduce novel products into the marketplace in the hope of increasing revenues, market share, and satisfy changing consumer and market needs. However, developing and introducing new products into the market can be expensive. In addition, thousands of new food products are introduced into the market every year with very low success rates. Thus, assessing consumers' valuation of these new products is critical. Secondary data are normally not available for new products. Hence, researchers need to use hypothetical or experimental markets to evaluate the market potential of novel products (Lusk and Hudson, 2004).

Over the last three decades, market researchers have been using conjoint analysis to measure consumer preferences and determine WTP. In addition, experimental economics have introduced some incentive compatible auctions to test economic theory and measure WTP. More recently, incentive aligned studies, taking advantage of both auction and conjoint analysis formats, have been proposed as the next step to measure WTP. We have reviewed the incentive aligned mechanism in an auction and conjoint analysis context. Using experiments in a retail setting, our results generally suggest that indeed, consumers' WTP values are influenced by the type of valuation or elicitation mechanism and by the hypothetical/non-hypothetical

nature of the valuation process. Interestingly, our findings suggest that auction WTP values are higher than conjoint analysis WTP. This result does not necessarily mean that one should be preferred over the other. On the contrary, the choice of a particular type of elicitation mechanism should be based, among others, on the objective and nature of the study. We also recommend that market researchers view these elicitation mechanisms as complementary to each other rather than substitutes. For example, experiences and values from a conjoint analysis study can be used to better design auction experiments and vice-versa. From our experiments, we also generally found that the hypothetical WTP values are higher than the non-hypothetical WTP values in both elicitation mechanisms. This result is expected due to the possible occurrence of hypothetical bias in hypothetical valuation studies. Evidence of this hypothetical bias in some contingent valuation studies is widespread (Cummings, Harrison and Rutstrom 1995; List and Gallet 2001; Loomis et al. 1997; Neill et al. 1994). Based on these results, our recommendation is for future valuation efforts to use nonhypothetical rather than hypothetical elicitation mechanisms especially when the new product of interest can be produced and available.

In conclusion, our results imply that the decision a researcher or manager makes with respect to the elicitation mechanism and their implementation can have a direct impact on estimates of the value of novel products. Since agribusinesses are continuously finding new ways of fulfilling a more demand and consumer-driven marketplace, this finding is of utmost importance due to cost of developing and launching novel products. Having appropriate estimates of consumers' valuation of these novel products can aid business managers decide which of these products should be adopted, market tested, or commercialized. It will also guide them in making optimal pricing decisions.

Future studies should attempt to design elicitation mechanisms that can provide consumer surplus and price elasticity of demand measures that can further aid business and managerial decision-making. For example, Corrigan (2006) and Depositario, Nayga, and Wu (2007) have examined the use of "reverse auction" mechanism. They argue that the reverse auction mechanism provides information that could enable the estimation of consumer surplus and price elasticities of demand. They also found that the reverse auction mechanism produces little bid affiliation and round effects in repeated auctions. Another promising tool that market researchers and managers can potentially use are virtual experiments (VE) (Nayga 2007). As Fiore et al. (2007) discussed, VE can bridge the gap between the controls of lab experiments and the naturalistic domain of field experiments, which can then provide tools that can assist managers make informed business decisions.

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Appendix:

Table 5: Marginal Effects and Standard Errors of the Random Effects Tobit Model

		4-Treatment Data Set
Groups		A, B,C,D
Sample Size		892
		Coefficient
	Intercept	-0.85*
		(0.44)
Product Indicators		
	Cubes with preservatives	Base
	Cubes without preservatives	0.61*
		(0.08)
	Segment with preservatives	0.23*
		(0.08)
	Segments without preservatives	0.83*
		(0.08)
Treatment Indicators		
	Treatment A (nonhypthetical auction)	Base
	Treatment B (hypothetical auction)	0.43*
		(0.20)
	Treatment C (nonhypothetical conjoint)	0.76*
		(0.18)
	Treatment D (hypothetical conjoint)	0.37*
		(0.17)
Income Indicators		
	$19,000 or less	0.39
		(0.27)
	$20,000-$39,999	0.18
		(0.26)
	$40,000-$59,000	0.08
		(0.29)
	$60,000-$79,999	0.63*
		(0.32)
	$80,000-$99,999	-0.04
		(0.33)
	More than $100,000	Base
Marital Status Indicators		
	Single	0.84*
		(0.35)
	Married	0.90*
		(0.36)
	Other (widow/divorced)	Base

Table 5: (Continued)

Educational Indicators		
	Less than 12 years	-0.50
		(0.35)
	12 years (graduated from high school)	0.31
		(0.21)
	More than 12 and less than 16 years	0.16
		(0.21)
	16 years (graduated from college)	0.22
		(0.19)
	More than 16 years	Base
Situational Indicator		
	Hungry and Thirsty	0.36*
		(0.14)
	Sigma_u	0.81*
		(0.05)
	Sigma_e	0.82*
		(0.02)
	Rho	0.49
		(0.04)

(*) Statistically significant at the 0.05 level.
Note: The values reported in parentheses are the standard error of the respective parameter.

