ESSAYS IN THREE DESIGN ISSUES IN EXPERIMENTAL AUCTIONS

by

JI YONG LEE

B.S., Chungbuk National University, 2008
M.S., Korea University, 2010

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics
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Manhattan, Kansas

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Abstract

The objective of this thesis is to investigate three design issues in experimental auctions: 1) the effects of allowing negative bids for a privately valued good, 2) the effects of introducing additional alternatives (substitutes) for the auctioned good in an endowment auction, and 3) respondent behavior in acquiring information. The thesis consists of three papers examining those issues.

The first paper examines participants' bidding behavior when negative bids are allowed for privately valued goods in an experimental auction. We focus on two questions: i) whether subjects with negative values tend to bid strategically – either overbidding or underbidding in an effort to enhancing earnings, and ii) the performance of random n^{th} and 5^{th} price auctions. We find that: a) WTP bids are demand revealing, b) subjects tend to underbid WTA values, c) controlling for risk attitude partially explains the bias in WTA bids, and d) negative values from random n^{th} auctions tend to be below those from 5^{th} price auctions.

In the second paper we 1) investigate the effect of the availability of varying numbers of alternatives (substitutes) for a privately valued good on participants' bidding behavior, and 2) identify whether the availability of additional alternatives: a) impacts the value of product information, and b) impacts the effect of new information on product valuations. We find that: a) allowing additional alternatives in a private value auction does not significantly decrease subjects' bids, and b) the presence of additional alternatives in the auction decreases both the value and effect of product information.

The third paper examines the effect of acquired information on auction participants' bidding behavior. We focus on three questions: i) how subjects choose/value different types of information, ii) whether the value of acquired information about a product influences the

subsequent valuation of the product itself, and iii) whether the effects of acquired information differ from those of exogenously provided information. We find that: a) subjects' behaviors of acquiring different types of information about the product are influenced by their heterogeneous characteristics (i.e. prior beliefs, risk attitudes, prior knowledge, etc.), b) subjects place more weight on acquired information than on provided information in their decision-making process, and c) individual subjects have different values of information which caused different impacts on product valuation.

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Chapter 1 - General Introduction

An experimental auction is a mechanism for eliciting consumers' willingness to pay (WTP) and/or willingness to accept (WTA) for new products and product attributes using non-hypothetical and incentive compatible mechanisms[1]. Experimental auctions are often preferred over alternative hypothetical valuation methods (e.g. conjoint analysis, contingent valuation) because they can better replicate some of the elements of a realistic market environment. Experiments can create realistic market environments using an appropriate experimental design and by employing an exchange mechanism with real products and real money to elicit subjects' own reservation price for an auctioned product. A well-developed or reality-based experimental design will thus be important since it can provide real economic incentives to auction participants to reveal their true valuation for a good.

Experimental scientists also implicitly assume the same decision-making behaviors in both a controlled environment and real market. Given this premise, they predict overall consumers' actual behaviors outside the laboratory by extrapolating from controlled small scale experiments. Better predictions of field phenomena are thus likely to result from an environment with more realistic experimental controls. Results confounded by a lack of experimental control from design incentives may cause a behavioral inconsistency in the experiment and predictions about the real market would be less instructive.

[1] An experimental auction is said to be incentive compatible when it induces a bidder to submit their true valuation for a good (Lusk and Shogren, 2007).

To develop a good experimental design, experimental practitioners should initially learn about individual's decision making process based on economic theory and reflect those theoretical behavior implications in designing the experiment. Practitioners also need to examine the consistency between theoretical prediction from the experimental design and actual behaviors in the real market prior to generalizing the design.

Some experimental design issues have been examined and debated (i.e. learning vs bid affiliation; endowment vs full bidding; choice of auction mechanism, use of cheap-talk scripts, etc.). Multiple rounds of auction trials with price feedback have been commonly utilized in experimental valuation studies (e.g. Fox et al., 1998; Lusk et al., 2004; Lee et al., 2011). Repeated bidding rounds for the same product help participants find their true values for the good (List and Shogren, 1999). However, price feedback may send a strong signal to participants who submit low bids and cause bid affiliation.[2] Auction mechanisms with bid affiliation are no longer demand revealing in a private value auction (Harrison et al., 2004). Practitioners have yet to reach a clear agreement about this design issue. Harrison et al (2004) recommended using only one bidding round to avoid bid affiliation but this approach requires many practice auctions with other products to reduce subjects' misperceptions (Plott and Zeiler, 2005). Alfnes et al (2008) suggested using an n^{th} price auction with a low numbers of rounds to reduce the bid affiliation from price feedback.

There are two approaches to using experimental auctions to elicit consumers' valuation for a good (i.e., the endowment and full bidding approaches). In the endowment approach, a participant is endowed with one product and submits a bid for another product, while in the full

[2] Bidders who have low bids are likely to submit high bids according to the price feedback. For example, a posted high bid submitted by one participant leads other participants who have low bids to submit higher bids in later rounds.

bidding approach a participant submits simultaneous bids for multiple products. Lusk and Shogren (2007) recommended the endowment approach if outside options are available for the auctioned product since the difference in value between two products is not confounded by the availability of field substitutes. On the other hand, Alfnes (2009) concluded that field substitutes have a significant impact on optimal bids in all private value auctions and thus the existence of field substitutes is not a valid reason against using the full bidding approach. He also argued that unequal treatment between two products (endow one product and bid for another) in the endowment approach may be more problematic.

Choice of an auction mechanism (e.g. 2^{nd} price, n^{th} price, BDM, and random n^{th} price auctions) is also an important design issues in experimental auctions because results can vary across different auction methods. Each mechanism has its pros and cons and they should theoretically yield a consistent true value. Thus, there is no clear decision rule to choose a specific auction mechanism. The best way of reducing the discrepancy in results from different auction mechanisms can be a detailed explanation of the mechanism to make sure participants fully understand the property of auction mechanism (Plott and Zeiler, 2005). Plott and Zeiler (2005) also recommended a practice auction in the experimental design since it can reduce subjects' misconceptions about experimental procedures.

There are many other design issues that already have been answered (e.g. practice or training) or still need to be answered (e.g. negative values, field substitutes) in the application of experimental auctions. Examining those design issues can explain some experimental anomalies, and thus improve the quality of an experimental design. This thesis will examine three design issues that have not been considered in detail (i.e. issues of allowing negative bids and

availability of field substitutes) or have never been considered (i.e. behavior in acquiring information).

Dissertation Organization

The primary focus of this dissertation is to examine three experimental design issues in private value experimental auctions, namely the impacts of 1) allowing negative bids, 2) the availability of market alternatives, and 3) respondent behavior in acquiring information. Each paper will follow a standard economic journal format.

Paper 1: *Bidding behavior in experimental auctions with positive and negative values*

Consumers have different perceptions about the benefits and risks of new products or controversial products (e.g., irradiated food or genetically modified food). Some people may view those products as benefits and value them positively while others may think they have potential risks and value them negatively. An advantage of allowing negative bids[3] in an experimental auction is that it would permit full revelation of the demand curve. However, auction practitioners rarely allow negative bids due to a potential drawback – i.e., subjects may bid strategically instead of revealing their true valuation. The first paper in this thesis investigates participants' bidding behavior when negative bids are allowed for privately valued goods in an experimental auction. We focus on two questions: i) whether subjects with negative values tend to bid strategically – either overbidding or underbidding in an effort to enhancing

[3] If an auctioned good has a mixed preference across subjects (i.e. GM food and irradiated food), there is a chance that some participants have negative values for the good. In this case, they are allowed to submit negative bids in the experiment to give up the preferred good and obtain less preferred good (i.e. willingness to accept).

earnings, and ii) the performance of random n^{th} and 5^{th} price auctions since the choice of auction can attenuate or exaggerate participants' negative reactions.

Paper 2: *The effects of allowing multiple alternatives on bidding behavior in a private value experimental auction*

The availability of substitutes is important in almost all valuation exercises since economic theory suggest that their availability influences demand. However, many researchers prefer to avoid the confounding effects from substitutes, particularly in studies where the focus is on valuing a specific attribute (e.g., food safety risk) whose level varies between two goods. This failure to control for the influence of substitutes does not reflect real world market situations and may lead to misinterpretation or poor predictions of consumer behavior. The second paper therefore investigates: i) the effect of awareness of the availability of alternatives for a privately valued good on participants' bidding behavior, ii) whether the availability of additional alternatives decreases the value of product information, and iii) whether the availability of alternatives mitigates the effect of new information on product valuations.

Paper 3: *The effect of acquired or provided information on consumer valuation in a private value experimental auction*

Information has value since it can help consumers make better market choices. Consumers seek out the information that is of most value to them and make purchase decisions based on that information. Thus, the types and amounts of information that is obtained is endogenously decided by consumers, and depends on each consumer's valuation of information. However, most experimental studies exogenously provide information to participants and then generally proceed to measure the effect of that information on consumers' choices. The results

from those studies might differ from the reality of the world since they do not consider the way that information is acquired by consumers. The third paper therefore examines the effect of acquired information on auction participants' purchasing behaviors in a private value experimental auction. We focus on: i) how subjects choose/value different types of information, ii) whether the value of acquired information about a product influences the subsequent valuation of the product itself, and iii) whether the effects of acquired information differ from those of exogenously provided information.

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Chapter 2 - Bidding Behavior in Experimental Auctions with Positive and Negative Values[4]

2.1. Introduction

Due to their having a mix of perceived benefits and risks, goods such as irradiated or genetically modified foods are valued positively by some consumers and negatively by others. Mixed logit estimation with choice experiment data readily accommodates simultaneous estimation of positive and negative values, but the same is not true for valuation experiments. Experimental auctions typically elicit either a willingness to pay (WTP) or a willingness to accept (WTA) value, and rarely allow negative bids which would facilitate simultaneous elicitation of both WTP and WTA (Lusk and Shogren, 2007). Instead, when faced with the likelihood of negative valuations, researchers typically truncate bids at zero, or separate participants based on preference and elicit WTP to upgrade to a preferred alternative (Fox et al., 1998).

Allowing negative bids in an experimental auction would permit full revelation of the demand curve. However, Dickenson and Bailey (2002) pointed to a potential drawback of allowing negative bids – i.e., subjects may bid strategically instead of revealing their true valuation. Their concern was motivated by results from induced value experiments reported by Shogren et al. (2002) and later by Parkhurst et al. (2004) showing that subjects with negative values tended to overbid (not reveal the full extent of the negative valuation) in a 2nd price auction. In the same study, results from a random nth price auction were less precise but did not reveal the same tendency to overbid negative values (Parkhurst et al., 2004).

[4] A revised version of this chapter was published in *Economics Letters* (http://www.sciencedirect.com/science/article/pii/S0165176515003717).

In this paper, we investigate participants' bidding behavior when negative bids are allowed for privately valued goods in an experimental auction. We focus on two questions: i) whether subjects with negative values tend to bid strategically – either overbidding (as found by Parkhurst *et al*.) or underbidding (i.e., demanding excess compensation) in an effort to enhancing earnings, and b) the performance of random n^{th} and 5^{th} price auctions when negative bids are allowed. Any tendency to either under- or over-bid a negative value would be important to recognize should practitioners begin to routinely allow negative bids in their experiments. We find that a) WTP bids are demand revealing, b) subjects tend to underbid WTA values, c) controlling for risk attitude partially explains the bias in WTA bids, and d) negative values from random n^{th} auctions tend to be below those from 5^{th} price auctions.

2.2. Experimental design

Participants were graduate and undergraduate students at Kansas State University, recruited via e-mail solicitation or from an undergraduate class. They were told they would be paid $5 and receive a pizza meal. A total of five sessions were held, each with ten participants. Two sessions used a 5^{th} price auction, two used a random n^{th} price auction, and one session used both auctions. The experiment thus provided 30 observations for each auction mechanism.

On arrival, participants signed a consent form, received the $5 payment, were provided with an ID number, and completed a short questionnaire. In stage 1, participants examined two products – a 10oz package of Trail Mix (TM) and a 6oz package of Dried Fruit (DF). They were then asked to indicate a preference - i.e., I prefer the Trail Mix; I prefer the Dried Fruit; I like them both equally well. Participants were then told that they would participate in a 2^{nd} price auction for both products. A practice auction using a small candy bar was used to demonstrate

the auction mechanism and to emphasize that the exercise was not hypothetical. At the end of the practice auction, the winning bidder obtained the candy bar and paid, in cash, an amount equal to the 2nd highest bid. Participants then bid for the packages of TM and DF in a "full bidding approach" with bids for both items were submitted simultaneously (Corrigan and Rousu, 2006). To avoid a wealth effect, participants were told that only one of the two auctions, selected by coin toss, would be binding. They were informed that the binding auction and winning bidder would be selected at the conclusion of the experiment.

In stage 2, participants were told that they would participate in a number of "endowment" auctions in which they would bid either a positive WTP or a negative WTA to exchange one good for another. Only one of these auctions (the number of auctions was not revealed) would be binding, and there would be N-1 winning bidders each paying an amount equal to the Nth bid. In sessions using the 5th price auction, N=5 was revealed prior to bidding. In sessions using the random nth auction participants were told that N would be a randomly drawn number between 2 and 8, determined after the bidding. An instruction sheet illustrated how the auction would work in a scenario with seven subjects bidding to exchange an oven mitt for a coffee mug. In that scenario, three people preferred the coffee mug (and bid positive WTP for the exchange), one was indifferent (and bid zero), and three preferred the oven mitt (and bid negative WTA for the exchange). Positive, zero, and negative bids were illustrated as points along a line. With N=5 winning bidders, the result was 4 bidders making the exchange and getting paid the amount of the (negative) 5th highest bid to do so. To ensure that subjects understood the mechanism, they were asked a series of questions about the scenario – e.g., what would happen if N=2, etc. To further familiarize them with the auction, another practice auction (also binding) was conducted using candy bars.

We then conducted Auction A, in which participants were endowed with a package of DF and could bid to exchange it for a package of TM. On the bid sheet, participants were asked to write "the most I am willing to pay" for the exchange or "the minimum I would accept" to make the exchange, and were further instructed to mark their bid along a line. The monitor checked bid sheets for consistency between the written bid amount and the location of the marked bid on the line and sought clarification from the subject in the event of any discrepancy. After bids were collected, participants handed back the DF and proceeded to Auction B in which the endowment was reversed, i.e., the endowment was TM and participants bid to exchange it for DF.[5]

In our analysis, performance of the subsequent endowment auctions will be assessed in terms of consistency between the initial bid differential between the two products in stage 1, and bids for upgrades or downgrades in stage 2.

2.3. Experimental results

After checking the data for consistency between initial bids and stated preferences, bids from three subjects (all from the session using both auction types) were discarded for inconsistency i.e., stating a preference for good A, but simultaneously submitting a larger bid for good B. Table 2-1 summarizes the bids for the remaining 27 observations on each auction.

[5] Two additional rounds, C and D, were conducted in the session that used both auction types.

Table 2-1. Stage 1 and Stage 2 bids by auction type

Auction type		Stage 1		Stage 2	
		Bid for TM	Bid for DF	DF→TM	TM→DF
5th price (N=27)	Mean	1.58	1.47	0.03	-0.54
	Median	1.25	1.00	0.1	-0.6
	St. Dev.	1.04	1.19	1.09	1.70
Random nth (N=27)	Mean	1.74	1.62	-0.35	-0.28
	Median	1.8	1.5	0.00	0.00
	St. Dev.	1.13	1.33	1.65	2.00

Stage 1 bids are slightly higher for Trail Mix (TM) than for Dried Fruit (DF) but the difference is not significant ($p = 0.43$)[6]. Stage1 bids suggest that the expected average bid for the DF→TM exchange in Stage2 should be \$0.11 and \$0.12 in the 5th and random nth auctions respectively. The observed DF → TM averages are lower, insignificantly in the 5th price (\$0.03, p=0.58), but significantly lower in the random nth (-\$0.35, p=0.01). For the opposite TM→DF exchange, average bids in the 5th and random nth auctions (-\$0.54 and -\$0.28) are again below the expected -\$0.11 and -\$0.12, but the differences are not significant (p=0.19, p=0.49). The average bid for the DF→TM exchange is higher in the 5th price auction, while that for the TM→DF exchange is higher in the random nth auction.

Comparing Stage 2 bids in the 5th price and random nth auctions reveals no clear pattern. The average bid for the DF→TM exchange is higher in the 5th price auction, while the average bid for the opposite TM→DF exchange is highest in the random nth auction. Bid variance is higher in the random nth auctions, but again, differences are not statistically significant.

[6] All p-values show paired t-test results.

We now re-categorize Stage 2 bids as either WTP or WTA values according to the preference revealed in Stage 1.[7] In table 2-2, "Upgrade WTP" represents WTP to exchange to the preferred alternative (whether DF or TM), and, similarly, "Downgrade WTA" represents the negative WTP for an exchange toward the less preferred alternative. The "Stage 1 Premium" is the premium for the preferred alternative revealed in Stage 1.

Table 2-2. Stage 1 premium, Upgrade WTP, and Downgrade WTA values, by auction type

Auction type		Stage 1 Premium	Upgrade WTP	Downgrade WTA
5th price (N=27)	Mean	0.69	0.74	-1.25
	Median	0.50	0.50	-1.00
	St. Dev.	0.71	0.85	1.22
Random nth (N=26)	Mean	0.93	0.95	-1.61
	Median	0.75	0.75	-1.30
	St. Dev.	0.77	1.16	1.49

Table 2-2 values suggest that upgrade WTP is similar to the Stage 1 premium, while downgrade WTA values exceed (in absolute value) the Stage 1 premium. Among 53 pairs of DF→TM, TM→DF bids, we found 16 that could be classified[8] as exhibiting WTA>>WTP, but only 3 where WTP>>WTA. We test the hypothesis of demand revealing bidding behavior in the Stage 2 auctions using the following structure:

(1) $WTP_i\ (WTA_i) = \alpha + \beta * PREM_i + \varepsilon_i$

[7] One subject indicated equal preference for TM and DF, bid equal amounts for both products, and bid zero WTP and WTA amounts in Stage 2. Because the Stage 2 bids could not be categorized as either WTP or WTA, the individual's bids were dropped from this analysis.

[8] Classifying WTA>>WTP if the absolute value of the negative bid is at least twice the value of the positive bid, or is at least $1 more than the positive bid.

where WTP_i (WTA_i) is the Stage 2 bid to upgrade (downgrade), and $PREM_i$ is the premium for the preferred good from Stage 1. Stage 2 bids are demand revealing if $\alpha=0$ and $\beta=1$ for WTP, and $\alpha=0$ and $\beta=-1$ for WTA. The estimated WTP/WTA equations for each auction, with standard errors in parentheses, are:

5th Price:	$WTP_i = 0.19 + 0.81*PREM_i$ (0.17) (0.18)	(W = 0.64; p = 0.53)
	$WTA_i = -0.75 - 0.73*PREM_i$ (0.31) (0.32)	(W = 3.73; p = 0.038)
Random N:	$WTP_i = 0.11 + 0.91*PREM_i$ (0.29) (0.24)	(W = 0.08; p = 0.92)
	$WTA_i = -0.36 - 1.35*PREM_i$ (0.33) (0.28)	(W = 5.98; p = 0.008)

The Wald test values (W) test the joint hypothesis $\alpha=0$ and $\beta=1/-1$ and indicate that, for both WTP auctions, the hypothesis of demand revealing bidding cannot be rejected. For both WTA auctions however, demand revealing bidding is rejected. WTA coefficient estimates indicate that participants demand more compensation to surrender the preferred good in exchange for the less preferred good than they are willing to pay for the opposite exchange. Divergence between elicited WTP and WTA is common in experimental valuation and is consistent with an endowment effect (Kahneman and Tversky, 1979). From table 2-2 we see that in the 5th price auction, WTA bids exceed their WTP counterparts by 0.51 on average (WTP=0.74, WTA = -1.25), while in the random nth treatment the difference was 0.66.

We now explore whether the subject's attitude to risk may have a role in explaining the WTA bids. Since the endowment effect posits the idea that losses are weighted more heavily than gains in the utility function, it seems possible that the weighting applied to losses may be correlated with an individual's risk attitude. Thus, individuals who are more risk averse may be

more inclined to exaggerate a WTA bid (i.e., demand more compensation) to reduce the possibility of losing a preferred good. Our questionnaire elicited risk attitude by asking respondents the degree to which they disagreed/agreed with the statement "*I am cautious in trying new and different things*." Responses were on a Likert scale from 1 (strongly disagree) to 5 (strongly agree), with higher values indicate higher risk aversion. The variable had a mean of 2.85 and St. Dev. 0.91. Including risk attitude in the WTA models provides the following estimates:

5^{th} Price: $WTA_i = -0.34 - 0.78*PREM_i - 0.12*Risk_i$ (W = 0.21; p = 0.81)
(0.87) (0.34) (0.24)

Random N: $WTA_i = 0.01 - 1.35*PREM_i - 0.14*Risk_i$ (W = 0.88; p = 0.43)
(0.81) (0.28) (0.27)

In both models, the coefficient on risk attitude is negative (as hypothesized) but not statistically significant. The coefficients on the first stage premium (*PREM*) are similar to the earlier estimates, but in both cases the intercept moves closer to the origin. With that change, the joint hypothesis that $\alpha=0$ and $\beta=-1$ is not rejected for either model.

The final objective is to compare performance of the 5^{th} price and random n^{th} price auctions. For subjects with large positive or negative values, Parkhurst *et al*. (2004) found that subjects in a 2^{nd} price auction tended to overbid while bids in the random n^{th} auction were unbiased. We investigate the hypothesis of similar behavior across auction mechanisms using:

(2) $WTP_i\ (WTA_i) = \alpha_1 + \beta_1*PREM_i + \alpha_2*RandomN + \beta_2*PREM*RandomN + \varepsilon_i$

where *RandomN* is a dummy variable for bids elicited in a random n^{th} auction, and *PREM*RandomN* an interaction term. Bidding behavior is similar in both auctions if α_2 and β_2 are both zero. The estimated equations are:

WTP_i = 0.19 + 0.81*$PREM_i$ – 0.07*$RandomN$ + 0.09 $PREM$*$RandomN$ (W=0.05; p=0.95)
(0.21) (0.22) (0.33) (0.31)

WTA_i = -0.75 - 0.73*$PREM_i$ + 0.39*$RandomN$ - 0.63 $PREM$*$RandomN$ (W=1.16; p=0.32)
(0.30) (0.31) (0.46) (0.42)

Wald tests for the joint hypothesis fails to reject similar bidding behavior in the two auction mechanisms for both positive (WTP) and negative (WTA) values. However, while the estimated α_2 and β_2 coefficients are both close to zero in the WTP equation, they are of considerably greater magnitude in the WTA equation. Figures 2-1 and 2-2 plot WTP and WTA bids against the stage 1 premium. Figure 2-2 shows that WTA bids elicited with the random nth auction are everywhere below the stage 1 premium, and that divergence from both the stage 1 premium and 5th price auction values increases with the stage 1 premium.

Figure 2-1. WTP bids vs Stage 1 Premium

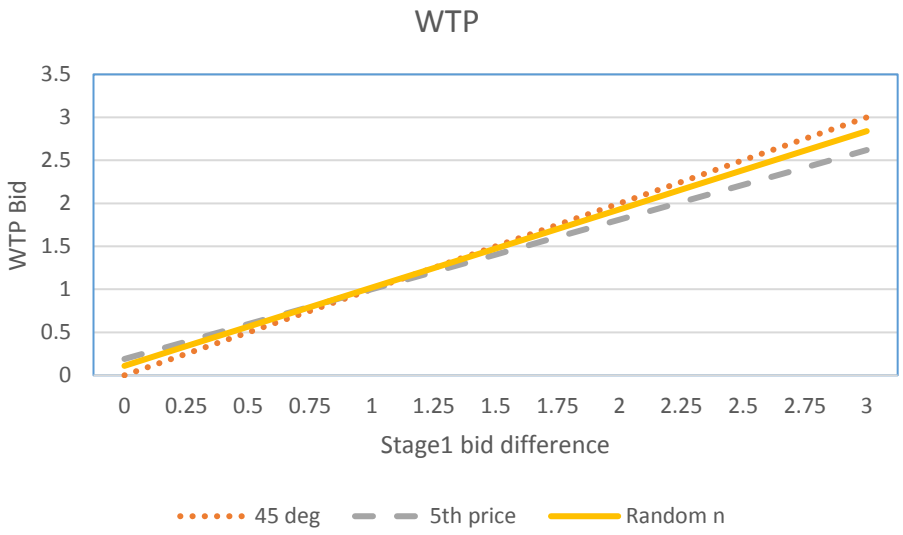
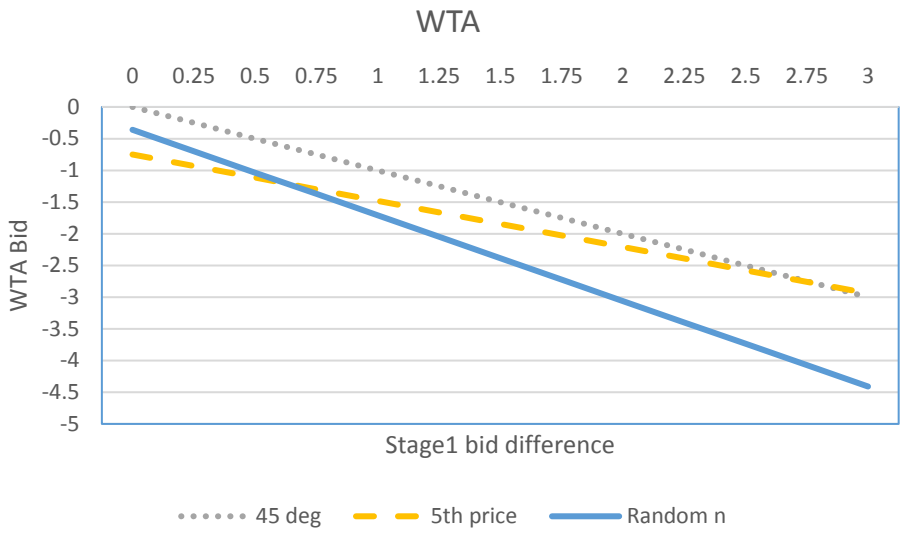


Figure 2-2. WTA bids vs Stage 1 Premium



2.4. Conclusions

Valuation studies often deal with goods for which some subjects hold positive value, others negative. In that context, experimental auctions that permit simultaneous elicitation of positive and negative values have advantages over other approaches such as truncation at zero, or screening and separating subjects based on preferences. Permitting negative bids allows for a more complete revelation of the demand curve, but may also introduce incentives for strategic bidding for subjects seeking a financial gain. Using an approach that compares values elicited in an endowment auction (Stage 2) that permits negative bids with values from prior "full-bidding" auctions (Stage 1) for the same two private goods, we show that allowing negative bids did not compromise accurate revelation of positive WTP values in either a 5^{th} price or random n^{th} auction mechanism.

As in many studies, we find evidence of a WTP/WTA divergence, with WTA exceeding (in absolute value) the WTP for the opposite exchange of goods. The hypothesis that the negative

WTA bids accurately revealed demand was rejected. Controlling for the subject's risk attitude was shown to partially explain the overbidding of WTA. The random n^{th} and 5^{th} price auctions performed similarly in eliciting WTP values; with negative values, however, the tendency to overbid (in absolute value) was more pronounced with the random n^{th} price mechanism, a finding similar to Lusk et al. (2004). Our findings are in contrast with those of Parkhurst *et al.* (2004) who reported demand revealing bidding in a repeated trial random n^{th} auction for both positive and negative induced values. We find no reason to discourage practitioners from allowing simultaneous positive/negative bidding in valuation experiments, but our results suggest that negative bids will reflect the commonly found WTP/WTA disparity, and that it may be more pronounced in a random n^{th} auction.

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Chapter 3 - The Effects of Allowing Multiple Alternatives on Bidding Behavior in a Private Value Experimental Auction

3.1. Introduction

Laboratory experimental auctions are a popular method for estimating values of new products and product attributes. Examples include valuation studies for new products (Fox et al., 1994; Hoffman et al., 1993), food safety (Fox et al., 2002; Hayes et al., 1995; Dickinson and Bailey, 2002; Hobbs et al., 2005; Lee et al., 2011), and food attributes (Lusk et al., 2001; Feuz et al., 2004; Melton et al., 1996). Experimental auctions have also been used to test economic theory such as investigations of the willingness to pay/willingness to accept disparity (Shogren et al., 1994; Plott and Zeiler, 2005), and preference reversals (List, 2002).

Experimental auctions that are non-hypothetical and that employ incentive compatible auction mechanisms are often preferred over hypothetical survey valuation methods because they can better replicate some features of a realistic market environment (Lusk, 2003). Carefully designed experiments that provide appropriate incentives for demand revelation may therefore provide more accurate predictions of consumer market behavior compared to hypothetical surveys. However, to the extent that an experimental design may fail to account for relevant features of the actual market setting that it seeks to replicate its predictions of consumer behavior in that market can be biased (Corrigan, 2005; Harrison, 1992). One such feature that has received somewhat limited attention in the experimental valuation literature is the availability of substitutes for the good or the attribute being valued.

The presence or absence of substitutes is potentially important in valuation since economic theory suggest that their availability influences demand for a good. However, many if

not most laboratory valuation studies have not explicitly accounted for field substitutes. This is particularly true in studies where the focus is on valuing a specific attribute (e.g., food safety risk) whose level varies between two goods (Rousu et al., 2008). Previous studies (e.g., Cherry et al., 2004; Harrison et al., 2004; Corrigan, 2005; Alfnes, 2009) have demonstrated that auction participants take field substitutes into account when they formulate bids. Thus, allowing for substitutes is one of the ways in which experimental valuation environments can be made more realistic.

However, the goal of realistically accounting for the availability of substitutes while at the same time preserving the incentives for participants to accurately reveal demand for the good(s) being valued poses some problems for the experimenter. In particular, if participants are allowed to bid for multiple goods there is the question of which good will ultimately be purchased. In an actual market setting it is, of course, the consumer who decides. But in an experimental auction, if the participant can decide which one of the multiple goods being valued they will purchase they will not have an incentive to accurately reveal their willingness-to-pay (i.e., demand) for the remaining alternatives. The basic problem of course is simply the fact that the position (or height) of the demand curve for any good depends on the price of its substitutes. Thus, one approach for accounting for substitutes is simply to inform experimental participants about the price of a substitute – be that substitute available within the experiment or in an outside market. The values obtained in that setting therefore reflect the provided price or prices of the substitute(s). A second approach, and the one we take here, is to simultaneously elicit value for multiple goods each of which can be considered substitutes for the other. The catch however, is that we do not allow the participant to choose which good is ultimately purchased. Instead, the good to be sold in the auction is determined via a random draw. Given that design mechanism,

i.e., the fact that the participant does not get to choose from among the substitutes, we cannot claim that our elicited values reflect the presence of substitutes – but they do at a minimum reflect participant awareness of the fact that substitutes exist and are potentially available, an awareness that is not explicitly accounted for in studies that do not include substitutes. Henceforth in the paper therefore (and in its title) we refer to our design as one that examines the effects of "*alternatives*" for the auctioned good rather than claiming that those alternatives are "*substitutes*" in the economic sense.

As noted, some previous studies have verified the influence of outside substitutes in experimental auctions. However, some important questions remain. First, does mere awareness of the availability of substitutes affect participants' bidding behaviors in a private value experimental auction? If so, does the measured impact have implications for designing valuation experiments? Second, does the availability of multiple alternatives influence participants' incentives to obtain new information about a good being valued, and, once obtained, how bids for the good respond to that new information? Examining information effects has become routine in experimental auctions. Many studies have identified that auction participants sensitively respond to information provided to them but no study has investigated whether the presence of substitutes may mitigate or amplify the effect of new information (Fox et al., 2002; Corrigan et al., 2009; Tegene et al., 2003; Lee et al., 2011). Thus, another important question is whether new information has the same impact on participants' bids as more alternative for the good being valued are made available? Answering these questions has potentially significant implications for the design of valuation experiments, particularly when we consider that the typical goal of a small scale valuation experiment is to predict consumer behavior in the broader market setting.

The objectives of this study are therefore 1) to investigate the effect of awareness of the potential availability of alternatives for a privately valued good (a beef burger) on participants' bidding behavior, and 2) to identify whether the presence of additional alternatives will: a) decrease the value of product information, and b) mitigate the effect of new information on product valuations. We especially focus on whether subjects in a valuation setting with multiple alternatives tend to bid differently compared to those in an environment with only one alternative (as is typical in many endowment type auctions). Theory suggests that the availability of additional substitutes should result in lower bids, but, as noted, our experimental design mitigates the substitution effect given that participants cannot freely choose which of the alternative goods they may end up consuming. But our design does assess awareness of substitutes and to the extent that mere awareness of substitutes can impact values the impact is important to recognize and to quantify. Ideally, that quantification might also provide a starting point for the calibration of elicited values from settings that do not (or cannot) include substitutes.

3.2. Experimental Design

A total of 112 consumers participated in our experiments in which the object of valuation was reduced food safety risk. In particular, we chose a beef burger as the auctioned good since most participants are familiar with the product and should have little difficulty placing a value on it. Our subjects were endowed with a "regular" beef burger and could bid to upgrade to an irradiated beef burger described as having a lower risk of bacterial contamination. Our design includes three treatments that each differ in the availability of alternatives for the irradiated burger. Those alternatives included a beef burger from cattle treated with direct-fed microbials (DFM burger), a high pressure processed beef burger (HPP burger), and a chicken sandwich.

Each treatment was conducted with four groups, with each group consisting of between 7 and 12 participants.

We recruited participants from four different sources. Forty subjects were recruited from respondents to a mail survey which was conducted in two cities about a month prior to the experimental auction (18 from one, 22 from the other). An additional 14 participants were recruited using either random digit dialing from the phone book in one city and from among the members of a standing taste testing panel in the other city. Those 54 participants were assigned to six groups – one for each of the three treatments in both cities. Twenty-eight subjects were recruited from the membership of the parent-teacher association of an elementary school. They were assigned to three groups, one group per treatment. Finally, thirty subjects were recruited from two undergraduate classes and were similarly assigned to three groups, one per treatment. Thus, while the sample was recruited from different sources, those sources were equally represented across the three treatments. Participants were not informed about the nature of the experiment but were screened to exclude non meat eaters.

On arrival, participants signed a consent form and were paid their participation fee.[9] They were provided with an ID number and asked to complete a questionnaire. On completing the questionnaire, the 4th price endowment auction was explained by the moderator. Subjects were explicitly informed that their best strategy was to bid an amount equal to their true valuation for the exchange of one good for another. A practice auction using candy bars was conducted to help participants understand the procedure and to emphasize that an actual monetary exchange would take place at the conclusion – i.e., the experiment was not hypothetical.

[9] Undergraduates were paid $20 each. Members of the PTA group received $30 each but had agreed beforehand to donate their participation fee to the PTA. All other subjects were paid $50.

Following the practice auction, subjects were told that they would participate in a number of 4th price auctions (the number of auctions was not revealed). They were also informed that the binding auction (hereafter referred to as round) and product to be sold in that binding round would be determined using a random draw at the end of experiment. Each treatment included four auction rounds. In Treatment 1, participants bid to exchange a "regular" beef burger for an "irradiated" burger in each of the first three bidding rounds. In each successive round they were provided with additional information about irradiation. Round 4 introduced an additional substitute, allowing participant to bid for both an "irradiated" and a "DFM" burger. Treatments 2 and 3 were similar but featured additional products. In Treatment 2, participants bid for both the "irradiated" and "DFM" burgers in the first three rounds, with round 4 introducing a "HPP" burger as an additional alternative. In Treatment 3, all three alternative burgers (irradiated, DFM, and HPP burgers) were available in the first three rounds, with round 4 introducing a chicken sandwich as an additional alternative. Following Lee and Fox (2015) the experiment permitted negative bids since each of the available alternatives could potentially be viewed as either superior or inferior to the endowed "regular" burger. The experiment also included a requirement that participants consume one burger at the end of the exercise – either the regular burger or the alternative acquired by way of the auction. Participants were provided with a brief description of food irradiation before bidding in the first round in treatment 1. Descriptions of both food irradiation and direct-fed microbials were provided in treatment 2, while participants in treatment 3 also received a description of high-pressure processing (see Appendix A for the descriptions provided).

Prior to the 2nd bidding round in each treatment we conducted a separate BDM auction in which participants could bid for additional information about food irradiation. Two types of

information were made available - one positive, focusing on the benefits of irradiation and the other negative, focusing on potential risks of irradiation (see Appendix 2). Subjects were allowed to bid for just one type of information, not both.[10] The price for information was determined in a random draw from an envelope containing 25 price tickets (the price distribution was not revealed to participants). Winning bidders were asked to read the information they acquired before bidding for the irradiated hamburger (and the alternative products) in round 2. Prior to round 3, all participants were provided, free of charge, the information they had not already acquired. Thus, if they had already acquired the positive information they were given the negative information and vice-versa. If they had not acquired either they were given both types of information. When bidding in round 3 and 4 therefore, all participants had obtained the same sets of information about food irradiation.

3.3. Experimental Results

Summary statistics for demographic and socioeconomic characteristics of our sample are provided in table 3-1. Average age was approximately 39 years old and the sample was evenly balanced between males and females. Almost all participants were either in college or had a college degree and over three quarters indicated that they purchased ground beef or hamburger once a week. Average prior knowledge of food irradiation was 1.8 on a 1 to 5 scale from 1= "*nothing*" to 5= "*a great deal*" indicating that the process was largely unfamiliar to participants. However, when asked about the acceptability of using food irradiation the average response was around 3.5 on a scale of 1= "*totally unacceptable*" to 5= "*perfectly acceptable*" suggesting that, on average, the process was viewed as somewhat acceptable.

[10] Our objective was two-fold; a) to force participants to reveal which of the two types of information they preferred to obtain and b) to ensure that each participant at most acquired just one type of information prior to the next bid.

Table 3-1. Sample Characteristics (n=112)

Variable	Categories	Mean	Std. Dev.
Age	Years	38.9	4.27
Household size	Persons	3.14	1.51
Gender	Male	48%	
	Female	52%	
Family income	Less than $40,000	17.8%	
	$40,001 - $100,000	43.7%	
	More than $100,001	38.3%	
Education level	High school graduate	0.9%	
	College graduate	61.6%	
	Graduate degree	37.5%	
Frequency[1]	At least once a week	77.6%	
	2-3 times a month	12.5%	
	About once a month	8%	
	Less than once a month	1.8%	
Concern[2]	1: Not at all concerned - 5: Very concerned	3.27	1.25
Prior knowledge[3]	1: Nothing – 5: A great deal	1.8	0.96
Acceptance[4]	1: Totally unacceptable – 5: Perfectly acceptable	3.48	1.18

[1] Frequency of buying Ground beef/Hamburger
[2] Safety concern of Ground beef/Hamburger
[3] Prior knowledge about Food irradiation
[4] Level of acceptance of using irradiation in meat processing

Objective 1: Effect of additional alternatives on valuations

Table 3-2 describes the distributions of bids across each round in each of the three treatments. We can examine the effect of introducing additional alternatives both across and within treatments. Focusing first on the first round (R1) bids for the irradiated burger we observe that the average bid tends to decrease with the availability of additional alternatives. In treatment 1 the average bid for the irradiated burger is -$0.15 compared to -$0.27 in treatment 2 and -$0.47 in treatment 3. However, their mean differences between treatments 1 and 2 ($p = 0.31$) and between treatments 1 and 3 ($p = 0.16$) are not statistically significant.[11] In R3 and R4,

[11] T-test was applied for mean equality tests.

in which all participants have obtained the additional positive and negative descriptions of food irradiation, the pattern across treatments is less clear. Average bids in treatment 3 are below those in treatment 1 but bids in treatment 2 are higher. For the DFM burger we observe lower average bids in treatment 3 compared to treatment 2. In R1 for example, the average bid for the DFM burger is -$0.02 in treatment 2 compared to -$0.07 in treatment 3 but again the difference is not significant. For the HPP burger the only cross treatment comparison available is in the R4 bid where again the bid is lower but not significantly so in treatment 3 compared to treatment 2 (-$0.05 vs -$0.19).

Table 3-2. Bid distributions

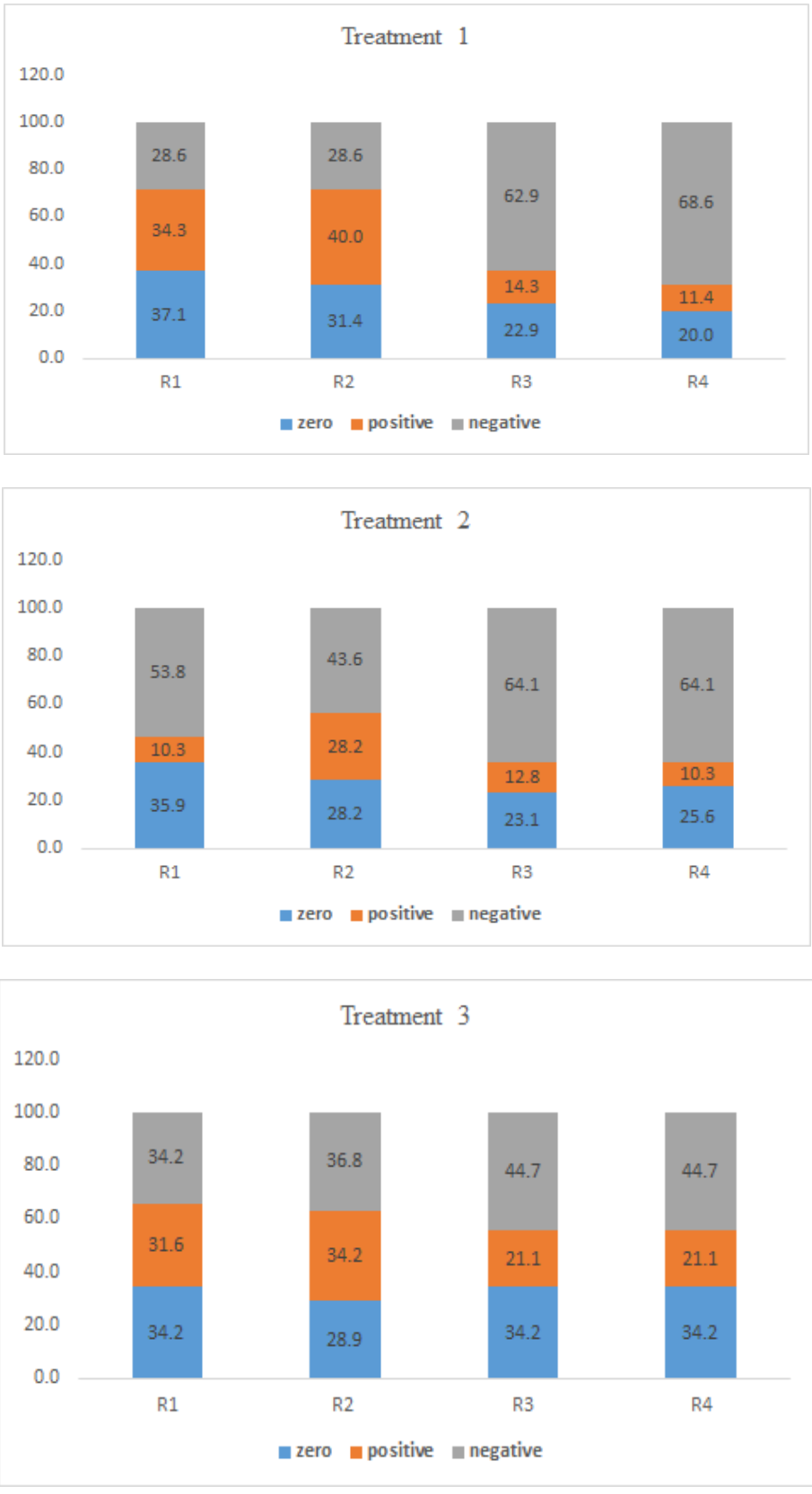
		Treatment 1 (N=35)			Treatment 2 (N=39)			Treatment 3 (N=38)		
		Mean	Median	St. Dev.	Mean	Median	St. Dev.	Mean	Median	St. Dev.
R1	Irradiation	-0.152	0	1.384	-0.274	-0.02	0.631	-0.471	0	1.351
	DFM				-0.021	0	0.674	-0.075	0	1.071
	HPP							0.001	0	0.719
R2	Irradiation	-0.026	0	1.336	-0.208	0	0.543	-1.561	0	4.362
	DFM				-0.075	0	0.635	-0.147	0	1.797
	HPP							-0.127	0	1.724
R3	Irradiation	-1.435	-0.25	3.544	-0.480	-0.15	0.953	-1.646	0	4.325
	DFM				-0.099	0	0.663	-0.226	0	1.754
	HPP							-0.169	0	1.719
R4	Irradiation	-1.427	-0.50	3.536	-0.483	-0.15	0.952	-1.643	0	4.326
	DFM	-0.105	0	1.023	-0.108	0	0.661	-0.489	0	3.315
	HPP				-0.048	0	0.552	-0.195	0	1.708
	Chicken							-0.008	0	0.344

Within-sample comparisons between R3 and R4 in each treatment also did not show a significant effect on the average bid of introducing an additional alternative. For the irradiated burger the average bid is essentially unchanged between R3 and R4. In treatments 1 and 2, only 4 out of 35 participants and 1 out of 39 participants respectively decreased their bids between R3 and R4, while nobody lowered their bid in treatment 3. Overall, the mean change in the bid for

the irradiated burger between R3 and R4 was 0.003. Similarly, there is little change in the bid for the DFM burger in treatment 2 but in treatment 3 its average bid falls from -$0.23 o -$0.49 between R3 and R4. Bids for the HPP burger also decline slightly in treatment 3 – from -$0.17 in R3 to -$0.19 in R4. Again however, none of these changes were statistically significant.

Finally, we examined the proportions of zero, positive and negative bids for an irradiated burger across rounds in each treatment (Figure 3-1). The first round in treatment 1 has more positive and zero bids than negative bids. On the other hand, subjects submitted more negative bids than positive and zero bids in treatment 2 and 3 as more alternatives were available. After providing both positive and negative information about food irradiation in R2 and R3 we observe an increase in the proportion of negative bids in all treatments. But the addition of a new alternative in R4 results in very little change in the overall distribution of bids. Overall, both the pattern of bidding and the unconditional mean equality tests indicate no significant impact associated with introducing additional product alternatives and we cannot reject the hypotheses of bid equality across treatments.

Figure 3-1. Percentage of zero, positive, and negative bids across rounds



Unconditional tests of mean bids across treatments do not however completely reveal the impact of introducing additional bidding alternatives. Individual bids and changes in bids may be influenced by individual characteristics and those individual characteristics are not equally distributed across treatments. We examine bidding behaviors at the individual level by estimating the conditional regression model (1) and testing for the significance of the coefficients β_1 and β_2 associated with treatments 2 and 3. Model (1) is estimated using only the R1 bids for an irradiated burger since these bids are not confounded by any information effects. Model (2) is estimated using the R4 bids where participants have obtained both the positive and negative information about food irradiation. Similarly, model (3) uses R4 bids for the DFM burger. Thus:

$$BidI1_i = \alpha + \beta_1 T2 + \beta_2 T3 + \beta_3 Control1_i + \beta_4 Control2_i + \epsilon_i \quad (1)$$

$$BidI4_i = \alpha + \beta_1 T2 + \beta_2 T3 + \beta_3 BidI1_i + \beta_4 Control1_i + \beta_5 Control2_i + \varepsilon_i \quad (2)$$

$$BidD4_i = \alpha + \beta_1 T2 + \beta_2 T3 + \beta_3 Control1_i + \beta_4 Control2_i + \mu_i \quad (3)$$

where $BidI1_i$ *and* $BidI4_i$ denote individual bids for an irradiated burger in round 1 and 4 respectively; $BidD4_i$ represents individual bids for a DFM burger in round 4; $T2$ and $T3$ are dummies for treatment 2 and 3; $BidI1_i$ in model (2) controls for individual's initial perception about the irradiated product; $Control1_i$ denotes control variables for general socio-demographic factors (gender, age, education level, annual income, and household size); $Control2_i$ denotes control variables for individuals frequency of beef consumption, concern about food safety, and prior knowledge about food irradiation or DFM; ϵ_i, ε_i, and μ_i are i.i.d. components.

Table 3-3 provides estimates from the regression models. They indicate that, after controlling for individual characteristics, treatment effects are insignificant. An exception is the unexpected positive coefficient associated with treatment 2 in Model 2. The coefficient estimate indicates that in Round 4, bids for the irradiated burger are \$1.32 higher in treatment 2 than in

treatment 1, ceteris paribus. The remaining treatment coefficients are statistically insignificant, consistent with the results from the unconditional tests.

Table 3-3. Regression results

	Model (1), R1	Model (2), R4	Model (3), R4 DFM
	Coefficient (Std. error)	Coefficient (Std. error)	Coefficient (Std. error)
Treatment 2	**0.03(0.28)**	**1.32(0.68)***	**0.13(0.50)**
Treatment 3	**-0.28(0.28)**	**0.09(0.67)**	**-0.32(0.49)**
Male	0.13(0.24)	1.33(0.58)**	0.23(0.42)
Age	0.002(0.008)	0.02(0.02)	0.001(0.01)
Education	-0.10(0.10)	-0.05(0.26)	0.11(0.19)
Household size	-0.03(0.08)	0.09(0.21)	0.05(0.16)
Income	0.09(0.05)*	-0.11(0.14)	0.14(0.10)
Frequency	0.03(0.16)	0.05(0.39)	0.21(0.28)
Concern	0.05(0.09)	-0.42(0.22)*	-0.18(0.16)
Prior knowledge	0.17(0.12)	0.06(0.29)	0.32(0.20)
Constant	-0.86(0.70)	-0.86(1.67)	-2.07(1.27)*
Bid1	-	1.40(0.23)***	-
Number of Obs.	112	112	112

*, **, and *** denote statistical significance at 10%, 5%, and 1% respectively.
( ) represents standard error.

To this point our estimated models utilize bids from single rounds of bidding and do not consider the panel nature of the bidding data. Therefore, we further analyze the effect of additional alternatives on bids by estimating the following random effects regression models using bids from multiple rounds:

$$Bid_{iR} = \alpha + \beta_1 T2 + \beta_2 T3 + \beta_3 DPos_{iR} + \beta_4 DNeg_{iR} + \beta_5 DNegPos_i + \beta_6 DPosNeg_i + \beta_7 Control1_i + \beta_8 Control2_i + u_i + \epsilon_{iR} \quad (4)$$

$$Bid34_{iR} = \alpha + \beta_1 DSub + \beta_2 T2 + \beta_3 T3 + \beta_4 Bid1_i + \beta_5 Control1_i + \beta_6 Control2_i + v_i + \varepsilon_{iR} \quad (5)$$

where Bid_{iR} is an individual's bid for an irradiated burger in round R; $Bid34_{iR}$ denotes an individual's bid in round 3 or 4; $T2$ and $T3$ are dummies for treatment 2 and 3; $DSub$ is a dummy variable denoting the availability of an additional alternative in round 4 (i.e. $DSub = 1$ if bids are in R4); $DPos_{iR}$ is a dummy variable indicating that the individual had positive information in round R; $DNeg_{iR}$ is a dummy indicating that an individual had negative information in round R; $DNegPos_i$ is a dummy for an individual who received negative information first and positive information later; $DPosNeg_i$ is dummy for an individual who received positive information first and negative information later; $Bid1_i$ is the individual's bid in round 1 which control for initial perceptions about the irradiated product; $Control1_i$ denotes control variables for socio-demographic factors (gender, age, education level, annual income, and household size); $Control2_i$ denotes control variables for frequency of beef consumption, concern for food safety, and prior knowledge about food irradiation; u_i and v_i are random effects which control for unobservable individual characteristics; ϵ_{iR} and ε_{iR} are i.i.d. components. We test whether β_1 and β_2 are negative for cross-treatment comparisons in model (4) and test whether β_1 is negative for within-samples comparisons in model (5).

Table 3-4 provides estimation results from equations (4) and (5). Again, the results show no significant effect of additional substitutes on bidding behavior - either across treatments or within samples. In model (4) the coefficient for treatment 2 is positive[12] and the coefficient for treatment 3 is negative but neither is significant. Model (4) show significant effects related to new information, particularly negative information. For example, the coefficient on *Negative*

[12] Bids in treatment 2 less sensitively responded to additional alternatives and information provided compared to bids in treatment 1 and 3. Thus, we compared participants' characteristics in treatment 2 with those in other treatments (Appendix 3). According to the results, participants in treatment 2 had more female participants (about 69%) which were different from other treatments (about 46% in treatment 1 and 40% in treatment 3). Participants in treatment 2 were also younger than participants in treatment 1 and 3 and they more frequently purchased ground beef/hamburger.

Information indicates a reduction of $1.12 in the bid for the irradiated burger for an individual who received negative information in R2, and the coefficient on *Negative Positive* indicates a reduction of $0.89 in the bid for the irradiated burger for an individual who received positive information in R3 having earlier received negative information in R2. Furthermore, in both model (4) and (5) the estimates suggest that males bid significantly more than females for the irradiated burger. In model (5) the coefficient associated with bidding in round 4 (where an additional substitute is made available) is negative but not statistically significant.

Table 3-4. Panel data analysis: Random effects estimation results

	Model (4), R1-4	Model (5), R3-4
	Coefficient (Std. error)	Coefficient (Std. error)
Treatment 2	**0.78 (0.55)**	1.34 (0.68)**
Treatment 3	**-0.44 (0.54)**	0.10 (0.67)
DSub *(Round 4*)	-	**-0.006 (0.005)**
Prior belief *(R1 bid)*	-	1.39 (0.24)***
Positive information	0.32 (0.23)	-
Negative information	-1.12 (0.22)***	-
Negative Positive	-0.89 (0.59)	-
Positive Negative	0.29 (0.55)	-
Male	1.09 (0.47)**	1.35 (0.58)**
Age	0.01 (0.02)	0.02 (0.02)
Education	-0.17 (0.21)	-0.05 (0.25)
Household size	-0.01 (0.17)	0.09 (0.21)
Income	0.08 (0.11)	-0.11 (0.14)
Frequency	-0.0009 (0.31)	0.05 (0.38)
Concern	-0.17 (0.18)	-0.42 (0.22)*
Prior knowledge	0.20 (0.23)	0.06 (0.29)
Constant	-0.85 (1.38)	-0.91 (1.67)
No. of observations	448	224

*, **, and *** denote statistical significance at 10%, 5%, and 1% respectively.

Results from conditional regression and unconditional mean tests suggest that allowing for additional alternatives in a private value experimental auction does not seem to decrease

participants' bids. This finding appears contrary to other work on substitutes – for example, Cherry et al (2004) found that the presence of an outside option lowers bids. However, as stated earlier, since our participants cannot choose which good they ultimately purchase our design does not assess the effect of substitutes, but, given the random selection of the good to be auctioned what we effectively assess is the effect of increased awareness of the potential availability of substitutes. The finding of no significant impact is important in that it suggests that preferences in this experimental setting may not be as context dependent as some studies suggest (see Tversky and Simonson, 1993; Tufano, 2010).

A number of studies have suggested that preferences may be constructed at the time decisions are made and are, therefore, context dependent (Slovic, Griffin and Tversky, 1990; Payne, Bettman and Johnson, 1993; Bettman, Luce, and Payne, 1998; Amir and Levav, 2008). The idea that expressed preferences are context dependent obviously raises a concern about any efforts to quantify those preferences. Some previous studies have argued that familiarity of objects and subject experience can increase the stability of preferences, and thus lead to context-independent preference (Hoeffler and Ariely, 1999; List, 2003; Yoon and Simonson, 2008). Our treatment effects in these experiments served to change a potentially important element of the context in which subjects submitted their bids – i.e., by changing the number of alternatives for which they bid and explicitly increasing awareness of potential substitutes. But our result, i.e. the failure to find significant treatment effects, suggests that preferences were robust to this particular element of context.

Our results also suggest that beef consumers generally have negative preferences for the food safety technologies we presented - food irradiation, direct-fed microbials, and high-pressure processing. Participants' negative valuations contrasted sharply with their relatively high levels

of stated acceptance for the same technologies.[13] This conflict may be explained by the fact that participants were largely unfamiliar with the technologies,[14] and thus, when placed in a position where they might potentially be required to consume an unfamiliar product opted to stick with the familiar "regular" burger.

Objective 2a: Effect of additional alternatives on demand for new information

Our second objective is to investigate whether the availability of additional alternatives influences participant behavior in acquiring information about the irradiated product. Our experiment allowed participants to bid to obtain either positive or negative information about food irradiation prior to bidding in R2. Our interest is in whether the choice to bid for positive or negative information and the amount bid for that information is influenced by the presence of substitutes for the irradiated burger.

Table 3-5 provides descriptive statistics of the bids for positive and negative information across treatments.[15] In all treatments a majority (63%) of those who bid for additional information chose to bid for positive information, and the overall average bid for positive information at \$0.54 exceeded that for negative information at \$0.46. The treatment 1 average bid for positive information at \$1.06 was significantly higher than the \$0.22 average bid in treatment 2 ($p = 0.005$) and the \$0.41 average bid in treatment 3 ($p = 0.06$). However, the bids for negative information did not show the same pattern – there were no significant differences across treatments but the highest average bid of \$0.58 occurred in treatment 3.

[13] Participants' levels of acceptance of food irradiation, DFM and HPP were 3.48, 3.93 and 3.91 respectively on a scale of 1= "*totally unacceptable*" to 5= "*perfectly acceptable*".
[14] Participants' prior knowledge about food irradiation, DFM and HPP were 1.80, 1.94 and 1.69 on a scale of 1= "*nothing*" to 5= "a great deal".
[15] We eliminate 12 subjects who submitted either no bid or a zero bid for information since we could not distinguish their preferred information.

Table 3-5. Bids for positive or negative information about irradiation (N=100)

		Positive information	Negative information
Treatment 1 (N=33)	Choice rate	60.6%	39.4%
	Mean	1.06	0.40
	Median	0.38	0.20
	St. Dev.	1.39	0.44
Treatment 2 (N=35)	Choice rate	68.6%	31.4%
	Mean	0.22	0.39
	Median	0.18	0.12
	St. Dev.	0.26	0.60
Treatment 3 (N=32)	Choice rate	59.4%	40.6%
	Mean	0.41	0.58
	Median	0.25	0.50
	St. Dev.	0.60	0.38

To test the effect of substitutes on choice and value of product information, we estimated the following Logit (model (6)) and Tobit (model (7)) models:

$$Cinfor_i = \alpha + \beta_1 T2 + \beta_2 T3 + \beta_3 Control1_i + \beta_4 Control2_i + \epsilon_i \qquad (6)$$

$$Vinfor_i = \alpha + \beta_1 T2 + \beta_2 T3 + \beta_3 Control1_i + \beta_4 Control2_i + \varepsilon_i \qquad (7)$$

where $Cinfor_i$ is a discrete dependent variable representing an individuals' choice to bid for positive information ($Cinfor_i$=1 if a subject bid for positive information and $Cinfor_i$=0 if a person bid for negative information); $Vinfor_i$ denotes an individual's bid for either positive or negative information; $Control1_i$ denotes control variables for socio-demographic factors (gender, age, education level, annual income, and household size); $Control2_i$ denotes control variables for frequency of beef consumption, concern about food safety, and prior knowledge about food irradiation.

Tables 3-6 and 3-7 provide the estimation results from models (6) and (7). The logit results in table 3-6 indicate that participants were more likely to bid for positive information

when additional alternatives were available in treatments 2 and 3 but the effect was not statistically significant. The estimates in table 3-7 indicate that the presence of substitutes significantly reduces the amount bid for positive information, but has no significant effect on the bids for negative information. The results suggest that participants may have a reduced incentive to acquire positive information about the product (i.e., the irradiated burger) if they have other more preferred alternatives available (bids for the other alternatives were higher than those for the irradiated burger).

Table 3-6. Logit model results: Probability of choosing positive information.

	Choice	
	Coefficient	Std. Err.
Treatment 2	**0.24**	**0.34**
Treatment 3	**0.05**	**0.34**
Prior belief (R1 bid)	0.23*	0.12
Prior knowledge	-0.02	0.14
Frequency	0.15	0.20
Male	-0.27	0.29
Age	0.01	0.01
Education	-0.04	0.14
Household size	-0.003	0.10
Income	0.001	0.07
Constant	-0.003	0.79
No. of observations	100	

* denotes statistical significance at 10%.

Table 3-7. Regression estimates: Bids for positive or negative information

	Positive	Negative
	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Treatment 2	**-0.78 (0.24)*** **	**0.09 (0.17)**
Treatment 3	**-0.51 (0.25)** **	**0.22 (0.18)**
Prior belief (R1 bid)	-0.03 (0.09)	-0.08 (0.05)
Prior knowledge	-0.23 (0.11)**	-0.03 (0.08)
Frequency	0.12 (0.13)	-0.11 (0.13)
Male	-0.22 (0.23)	0.18 (0.14)
Age	0.002 (0.006)	-0.01 (0.005)**
Education	-0.12 (0.09)	0.12 (0.07)*
Household size	-0.16 (0.07)**	-0.14 (0.06)**
Income	0.08 (0.06)	0.06 (0.04)
Constant	1.84 (0.58)***	0.54 (0.43)
No. of observations	63	37

*, **, and *** denote statistical significance at 10%, 5%, and 1% respectively.

Objective 2b: Effect of additional alternatives on the response to new information

Our final objective investigates whether the availability of additional alternatives (substitutes) for the irradiated burger influences the effect of new information on participants' valuation for the product. Table 3-8 shows average bid changes for 79 participants who acquired new information prior to R2. Bid changes between round 1 and 2 and between round 2 and 3 were used to estimate effects of both positive and negative information.[16] Participants more sensitively responded to negative information than to positive information which is consistent with findings from previous works (Tegene et al., 2003; Corrigan et al., 2009; Lee et al., 2011).

[16] Some participants (3 subjects in treatment 1, 1 subject in treatment 2, and 5 subjects in treatment 3) submitted high over-bids (e.g. -$10, -$15, -$20) after information was provided. We treated those bids as -$3.95 since they had seen price for a regular beef burger as $3.95 in the questionnaire and we thought that subjects had no reason to bid less than -$3.95. Descriptive statistics and regression results with original data are in appendix. Results with original data were similar to presented results in this study. However, the standard deviation of mean bid changes from original data was higher than the presented results and some variables were not significant due to abnormally high bids.

Between R1 and R2 participants who acquired positive information increased their bid by $0.39 in treatment 1, by $0.28 in treatment 2, and by $0.13 in treatment 3. Between R2 and R3, participants acquiring positive information (who had earlier acquired negative information) increased their bid by $0.03 in treatment 1, by $0.04 in treatment 2, and by $0.15 in treatment 3. Pooling the effects of positive information for all 79 participants (50 acquiring positive information prior to R2, 29 acquiring positive information prior to R3) we observe that the mean change is highest in treatment 1 at $0.28 but not significantly different from the change in treatment 2 ($0.19, p=0.52) or that in treatment 3 ($0.14, p=0.22). Mean bid changes caused by negative information also decreased with the availability of additional substitutes. In treatment 1 the overall average reduction in bid in response to negative information was $1.19 which was significantly greater (in absolute value) than the change observed in treatment 2 (-$0.24, p=0.02) or in treatment 3 (-$0.57, p=0.07).

Table 3-8. Effect of information on bids across treatments

		R1 to R2		R2 to R3		All	
		Positive	Negative	Positive	Negative	Positive	Negative
T1 (N=26)	Mean*	0.39(18)	-0.55(8)	0.03(8)	-1.49(18)	0.28(26)	-1.19(26)
	Median	0.17	-0.45	0	-0.43	0	-0.45
	St. Dev.	0.62	0.48	0.08	2.27	0.54	1.94
T2 (N=26)	Mean	0.28(17)	-0.31(9)	0.04(9)	-0.21(17)	0.19(26)	-0.24(26)
	Median	0.05	-0.10	0	-0.05	0	-0.08
	St. Dev.	0.52	0.42	0.09	0.33	0.43	0.36
T3 (N=27)	Mean	0.13(15)	-0.94(12)	0.15(12)	-0.27(15)	0.14(27)	-0.57(27)
	Median	0.15	-0.08	0	-0.22	0.10	-0.15
	St. Dev.	0.11	1.48	0.36	0.30	0.25	1.04

* Entries represent the change in the mean bid. Numbers in parentheses are the number of observations. N=79 participants acquired new information prior to R2.

We estimated the following model to investigate the hypothesis of a decreasing effect of information on bids at the individual level as more product alternatives were available:

$$Einfor_i = \alpha + \beta_1 T2 + \beta_2 T3 + \beta_3 PriorBelief_i + \beta_4 DNegPos_i + \beta_5 Control1_i + \beta_6 Control2_i + \varepsilon_i \quad (8)$$

where $Einfor_i$ is the change in an individual's bid after information is provided; $T2$ and $T3$ are dummies for treatments 2 and 3; $PriorBelief_i$ is an individual's bid in round 1 which controls for individual prior perception about the product; $NegPos_i$ controls for order of providing information ($DNegPos_i$=1 if a person was provided negative information first and positive information later); and $Control1_i$ and $Control2_i$ contain, as earlier defined, control variables for demographic and other individual characteristics.

Table 3-9 provides estimation results for equation (8). The results indicate that allowing additional substitutes in treatments 2 and 3 reduces the effect of both types of product information. Participants less sensitively responded to product information when they had more alternatives for the product in the experiment. The treatment effect is in the expected direction for both positive and negative information – a smaller increase for positive information and a smaller decrease (positive coefficient) in the case of negative information – but significant only in the case of negative information. We combined data from the effects of both positive and negative information and included a dummy for positive information effect (i.e. *DPos*=1 if a bid change is caused by positive information) and its interactions with the two treatments (i.e. *DPos**T2 and *DPos**T3). Results from the pooled model results also showed that participants significantly decrease their bid changes caused by information when additional alternatives are available in the experiment. This result has important implications for experimental auction applications since many previous valuation studies focusing on the effect of product information do not allow multiple substitutes and this environment might cause an overstatement of the information effect.

Table 3-9. Impact of allowing substitutes on the effect of information

	Positive	Negative	Pooling
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Treatment 2	**-0.06 (0.12)**	**0.96 (0.35)*** **	**0.97 (0.26)*** **
Treatment 3	**-0.05 (0.12)**	**0.57 (0.34)***	**0.65 (0.26)** **
Prior belief	-0.06 (0.04)	-0.31 (0.11)***	-0.19 (0.06)***
Prior knowledge	-0.07 (0.06)	0.02 (0.16)	-0.02 (0.09)
Frequency	-0.06 (0.07)	-0.18 (0.19)	-0.12 (0.11)
Concern	-0.03 (0.04)	-0.07 (0.11)	-0.05 (0.06)
Negpos	-0.16 (0.11)	-0.30 (0.30)	-0.23 (0.17)
Gender	0.002 (0.11)	0.63 (0.30)**	0.32 (0.16)*
Age	0.005 (0.003)	0.002 (0.01)	0.003 (0.005)
Education	-0.01 (0.04)	0.18 (0.12)	0.08 (0.07)
Household size	-0.04 (0.04)	0.14 (0.11)	0.05 (0.06)
Income	0.01 (0.03)	-0.14 (0.07)*	-0.06 (0.04)
Constant	0.52 (0.30)*	-1.48 (0.85)*	-1.22 (0.48)**
DPos	-	-	1.48 (0.25)***
DPos*T2	-	-	**-1.04 (0.36)*** **
DPos*T3	-	-	**-0.77 (0.36)** **
No. of Obs.	79	79	158

*, **, and *** denote statistical significance at 10%, 5%, and 1% respectively.

3.4. Conclusions

Experimental auctions frequently use a controlled small scale environment in an attempt to predict how consumers might behave in the real world market. It is important therefore that the experimental market environment reflects, to the greatest extent possible, the relevant characteristics of that wider market. According to previous findings, allowing substitutes can impact the values elicited in experimental markets and thus the inclusion of substitutes is one of the ways in which experimental auction markets can be made more realistic.

In this study we designed an experimental to examine the effects of the availability of additional alternatives on participants' values for a private good. Our design does not permit the additional alternatives to serve as substitutes in the true economic sense because our participants

do not have the ability to choose which of the alternative products to purchase – that selection was made via a random draw. Thus, while our treatments alter the context in which bidding takes place, and enhance participants' awareness of the potential availability of substitutes in the wider market, any impacts due to treatments are, at most, a lower bound estimate of the impact of substitutes.

Our results indicate that allowing additional alternatives in a private value auction did not significantly affect valuation for primary product of interest – the exchange of a regular burger for an irradiated burger. Differences in bidding across treatments were not sufficiently large to reject the hypothesis of bid equality. Economic theory and prior studies suggest that the presence of substitutes will result in lower bids for the product of interest. Our results suggest that our subjects did not consider the additional alternatives as substitutes – which, given the experimental design in which the product they would obtain was determined via a random draw, they were not. The fact that altering the context of bidding by introducing additional alternatives (which are not substitutes) did not produce a significant change in bidding behavior is itself important – as it suggests that bidding behavior in the 4th price auction is robust to such changes in context. If this result holds with replication and larger samples, it suggests that experimental practitioners need not be concerned about whether their designs value individual goods or multiple related goods – the elicited values ought not to be affected.

Our results did however indicate that the presence of additional alternatives tended to reduce both the value and effect of additional product information. In the wider market, the availability of additional substitutes reduces demand for a product and may in turn reduce demand for additional information about that product and also mitigate the impact of that information once acquired. Our results appear to reflect those effects – suggesting that, in regard

to their behavior in acquiring and using information, subjects treated the additional alternatives as if they were in fact substitutes. Beyond merely attributing the difference to context, it may be that simply informing participants about the potential availability of substitutes has a similar effect to making substitutes available. The finding is important because it reminds experimentalists examining information effects that their results may very much depend on context. Identifying information effect has become quite routine in experimental valuation studies for new products or product attributes. Studies examining information effects without the context of substitutes may well be overestimating both the interest in acquiring information and the impact of that information on product valuation.

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Appendix 1. Description of food irradiation, DFM, and HPP provided prior to bidding

Food Irradiation

Food is irradiated in special processing facilities where it is exposed to an electron beam or X-rays generated using electricity, or to gamma rays emitted by cobalt-60. Food irradiation controls spoilage and eliminates harmful foodborne bacteria. The result is similar to pasteurization. The fundamental difference between food irradiation and pasteurization is the source of the energy used to destroy the bacteria. While conventional pasteurization uses heat, irradiation uses energy from ionizing radiation.

Direct-Fed Microbials (Probiotics)

The terms direct-fed microbial and probiotic are used interchangeably. They are animal feed additives that contain microbial species that are considered to be non-pathogenic normal flora. A probiotic is defined as "*a live microbial feed supplement which beneficially affects the host by improving its intestinal microbial balance*" Direct-fed microbials or probiotics can potentially improve resistance to disease, reduce shedding of pathogens, increase intestinal immunity, reduce disease symptoms, and improve animal health.

High Pressure Processing (HPP)

High Pressure Processing (HPP) is an antimicrobial treatment for meat and poultry products. HPP subjects food to elevated pressures, with or without the addition of heat, to inactivate microorganisms and extend microbiological shelf life. Product processed with HPP is placed in a sealed flexible container. The flexible container is placed in a basket or barrel and moved to a high-pressure chamber filled with a pressure-transmitting fluid (usually water) that does not come in contact with the food product. The high pressure kills or damages harmful foodborne bacteria.

Appendix 2. Positive and Negative Descriptions of Food Irradiation

Pro-Food irradiation perspective

Food irradiation is a process that destroys harmful bacteria and pathogens by treating foods with ionizing radiation. Food irradiation has been shown to be highly effective in destroying bacteria and parasites responsible for food poisoning. Extensive research has proven that irradiation is a safe and reliable process, and it has been approved by the Food and Drug Administration, the American Medical Association, and the World Health Organization.
Each year as many as 9,000 people die in the U.S. from food-borne illness. Millions more suffer short term illness due to pathogens such as Salmonella, Listeria and E.coli. By eliminating these pathogens from food, irradiation can help to greatly reduce the number of food borne illnesses.

Anti-Food irradiation perspective

Food irradiation is a process whereby food is exposed to radioactive materials, and receives as much as 300,000 rads of radiation - the equivalent of 30 million chest x-rays- in order to extend the shelf life of the food and kill insects and bacteria. While it is unlikely that food products themselves will become radioactive, irradiation results in the creation of chemicals called radiolytic products, some of which are known carcinogens. Studies have also suggested that irradiation may be linked to cancer and birth defects. Food irradiation can kill most of the pathogenic bacteria present in food, but so can proper cooking. Food irradiation was developed in the 1950's by the Atomic Energy Commission. The objective was to seek potential uses for the byproducts of nuclear weapons production. Today's food irradiation industry is a private, for-profit business enterprise with ties to the U.S. nuclear weapons and nuclear power industries.

Appendix 3. Sample Characteristics across treatments

Variable	Categories	T1 (N=35)	T2 (N=39)	T3 (N=38)
		Mean (Std.Dev.)	Mean (Std.Dev.)	Mean (Std.Dev.)
Age	Years	42.9 (17.1)	35.9 (17.7)	38.3 (16.5)
Household size	Persons	2.9 (1.4)	3.1 (1.4)	3.3 (1.6)
Gender	Male	54.3%	30.8%	60.5%
	Female	45.7%	69.2%	39.5%
Family income	Less than $40,000	8.6%	20.5%	23.7%
	$40,001 - $100,000	37.1%	53.8%	39.5%
	More than $100,001	54.3%	25.6%	36.8%
Education level	High school graduate	2.9%	0%	0%
	College graduate	48.6%	66.7%	68.4%
	Graduate degree	48.6%	33.3%	31.6%
Frequency[1]	At least once a week	80.0%	87.2%	65.8%
	2-3 times a month	14.3%	5.1%	18.4%
	About once a month	2.9%	5.1%	15.8%
	Less than once a month	2.9%	2.6%	0%
Concern[2]	1: Not at all concerned - 5: Very concerned	3.4 (1.3)	3.1 (1.3)	3.3 (1.1)
Prior knowledge[3]	1: Nothing - 5: A great deal	1.9 (0.9)	1.7 (0.9)	1.8 (1.1)
Acceptance[4]	1: Totally unacceptable - 5: Perfectly acceptable	3.4 (1.2)	3.3 (1.1)	3.7 (1.2)

[1] Frequency of buying Ground beef/Hamburger
[2] Safety concern about Ground beef/Hamburger
[3] Prior knowledge about Food Irradiation
[4] Level of acceptance of using Food Irradiation in meat processing

Appendix 4. Effects of information across treatments from original data

		A1 to A2		A2 to A3		All	
		Positive	Negative	Positive	Negative	Positive	Negative
T1 (N=26)	Mean	0.45	-0.55	0.03	-2.27	0.32	-1.74
	Median	0.17	-0.45	0	-0.43	0	-0.45
	St. Dev.	0.71	0.48	0.08	5.22	0.62	4.38
T2 (N=26)	Mean	0.28	-0.31	0.04	-0.21	0.19	-0.24
	Median	0.05	-0.10	0	-0.05	0	-0.08
	St. Dev.	0.52	0.42	0.09	0.33	0.43	0.36
T3 (N=27)	Mean	0.13	-3.70	0.24	-0.27	0.18	-1.80
	Median	0.15	-0.88	0	-0.22	0.10	-0.25
	St. Dev.	0.11	5.21	0.43	0.30	0.29	3.81

Appendix 5. Impact of allowing substitutes on information effect from original data

	Positive	Negative	Pooling
	Coefficient (Std.Err.)	Coefficient (Std.Err.)	Coefficient (Std.Err.)
Treatment 2	**-0.11 (0.14)**	**1.82 (0.98)***	**1.67 (0.69)****
Treatment 3	**-0.10 (0.13)**	**-0.09 (0.96)**	**-0.05 (0.67)**
Prior belief	-0.11 (0.04)**	0.66 (0.31)**	0.28 (0.16)*
Prior knowledge	-0.03 (0.06)	0.06 (0.44)	0.02 (0.22)
Frequency	0.04 (0.07)	0.01 (0.55)	0.03 (0.28)
Concern	-0.04 (0.04)	-0.32 (0.32)	-0.18 (0.16)
Negpos	-0.17 (0.11)	-0.47 (0.84)	-0.32 (0.43)
Gender	-0.006 (0.12)	1.77 (0.84)**	0.88 (0.43)**
Age	0.004 (0.003)	0.01 (0.03)	0.007 (0.01)
Education	-0.03 (0.05)	-0.06 (0.34)	-0.05 (0.18)
Household size	-0.06 (0.04)	0.13 (0.29)	0.03 (0.15)
Income	0.004 (0.03)	-0.08 (0.20)	-0.04 (0.11)
Constant	0.60 (0.33)*	-1.33 (2.36)	-1.39 (1.25)
DPos	-	-	2.06 (0.66)***
DPos*T2	-	-	**-1.63 (0.94)***
DPos*T3	-	-	**-0.09 (0.93)**
No. of obs.	79	79	158

*, **, and *** denote statistical significance at 10%, 5%, and 1% respectively.

Chapter 4 - The Effect of Acquired or Provided Information on Consumer Valuation in a Private Value Experimental Auction

4.1. Introduction

Markets for some food attributes or processes such as genetic modification (GM), food irradiation, etc. can be characterized as having disparate information. Thus, opponents of GM cite its potential risks to human health and the environment while proponents may tout its record of safety and its role in enhancing food security. For consumers, information has value since it can help them make better market choices (Rousu and Lusk, 2009). Acquiring information is not costless however, and the cost of acquiring and verifying information will differ across individuals and among products and product attributes. Consumers seek out the information that is of most value to them and make purchase decisions based on that information. Thus, in market settings the types and amounts of information that is obtained is endogenously decided by consumers, and depends on each consumer's valuation of information.

Previous studies have investigated the effects of information in experimental auction markets (Fox *et al*., 2002; Tegene *et al*., 2003; Lusk *et al*., 2004; Rousu *et al*., 2004; Corrigan *et al*., 2009; Lee *et al*., 2011; Schmit *et al*., 2013). Without exception, however, those studies provide information to participants at no restriction and then generally proceed to measure the effect of that information on consumers' choices. The results of those studies might differ from the reality of the world since they do not account for the way that information is actually acquired by consumers.

To our knowledge, no study has explicitly considered consumer behavior in acquiring information in an experimental auction. We therefore design an experiment to examine the effect of acquired information on auction participants' purchasing behaviors in a private value

experimental auction. We focus on three questions: i) how subjects choose/value different types of information, ii) whether the value of acquired information about a product influences the subsequent valuation of the product itself, and iii) whether the effects of acquired information differ from those of exogenously provided information.

Answering these questions will be important to recognize in experimental auction applications. Consumers make decisions under imperfect information in real world markets. Under imperfection of information, consumers' decision making relies on their current information and acquired new information (Simonson et al., 1988). Thus, acquiring new information is critical in the decision-making process. The main objective of applying experimental auctions in consumer economy is to predict decision makers' behaviors outside of the laboratory. To the extent that the laboratory environment can better replicate aspects of real world markets it should produce better predictions of consumer behavior in those real world markets. Thus, a laboratory environment that better replicates the way information is acquired in the real world may better predict consumer behavior in the market.

4.2. Information Acquisition

Acquiring information is an important market activity since decision makers formulate knowledge about products or product attributes based on acquired information. According to Stigler (1961) and Nelson (1970), the most obvious way of obtaining information is search and this activity is costly. Knowledge formation based on information is also heterogeneous across people since each person has different prior knowledge, experiences and beliefs about the product so their strategies of acquiring information will be different (Bucklin, 1966; Green et al., 1967; Dickson, 1981; Moore and Lehmann, 1980).

Several previous studies have examined consumer information acquisition. The fundamental studies are those of Stigler (1961) and Nelson (1970). Stigler (1961) examined consumer behavior in purchasing homogenous goods under imperfect information. In his model, only price varies across firms and all product information is reflected by price offered by firms. Because of costly search activity which is not equal for each consumer, a consumer makes a strategy for acquiring information. They fix the number of searches (i.e. stores) prior to searching and choose the best alternative (i.e. the store offering the lowest price). Nelson (1970) extended Stigler's search theory by considering both the quality and price variation of products. He argued that information about quality is more expensive to buy than information about price, which can cause different consumer behaviors. Consumers also use 'experience' as an alternative to 'search' in order to obtain information about the quality of goods. Both studies assumed that search for information continued only if the expected utility benefit from the additional information is greater than the expected search cost.

Search theory predicts that in markets with imperfect information consumers will first acquire the most valued information, followed by less valued information. Given this premise, some previous studies have investigated the sequence of information acquisition (Hagerty and Aaker, 1984; Meyer, 1982). Meyer (1982) presented a model for information search that focuses on the choice between alternatives given the assumption that consumers cognitively formulate subjective values for the attributes of alternatives and follow a recursive process of information search. In that model, subjective utility values are first assigned to product brands using available information about products' attributes, and then a selected brand among alternatives is evaluated. Subjective values can be updated using acquired new information about product attributes. Hagerty and Aaker (1984) developed a normative model predicting consumer behaviors of

searching for information and then compared these predictions with actual information search patterns. According to their framework, information search reduces the uncertainty in evaluation of alternatives and improves the consumer decision process. The results also showed that a greater utility differences between alternatives results in a smaller value for additional information.

Knowledgeable consumers can facilitate more efficient information processing since they can focus only on relevant information which is related to decision making (Johnson and Russo, 1984). Based on this expectation, some previous studies have examined the relationship between prior knowledge about product/product attributes and information acquisition (Bettman and Park, 1980; Simonson et al., 1988; Rao and Sieben, 1992). Bettman and Park (1980) analyzed effects of prior knowledge and experience on choice processes in terms of both the types of information used and the kinds of processing used. According to their results, moderate-knowledge subjects have enough ability and motivation to process the new information presented to them and to devote substantial processing effort to the product choice task. However, low-knowledge subjects do not have enough ability and motivation to process the information. High-knowledge subjects also have enough ability to process information but less motivation to do so since they do not need additional information in the decision process. Instead, they rely on their prior knowledge and experience. Simonson et al (1988) examined the effects of prior brand knowledge and information certainty on the acquisition order of additional information. Both prior beliefs and the degree of certainty of those beliefs have impacts on the acquisition order of new information. In particular, lower certainty of prior knowledge and less favorable prior beliefs lead to earlier acquisition of information. Rao and Sieben (1992) identified how prior knowledge affects the acceptable price range of products and the examination of different types of

information used in value judgements. The results showed that low-knowledge subjects have the lowest price range limits and that the price range limits increase with higher prior knowledge. Moreover, knowledgeable subjects tended to more rely on extrinsic information such as price which is perceived as product quality and moderately knowledgeable subjects used intrinsic information such as physical attributes of the product. Low knowledgeable subjects could not interpret intrinsic information and thus relied more on interpretable information such as physical attributes of the product.

Perceived risk can be positively related to information acquisition since people try to reduce risk by seeking more information (Cox, 1967). One strand of research confirmed a positive relationship between risk and information acquisition (Capon and Burke, 1980; Locander and Hermann, 1979), while another found contradictory evidence (Ring et al., 1980; Jacoby et al., 1978). Several researchers have also argued that search cost which can affect information acquisition is reflected in an individual's income since higher income potentially has a higher opportunity cost of time (Farley, 1964; Ratchford, 1982; Punj and Staelin, 1983). However, Goldman and Johansson (1978) showed no significant relationship between income and information search. Intelligence is also closely related to capacity for processing and storing information (Bachelder and Denny, 1977). Given this premise, Loudon and Della Bitta (1979) concluded that highly-educated consumers (i.e. more intelligent individuals) are more interested in seeking information about the product than less intelligent consumers.

Information acquisition is an important process in decision making under imperfect information. The way people acquire and process information influences their choice processes. According to previous studies, individual behavior in seeking information will differ because search cost and motivations for obtaining information vary across individuals. Moreover, prior

knowledge (i.e. information held in an individual's memory), experience (i.e. purchasing experience), and individual characteristics (i.e. risk attitude, income, education) have important roles in information acquisition. In this study, we consider factors affecting information acquisition by allowing subjects to directly value and obtain information in an experimental auction market and investigate the effect of acquired information on consumers' choice behaviors.

4.3. Experimental Design

A total of 112 consumers participated in experimental auctions in which the object of valuation was reduced food safety risk. Subjects were endowed with a "regular" beef burger and could bid to upgrade to an "irradiated" beef burger described as having lower risk of bacterial contamination. The design included three treatments that differed in the availability of alternatives for the irradiated burger. Only the irradiated beef burger was available in the first treatment. The second treatment added a burger from cattle treated with direct-fed microbials (DFM burger), and the third added both the DFM burger and a burger treated with high pressure processing (HPP burger).

On arrival, participants signed a consent form, were provided an ID number, and were paid their participation fee. Next they completed a questionnaire and were then surveyed about their risk preferences. To elicit an individual risk preference, we used the multiple price list (MPL) devised by Holt and Laury (2002). Using the same design as Lusk and Coble (2005) (table 4-1) each participant was asked to make 11 decisions between lottery A and lottery B. With each successive row, the expected value of lottery B increases relative to lottery A. A highly risk-loving individual would choose lottery B in the second decision row and a very risk-

averse individual would choose lottery A in the tenth decision row. A risk neutral individual would choose lottery A in the first five rows and switch to lottery B in the sixth. To help participants better understand the process, we made the first and last decisions for them.

Table 4-1. Lottery selection

Decision Row	Lottery A	Lottery B	Your preference
1	0% chance of $10.00, 100% chance of $8.00	0% chance of $19.00, 100% chance of $1.00	A
2	10% chance of $10.00, 90% chance of $8.00	10% chance of $19.00, 90% chance of $1.00	
3	20% chance of $10.00, 80% chance of $8.00	20% chance of $19.00, 80% chance of $1.00	
4	30% chance of $10.00, 70% chance of $8.00	30% chance of $19.00, 70% chance of $1.00	
5	40% chance of $10.00, 60% chance of $8.00	40% chance of $19.00, 60% chance of $1.00	
6	50% chance of $10.00, 50% chance of $8.00	50% chance of $19.00, 50% chance of $1.00	
7	60% chance of $10.00, 40% chance of $8.00	60% chance of $19.00, 40% chance of $1.00	
8	70% chance of $10.00, 30% chance of $8.00	70% chance of $19.00, 30% chance of $1.00	
9	80% chance of $10.00, 20% chance of $8.00	80% chance of $19.00, 20% chance of $1.00	
10	90% chance of $10.00, 10% chance of $8.00	90% chance of $19.00, 10% chance of $1.00	
11	100% chance of $10.00, 0% chance of $8.00	100% chance of $19.00, 0% chance of $1.00	B

Participants were told that the winner would be determined at the end of the experiment. To select the winner, we would randomly select one participant's ID number from an envelope. That individual would then select from another envelope a number corresponding to a row from table 1 and would then play the lottery they had selected on that row to determine their winnings.

Following the risk preference elicitation, subject were informed they would participate in a number of non-hypothetical 4th price endowment auctions in which they could bid to exchange one good for another. A practice auction was conducted using candy bars, and subjects were told

that their best strategy in the auction was to bid an amount equal to the true value they placed on exchanging one good for the other.[17] Following Lee and Fox (2015) the auction permitted negative bids. We allow negative bids because the auctioned products be perceived as either superior or inferior to the endowed product. At the end of the candy bar auction the top three bidders exchanged their endowed candy bar for the auctioned candy bar and paid (or received) an amount equal to the 4th highest bid.

Next, participants were shown a burger and informed that they owned (and would be required to consume) a similar burger but would have an opportunity to exchange it for an alternative burger in a series of auctions (henceforth referred to as rounds), one of which – determined via a random draw - would be binding. Descriptions of the endowed "regular" burger and the alternative (irradiated, DFM, or HPP) burgers were provided. If the binding auction round featured more than one alternative burger, the burger to be sold would also be determined via a random draw.

Following the first of four bidding rounds we conducted an auction for additional information about food irradiation. Two types of information were available - a pro-food irradiation perspective focusing on the safety and benefits of the process, and an anti-food irradiation perspective focusing on potential risks. Subjects were allowed to bid for only one type of information, not for both. For the information auction we used a BDM mechanism with a low price distribution (max price 12c) selected to maximize the probability of participants' actually purchasing one type of information. Winning bidders read the information they acquired before bidding in round 2. Subsequently, prior to product bidding in round 3, all participants were provided, free of charge, the information they had not already acquired in information auction.

[17] A copy of the instructions used in the experiment is available from the authors.

Thus, if they had already obtained the positive information via the information auction they were given the negative information and vice-versa. If they had not acquired either type of information they were provided both types of information about food irradiation.

4.4. Experimental Results

Table 4-2 provides summary statistics of participants' demographic variables. Participants frequently buy ground beef and hamburger and they are moderately concerned about the safety of consuming those products. Participants also indicate moderately high safety ratings for meat treated with irradiation and moderately high levels of acceptance of using food irradiation in meat processing.

Table 4-2. Summary statistics of demographic variables (N=112)

Variable	Categories	Mean	Std. Dev.
Age	Years	38.9	4.27
Household size	Persons	3.14	1.51
Gender	Male =1, Female = 0	0.48	0.50
Prior knowledge[1]	1: Nothing – 5: A great deal	1.8	0.96
Concern[2]	1: Not at all concerned - 5: Very concerned	3.27	1.25
Acceptance[3]	1: Totally unacceptable – 5: Perfectly acceptable	3.48	1.18
Rate of safety[4]	1: Very unsafe – 5: Very safe	3.60	1.11
Family income	Less than $20,000	7.14%	
	$20,001 – 30,000	5.36%	
	$30,001 – 40,000	5.36%	
	$40,001 – 50,000	8.04%	
	$50,001 – 75,000	14.3%	
	$75,001 – 100,000	21.4%	
	$100,001 – 125,000	16.1%	
	$125,001 – 150,000	12.5%	
	More than $150,000	9.8%	
Education level	High school graduate	0.9%	
	College graduate	61.6%	
	Graduate degree	37.5%	
Frequency[5]	At least once a week	77.6%	
	2-3 times a month	12.5%	
	About once a month	8%	
	Less than once a month	1.8%	

[1] Prior knowledge about food irradiation
[2] Safety concern about ground beef/hamburger
[3] Level of acceptance of using irradiation in meat processing
[4] Rate of the safety of meat treated with irradiation
[5] Frequency of buying Ground beef/Hamburger

As mentioned earlier, we measured individuals' risk preference using a multiple price list (MPL) since individual risk attitudes can influence information acquisition (Capon and Burke, 1980; Locander and Hermann, 1979). Table 3 shows the frequency of participants' lottery

choices.[18] We eliminated 8 subjects from the sample since they changed their decisions more than two times during the lottery experiment. We assumed that participants have a constant relative risk aversion utility function, $U(x) = x^{(1-rr)}/(1-rr)$, to determine the range of the coefficient of relative risk aversion (rr) and assumed that participants have a constant absolute risk aversion utility function, $U(x) = -\exp(-ar * x)$, to determine the range of the coefficient of absolute risk aversion (ar).

Table 4-3. Risk Aversion Coefficients based on Lottery Choices

Decision Row	Range of Relative Risk (rr) Aversion	Range of Absolute Risk (ar) Aversion	Percentage of Choices			
			T1*	T2	T3	All
~ 2	<-0.968	<-0.112	3.0%	0.0%	0.0%	0.9%
3	-0.968<rr<-0.488	-0.112<ar<-0.059	3.0%	0.0%	0.0%	0.9%
4	-0.488<rr<-0.122	-0.059<ar<-0.015	9.1%	19.4%	17.1%	15.4%
5	-0.122<rr<0.192	-0.015<ar<0.025	21.2%	16.7%	31.4%	23.1%
6	0.192<rr<0.487	0.025<ar<0.066	21.2%	11.1%	11.4%	14.4%
7	0.487<rr<0.788	0.066<ar<0.111	24.2%	36.1%	22.9%	27.9%
8	0.788<rr<1.131	0.111<ar<0.167	15.2%	11.1%	11.4%	12.5%
9	1.131<rr<1.608	0.167<ar<0.253	0.0%	5.6%	2.9%	2.9%
10 ~	1.608<	0.253<	3.0%	0.0%	2.9%	1.9%
Number of Observations			33	36	35	104

*T1, T2, and T3 denoted experimental treatments.

According to the results, about 17% of participants showed risk-loving behavior while the majority exhibited risk-averse behavior. In the following analysis we use individuals' relative risk aversion coefficient since the utility function we assumed to estimate this coefficient has been used by previous studies (e.g. Holt and Laury, 2002; Andersen et al., 2008) and this function allows decreasing absolute risk aversion which is mostly consistent with experimental

[18] We estimated both relative and absolute risk aversion by creating indifference of the expected utility between lottery A and lottery B with different assumption of utility function.

evidence (Friden and Blume, 1975). As a measure of individual risk preference, we use the median value of the minimum and maximum of each range (Lusk and Coble, 2005).

Table 4-4 summarizes the data from both the product and information auctions. As reflected by the negative average bids participants have lower valuations for the alternative beef burgers (irradiated, direct-fed microbials, and high pressure processed) compared to the regular beef burger. The overall valuations for positive and negative information are 0.47 and 0.36 respectively with higher average valuation for negative information in treatments 2 and 3.[19] Within each treatment the difference in mean value between positive and negative information is not statistically significant ($p = 0.11$, $p = 0.39$, and $p = 0.58$ for each treatment) and similarly the value difference in also not significant for the full sample ($p = 0.44$).

Table 4-4. Bids for alternative burgers and for positive/negative information about irradiation.

		Treatment 1 (N=35)			Treatment 2 (N=39)			Treatment 3 (N=38)		
		Mean	Median	St. Dev.	Mean	Median	St. Dev.	Mean	Median	St. Dev.
Round 1	Irradiation	-0.152	0	1.384	-0.274	-0.02	0.631	-0.471	0	1.351
	DFM				-0.021	0	0.674	-0.075	0	1.071
	HPP							0.001	0	0.719
Information	Positive	1.063	0.375	1.386	0.189	0.100	0.251	0.310	0.100	0.552
	Negative	0.402	0.200	0.435	0.291	0.100	0.541	0.394	0.250	0.412
Round 2	Irradiation	-0.026	0	1.336	-0.208	0	0.543	-1.561	0	4.362
	DFM				-0.075	0	0.635	-0.147	0	1.797
	HPP							-0.127	0	1.724
Round 3	Irradiation	-1.435	-0.25	3.544	-0.480	-0.15	0.953	-1.646	0	4.325
	DFM				-0.099	0	0.663	-0.226	0	1.754
	HPP							-0.169	0	1.719

[19] Four participants submitted unusually high bids for positive information in treatment 1 (e.g. one subject bid $5 and three subjects bid $3). If we eliminate those bids, the average bid for positive information becomes 0.403 which is quite similar to the average bid for negative information in treatment 1. The overall bid for positive information without those four high bids becomes 0.29 which is smaller than overall bid for negative information.

Choice and value of information.

Our first objective was to identify factors affecting individuals' choice and value of different types of information about food irradiation. We use the following Probit and Tobit specifications to examine the question:

$$Cinfor_i = \alpha + \beta_1 Bid1_i + \beta_2 PriorK_i + \beta_3 RP_i + \beta_4 RR_i + \beta_5 Freq_i + \beta_6 Inc_i + \beta_7 Gend_i + \beta_8 Age_i + \beta_9 Edu_i + \beta_{10} HHsize_i + \beta_{11} Tret2 + \beta_{12} Tret3 + \epsilon_i \quad (1)$$

$$VInfor_i = \alpha + \beta_1 Bid1_i + \beta_2 PriorK_i + \beta_3 RP_i + \beta_4 RR_i + \beta_5 Freq_i + \beta_6 Inc_i + \beta_7 Gend_i + \beta_8 Age_i + \beta_9 Edu_i + \beta_{10} HHsize_i + \beta_{11} Tret2 + \beta_{12} Tret3 + \varepsilon_i \quad (2)$$

where $Cinfor_i$ is an individuals' choice of positive information ($Cinfor_i$=1 if a person chose positive information, $Cinfor_i$=0 if a person chose negative information); $VInfor_i$ is the individual's bid for either positive or negative information; $Bid1_i$ denotes an individual's bids to exchange the regular beef burger for an irradiated beef burger in round 1; $PriorK_i$ is prior knowledge about food irradiation; RP_i is individual risk perception about food safety; RR_i is an individuals' relative risk aversion coefficient; $Freq_i$ denotes frequency of consuming ground beef/hamburger; Inc_i is individual household income; $Gend_i$, Age_i, Edu_i, and $HHsize_i$ represent gender (male = 1, female =0), age, education level, and household size respectively; $Tret2$ and $Tret3$ denote dummies for treatments 2 and 3; ϵ_i and ε_i are distributed by the normal distribution.

Consumers' choice of information can depend on their prior belief and prior knowledge about the product (Bettman and Park, 1980; Simonson et al., 1988; Rao and Sieben, 1992; Rabin and Schrag, 1999; Jones and Sugden, 2001). To represent prior belief about the product (i.e., about the irradiated beef burger), we include the participants' first round bids since they directly reflect perception about the product before having any additional information. We elicited

participants knowledge about food irradiation with the question "*How much do you know about food irradiation?*" with responses on a 5 point Likert scale from 1 (Nothing) to 5 (A great deal).

Perceived risk and risk preference are also considered as important factors affecting information acquisition (Cox, 1967; Locander and Hermann, 1979; Capon and Burke, 1980) and both factors have been considered in consumer demand for controversial food products such as genetically modified and irradiated food (Lusk and Coble, 2005). As earlier described, individual risk attitudes were elicited using preferences over lotteries. To quantify individuals' perceived risk in consuming meat products, participants were asked whether they agreed or disagreed with four statements. Responses to each question were on a 10 point Likert scale from 1 (Strongly disagree) to 10 (Strongly agree). Table 4-5 provides summary statistics for the risk perception questions. In order to use these questions as a measure of risk perception, we summed the responses from each question and standardized it to have zero mean and unit standard deviation (Lusk and Coble, 2005). Pennings and Wansink (2004) used the interaction effect between risk preference and risk perception instead of separate effects since perceived risk would depend on risk preference and using an interaction term was consistent with the work of Pratt (1964) and Arrow (1971). Our risk preference and perception measures showed low correlation ($\rho = -0.14$) and was not statistically significant (p = 0.15). Thus, we included them in the model as linear effects instead of using an interaction term.

Participants' socio-demographic factors (i.e. income, gender, age, education level, household size) are also included in the model since these variables may affect acquisition of different type of information based on results from previous studies. Frequency of consuming beef products is also included because people who buy more beef products may have a greater

interest in obtaining additional information. To control for treatment effects, we include a dummy for each treatment.

Table 4-5. Risk perception in consuming meat products

Statement	Mean	St. Dev.
Consuming meat products always involves some level of risk from harmful bacteria	6.09	2.34
Bacteria such as *E. coli* pose a great risks of illness to my family and me	4.54	2.53
Meat processors need to implement additional safeguards to reduce the risk of foodborne disease to consumers	6.45	2.49
My family and I need to be careful when preparing meat products at home in order to reduce the risk of foodborne disease	8.45	1.84
Number of observations*	111	

* One participant did not finish questions so summary statistics were based on 111 subjects.

Consumers' valuation for a specific product can be affected by individual characteristics. Thus, we initially thought that the model may have an endogeneity problem since the first round bid could be correlated with other regressors. However, the preliminary data analysis showed relatively low correlations ranging from 0.02 to 0.19 between the first bid and other explanatory variables. We also conducted the exogeneity test of the first bid in both models. According to Wald tests, we failed to reject the hypothesis of exogeneity (positive information: $p = 0.59$ in model (1) and $p = 0.63$ in model (2); negative information: $p = 0.53$ in model (1) and $p = 0.99$ in model (2)).

Table 4-6 provides regression results from equation (1) and (2). The choice of which type of information about food irradiation to bid relied only on prior belief about the product. Participants were more likely to bid for positive information and less likely to bid for negative information when they had positive prior belief about the product. People have a tendency to confirm their prior belief by searching for new information which agrees with the prior belief.

We call this human behavior "*Positive confirmation bias*". Many psychologists have proposed that this positive confirmation is a part of natural human reasoning which can affect the decision process (Jones and Sugden, 2001). Our experimental data showed that about 68 percent of participants who bid a positive value for the exchange for the irradiated burger bid for positive information about food irradiation. However, only 43 percent of participants who placed a negative value on the exchange for the irradiated burger chose to bid for negative information. This may imply that participants who have positive prior belief tend to confirm their prior belief by acquiring new information which agrees with their beliefs while participants who have negative prior belief tended to disconfirm their belief by acquiring information which disagree with their belief.

Table 4-6. Factors affecting choice and value of information

	Model (1)	Model (2)	
	Positive information=1 Negative information=0	Positive information	Negative information
	Coefficient	Coefficient	Coefficient
Prior belief	0.26 (0.12)**	0.02 (0.09)	-0.05 (0.04)
Prior Knowledge	-0.02 (0.15)	-0.27 (0.11)**	-0.05 (0.07)
Risk perception	-0.14 (0.14)	-0.20 (0.10)*	0.07 (0.06)
Risk preference	0.27 (0.29)	0.27 (0.21)	-0.31 (0.10)***
Frequency	0.16 (0.20)	0.13 (0.13)	-0.12 (0.11)
Income	0.008 (0.07)	0.07 (0.06)	0.04 (0.03)
Gender	-0.32 (0.29)	-0.29 (0.22)	0.14 (0.12)
Age	0.02 (0.01)	0.008 (0.006)	-0.02 (0.005)***
Education	-0.07 (0.14)	-0.16 (0.09)*	0.13 (0.06)**
HHsize	-0.001 (0.10)	-0.15 (0.07)**	-0.14 (0.05)**
Tret2	0.21 (0.34)	-0.81 (0.23)***	0.15 (0.15)
Tret3	0.10 (0.34)	-0.42 (0.24)*	0.25 (0.16)
Constant	-0.15 (0.81)	1.78 (0.55)***	0.81 (0.38)**
Number of Obs.	100	63	37

*, **, and *** denote statistical significance at 10%, 5%, and 1% respectively.

( ) represents standard error.

The results did not indicate any relationship between prior knowledge and information choice. Similarly, there was no impact associated with individuals' risk characteristics which is consistent with previous studies (Jacoby et al., 1978; Ring et al., 1980) nor with any demographic characteristics such as age or gender.

The results from model (2) illustrate factors affecting valuation for both positive and negative information. Individuals with higher prior knowledge about irradiation bid less for both positive and negative information. They possibly had less incentive to acquire new information since they did not need additional information in the decision-making process (Bettman and Park, 1980). Interestingly, subjects' values for positive information were negatively related to their perceived risk about the product and positively related to their natural risk attitudes while subjects' values of negative information were in the opposite direction. Subjects in our experiment were mostly risk averse and limited to choose only one between positive and negative information (i.e. imperfect information). People who are risk averse tend to avoid risky situations and choose the safe option under imperfect information, and thus subjects may value less for negative information and more for positive information. However when risk was more product specific, especially when it was related to food safety, their values for information were changed to the opposite direction. Participants were asked to consume one burger at the end of the experiment and many participants less preferred an irradiated burger to other alternatives. With this non-hypothetical situation, subjects might try to verify potential risk from food irradiation.

While a subjects level of education appear to play no role in influencing the type of information chosen (i.e., bid on) the results indicate that, conditional on which information they bid for, more highly educated subjects placed a higher value on negative information and a lower

value on positive information. Subjects who have more family members placed lower value on both positive and negative information, possibly reflecting their budget constraints.

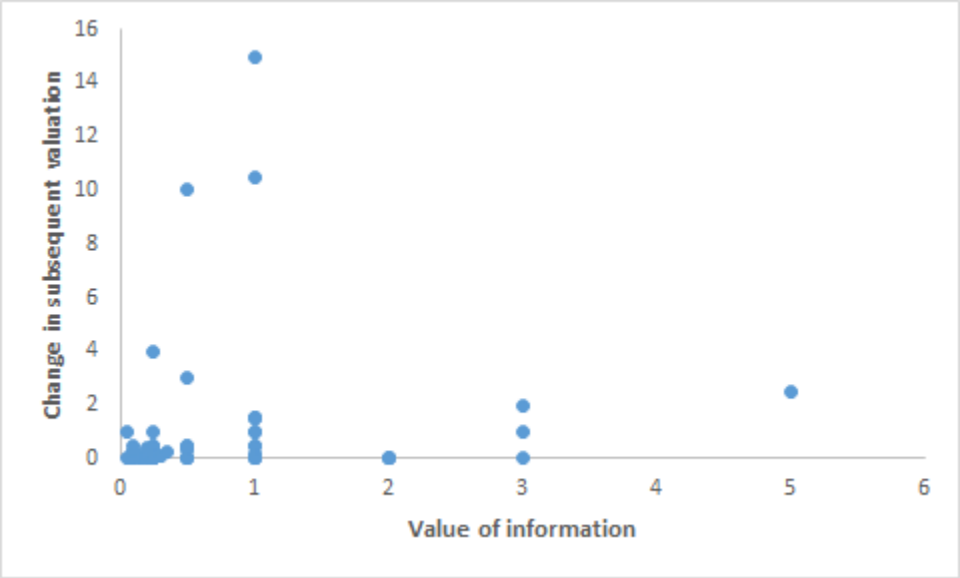
Overall, our results suggest that participants' choice and value of information are influenced by their prior beliefs and other characteristics (i.e. prior knowledge, risk attitude, and education level, etc.). In particular, the choice of which type of information to acquire depended on prior beliefs about the product, while the valuation of information was influenced by prior knowledge about the product, risk perception and preference, and other socio-characteristics. Ignoring these factors and behavior of acquiring information in the decision process may cause biased results, and prediction of consumer behavior from this environment would be less instructive.

Impact of value of information on subsequent valuation.

Our second question was to identify whether the value of acquired information had an impact on the subsequent valuation of the product. Figure 4-1 plots the absolute change in subsequent valuation for the product against the value of information. It shows a positive correlation between changes in subsequent valuation and values of information.[20] Preliminary data analysis also showed relatively high positive correlation ($\rho = 0.34$) between the two variables.

[20] As shown in figure 4-1, three subjects changed their bid by \$15, \$10.5, and \$10 – amounts which are much higher than the market price of a regular beef burger. Those three subjects were excluded from the regression analysis.

Figure 4-1. Value of information and absolute change in subsequent product valuation



We estimated the following Tobit model to test whether value of acquired information influences subsequent valuation for the product:

$$CValue_i = \alpha + \beta_1 Vinfor_i + \beta_2 Dneg + \beta_3 Dneg * Vinfor_i + \beta_4 Tret2 + \beta_5 Tret3 + \varepsilon_i \quad (3)$$

where $CValue_i$ is absolute change in subsequent valuation for the product; $Vinfor_i$ denotes the amount bid for either positive and negative information; $Dneg$ is a dummy for negative information ($Dneg = 1$ if valuation change is caused by negative information); $Dneg * Vinfor_i$ is an interaction variable that captures effect of value of negative information on subsequent valuation; $Tret2$ and $Tret3$ are dummies for treatment 2 and 3; ε_i is an i.i.d. error term.

Table 4-7 provides the estimation results from model (3). The results show that value of information has a positive influence on the subsequent change in valuation for the product. Thus, participants who place higher value on new information change valuation for the product to a greater degree based on that information than participants who place lower value on new information. Each individual has different prior knowledge, experience and beliefs about the product which causes them to have different needs and values for additional information. A

person who has a higher need for additional information may have a stronger incentive to process additional information in their decision-making processes which may result in a greater change in product valuation. On the other hand, a person with a lower incentive to obtain information may have a lower motivation to process new information and that information in turn may result in a smaller valuation change.

Table 4-7. Effect of valuation for information on change in valuation for the product

	Coefficient	Std. Err.
Value of information	0.36**	0.13
Dummy for negative information	0.75**	0.32
Interaction term	-0.53	0.42
Treatment 2	-0.13	0.27
Treatment 3	0.11	0.27
Constant	-0.20	0.24
Number of Obs.	76	

** denotes statistical significance at 5% level.

We also investigated whether valuation changes are similar across different types of acquired information – i.e. positive versus negative. Subsequent valuation changes are similar for both types of information if β_2 and β_3 are both zero in model (3). Using a Wald test, we reject the hypothesis of similar valuation changes across different types of information (F = 2.82; p = 0.06). The results indicate that the value effect of negative information on subsequent valuation for the product is larger than the value effect of positive information but we could not find a clear positive correlation between value of negative information and change in subsequent valuation.

Impact of acquired vs provided information.

Our final objective was to investigate whether the effects of acquired information differ from those of exogenously provided information. The literature suggests that people have a tendency to first obtain the type of information they valued highest (Meyer, 1982; Hagerty and Aaker, 1984). Many experimental auction studies have not considered the fact that participants will have higher value for one type of information over another and generally provide information without giving participants an opportunity to choose a preferred type of information. Ignoring the idea that participants have preferences over what type of information they wish to acquire and, importantly, in which order may bias findings related to the effect of information since we lose one important part of the decision-making process. Table 4-8 compares the effects of acquired and provided information on valuation for the product. The descriptive results indicate different effects between acquired and provided information. In particular, the effect of acquired information on valuation for the product is bigger than that of exogenously provided information. According to mean equality tests, the difference between the effects of acquired and provided information was statistically significant for positive information ($p = 0.09$) but differences in pooled and negative information were not statistically significant ($p = 0.80$ in pooled; $p = 0.39$ in negative information).

Table 4-8. Effect of acquired/provided information on participants' bids

	Pooled		Positive Information		Negative Information	
	Acquired Information	Provided Information	Acquired Information	Provided Information	Acquired Information	Provided Information
Mean*	0.842 (79)	0.741 (79)	0.297 (50)	0.117 (29)	1.780 (29)	1.087 (50)
Median	0.150	0.100	0.100	0	0.300	0.210
St. Dev.	2.351	2.672	0.534	0.293	3.669	3.313

* Entries represent the absolute value of the change in the mean bid. Numbers in parentheses are the number of observations. N=79 participants acquired new information prior to R2.

We now examine the effects of acquired and provided information on participants' valuation at the individual level by estimating the following Tobit structure:

$$Einfor_i = \alpha + \beta_1 Dacq + \beta_2 Dneg + \beta_3 Dacq * Dneg + \beta_4 Tret2 + \beta_5 Tret3 + \varepsilon_i \quad (4)$$

where $Einfor_i$ is absolute effect (i.e., change in product valuation) of either acquired and provided information; $Dacq$ is a dummy for acquired information ($Dacq$=1 if product valuation change is caused by acquired information); $Dneg$ denotes a dummy for negative information ($Dneg$=1 if product valuation change is caused by negative information); $Dacq * Dneg$ is an interaction term between dummies for acquired and negative information; $Tret2$ and $Tret3$ are dummies for treatment 2 and 3; ε_i is i.i.d component.

To better understand the comparison between the effects of acquired and provided information, we also performed a separate analysis for the two different types of information. Table 4-9 shows regression results from equation (4). According to the results, the effect of acquired information was bigger than that of exogenously provided information in all three models. This implies that participants consider the sequence choice of information and they put more weight on acquired information than exogenously provided information in the decision-making process. Our results imply that previous studies potentially underestimated the effect of information by exogenously providing information to participants in experimental auctions.

We also examined whether effects of acquired positive and negative information are similar. Both acquired information have similar effects if β_2 and β_3 are both zero in the model. Results from a Wald test (F = 8.96; p = 0.00) rejects the hypothesis of similar effects for both types acquired information. The effect of acquired negative information outweighs that of acquired positive information which is consistent with findings from previous studies (Fox *et al*.,

2002; Tegene *et al*., 2003; Lusk *et al*., 2004; Rousu *et al*., 2004; Corrigan *et al*., 2009; Lee *et al*., 2011).

Table 4-9. Comparison effects of acquired and provided information

	Pooled	Positive information	Negative information
	Coefficient	Coefficient	Coefficient
Dummy for acquired	1.84 (0.92)**	0.55 (0.21)**	0.67 (0.97)
Dummy for negative	3.15 (0.92)***	-	-
Interaction term	-1.19 (1.21)	-	-
Treatment 2	-1.51 (0.69)**	-0.17 (0.23)	-2.68 (1.16)**
Treatment 3	-0.10 (0.67)	0.004 (0.23)	-0.80 (1.13)
Constant	-2.11 (0.90)**	-0.41 (0.24)*	1.45 (0.84)*
Number of Obs.	158	79	79

*, **, and *** denote statistical significance at 10%, 5%, and 1% respectively.
( ) represents standard error.

4.5. Conclusion

Information acquisition is an important process in decision-making and behaviors of acquiring information are heterogeneous across individuals and closely related to their characteristics such as prior knowledge, belief, experience, risk attitude, etc. Information is also not free for everybody under imperfect information. People choose information based on their preferences and assessments of costs and benefits, and are hypothesized to seek first the information they most value (Meyer, 1982).

Experimental auctions use controlled market environments in an effort to predict behavior in the real markets outside the laboratory. We could greatly increase the external validity of the findings from experimental auction by reflecting the reality of the world, and allowing information acquisition is one of the ways in which experimental environments are able to be made more realistic. No previous experimental auction studies have considered information

acquisition in their experiments. Our main objective of this study was thus to identify the effect of acquired information on participants' bidding behaviors and to compare it with the traditional information treatment (i.e. providing information without restriction).

Our results showed that subjects' behaviors in acquiring different types of information are influenced by their heterogeneous characteristics (i.e. prior belief, risk attitude, and prior knowledge, etc.). Subjects also placed greater weight on acquired information than provided information in their decision-making process. Moreover, individual subjects had different values of information which caused different impacts on product valuation.

The results generally suggest that auction practitioners should consider the process of information acquisition in experimental auctions to obtain better predictions about real world behavior. However, to our knowledge this study is a pioneering work in experimental auction researches. It may thus have potential limitations that may cause different results from this study. Future studies should replicate our study for other population groups and different products to test the robustness of our findings.

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Chapter 5 - General Summary

Valuation of private goods in a laboratory experimental auction is often conducted in an effort to predict consumer behavior in a real market. The laboratory environment should then try to replicate to the extent possible factors that will influence consumer behavior in the market outside the laboratory. To the extent that the laboratory setting fails to account for such influences its predictions may be biased. In this thesis we examined three design issues - allowing negative bids, availability of alternatives (substitutes), and respondent behavior in acquiring information – that are often not considered in experimental auction valuation but which may influence predictions about market behavior.

In the first paper we investigated auction participants' bidding behavior when negative bids were allowed in a private value auction. Most auction studies prefer to bypass or ignore the potential complications of allowing negative bids and instead typically truncate bidding at zero. We focused on two questions: i) whether subjects with negative values tend to bid strategically – either overbidding or underbidding, and ii) the performance of random n^{th} and 5^{th} price auction mechanisms when negative bids were allowed. We used an approach that compared values elicited in an "endowment" auction that allowed negative bids with values from prior "full-bidding" auctions for the same two private goods. The results indicate that allowing negative bids did not compromise accurate revelation of positive WTP values with either auction mechanism. With negative values however, subjects tended to overbid (i.e., seek additional compensation above revealed value for surrendering a preferred good), and that tendency to overbid was more pronounced with the random n^{th} price auction. Overall, the results suggest that

there is no reason to discourage practitioners from allowing simultaneous positive/negative bidding in endowment auctions.

The second paper investigated the effect of the availability of varying numbers of alternatives (substitutes) for a privately valued good on participants' bidding behavior. We also identified whether the presence of additional alternatives impacted the value of product information and/or impacted the effect of new information on product valuations. We especially focus on whether subjects in a valuation setting with multiple alternatives tend to bid differently compared to those in an environment with fewer or only one alternative (as is typical in many endowment type auctions). The results showed: (1) incorporating bids for additional alternatives in a private value auction did not have a significant impact on subjects' bids, but (2) the presence of additional alternatives did reduce both the value and impact of product information. The results suggest that allowing additional alternatives (substitutes) in a private value auction is still valuable even though it does not significantly affect product valuation because it allows auction practitioners to avoid potential overstatement of the value and impact of product information.

The third paper examined the effect of acquired information on auction participants' bidding behavior. We focused on three questions: i) how subjects choose/value different types of information, ii) whether the value of acquired information about a product influences the subsequent valuation of the product itself, and iii) whether the effects of acquired information differ from those of exogenously provided information. We allowed participants to bid for one type of additional information (positive or negative) about the auctioned product (an irradiated hamburger) via an auction mechanism and compared product value changes after acquiring information with value changes after subsequently providing, at no cost, the alternative information they had not already been acquired in the information auction. The results showed:

(1) subjects' behavior in acquiring information was influenced by their characteristics (i.e. prior beliefs, risk attitudes, prior knowledge, etc.), (2) subjects placed greater weight on acquired information than on exogenously provided information in their decision-making process, and (3) individual subjects had different values of information which caused different impacts on product valuation.

An experimental auction is a popular method to estimate consumer value of new products and product attributes. Experimental economists have utilized auctions to predict market responses, to investigate acceptability of new products, and to investigate the impact of information on product valuation. Since they were first introduced, experimental valuation procedures have evolved through investigation of the effects of numerous design features and, compared to two decades ago, today's experiments are, for example, more likely to feature: a) up-front payments to participants rather than payment at the conclusion of the experiment, b) fewer rounds of bidding, c) random n^{th} or 4^{th} or 5^{th} price auctions rather than a 2^{nd} price auction in an effort to better engage off-margin bidders, and d) cheap-talk scripts to remind participants about budget constraints. On some other design issues there is as yet no broad agreement – for example on the choice of full-price versus endowment designs. This thesis examined three elements in experimental auction design – allowing negative bids, incorporating varying numbers of alternatives (substitutes) for the auctioned good, and subject behavior in acquiring new information – in an effort to provide insights to guide future experimental auction work. First, our findings suggest that when participants have divergent perceptions about whether an auctioned good is superior or inferior to an endowed good, there is nothing to lose by allowing simultaneous positive and negative bidding instead of truncating bids at zero. The negative bidding concept is fairly readily explained to participants and, for positive values at least,

allowing negative bids does not appear to compromise the demand revealing properties of a 4th price auction. Negative values may be overstated however, particularly with a random nth auction mechanism.

Second, we find that the number of alternatives that subjects bid on in an endowment auction does not appear to significantly impact bids. We want to stress that the design we tested did not allow the alternatives to be treated as substitutes for one another – because participants were not allowed to choose which among the alternatives they bid for would actually be purchased. Thus the finding of no impact on bids is not a rejection of the idea that the availability of substitutes influences demand. Economic theory and other experimental studies (and perhaps common sense) all agree that the availability of substitutes does impact the height of the demand curve (i.e., influences willingness-to-pay values). What our finding means however is that this particular aspect of the **context** in which bids are elicited does not appear to have a bearing on revealed values. The finding is important – the fact that bids are robust to variation in the number of simultaneously-valued similar goods is good news. It means in effect, that, in an endowment auction, it doesn't matter whether one elicits bids to exchange for just one or as many as four alternatives – if each alternative has an equal probability of being the one that is ultimately sold to the participant then the number of alternatives effectively does not matter.

Third however, our findings illustrate the idea that consumers have preferences when it comes to acquiring information about new products that are unfamiliar to them. In this regard, three findings are particularly relevant – one, that the effect of information on subsequent valuation of the good being auctioned depends on the value placed on the information itself, two, that information acquired via a bid process appears to have a greater impact on subsequent valuation than information provided at no cost by the experimenter, and three, that the presence

of multiple alternatives in the auction environment appears to mitigate the effect of new information on valuation (as if those alternatives were substitutes for the good being valued). Those findings, and their implications, should be kept in mind in studies that seek to quantify the effect of new information

So, the final advice is quite simple. If some consumers have negative values for the good being auctioned – go ahead and allow negative bids. And if you are investigating the effect of new information on values, be mindful that consumers have preferences with regard to the type of information they seek and consider a design that incorporates bids for multiple alternatives.

Appendix A - Experimental Design for Chapter 2[21]

INSTRUCTIONS

You are about to participate in an experimental auction. You will also be asked to complete a short survey. Please follow all instructions carefully.

You will receive $5 for participating in this experiment. During the auction you may purchase or sell goods. Accordingly, your take home income may be greater or less than $5.

When bidding in the auction, you are requested not to reveal your bids to any other participant. Any communication between bidders will result in a request to withdraw from the experiment.

You will be provided with an I.D. number. Please write this number where requested on the survey instrument and on all bidding sheets.

CONSENT FORM

We need your signed consent if you are to participate in this experiment. Your participation is completely voluntary and you may withdraw from the experiment at any time without prejudice to you. Results from the experiment will be reported in aggregate form and will not be associated with any individual participant. Any names associated with the experiment will be deleted upon completion.

If you consent to participate, please sign and date the consent form below. On the following page, your address and SSN is required to account for our distribution of funds.

I have read the consent form statement and agree to act as subject in this experimental auction, with the understanding that I can withdraw at any time without prejudice to me.

_____ ____/___/____

Signature Date

[21] We only present the design for the 4th price auction. The design for the random nth price auction is equivalent to this design except the auction mechanism.

This information is required to account for our distribution of funds

Name: _____

SSN: _____

Street Address: _____

City: _____

State: _____ ZIP Code: _____

Phone _____ **OR** E-mail:_____

I hereby certify that I have received a $5.00 payment for my participation in an Economic Experiment at Kansas State University on December 3, 2013.

Signature: _____ Date: _____

I.D. # _____

To begin, we would like to collect some background information about you. We would like to remind you that all information will be treated as confidential and cannot be connected to you. Data will be reported only in aggregate form – i.e., as group averages.

1. **What gender are you?** *Male* ____ *Female* ____

2. **In what year were you born?** 19_____

3. **What is the highest level of education you have completed?** (*Circle one*)

Some high school	College graduate
High school graduate	Some post graduate
Some college	Graduate degree

4. **Have you ever lived or worked on a farm or ranch?** *(Please circle)*

Yes *No*

5. **Answer the following question by circling a number, 1 through 5**.

I am cautious in trying new and different things.

1	2	3	4	5
strongly disagree		neutral		strongly agree

6. **Do any children living in your household? (***Please circle*)

Under age 6	yes	no
Age 6 to 18	yes	no

7. **How frequently, on average, do you consume the following?**

beef	_____ meals per week	**OR**	_____ meals per month	
pork	_____ meals per week	**OR**	_____ meals per month	
chicken	_____ meals per week	**OR**	_____ meals per month	
fish	_____ meals per week	**OR**	_____ meals per month	

8. On a scale of 1 to 5, with 1 being "not at all concerned" and 5 being "very concerned" how concerned are you about the safety of the food you buy? _____

9. On a scale of 1 to 5 with 1 being 'not at all concerned' and 5 being 'very concerned', indicate your level of concern about how each of the following affects food safety.

Item	**Not at all concerned**				**Very Concerned**
Spoilage	1	2	3	4	5
Pesticides / Herbicides	1	2	3	4	5
Chemicals	1	2	3	4	5
Additives / Preservatives	1	2	3	4	5
Pollution	1	2	3	4	5
Bacteria – e.g., *Salmonella, E.coli*	1	2	3	4	5
Bugs/pests/rats	1	2	3	4	5
Use of antibiotics	1	2	3	4	5
Irradiation of food	1	2	3	4	5
Animal growth enhancers	1	2	3	4	5
Genetic engineering/biotechnology	1	2	3	4	5

Food Safety and E. coli

You may be aware of the possibility of ground beef being contaminated with bacteria such as *E.coli*. These bacteria can cause food poisoning if the meat is not properly handled and cooked. Scientists estimate that perhaps **one hamburger in every thousand may contain *E.coli***. But, because proper cooking kills bacteria, **less than one hamburger in every million causes an illness from *E.coli***.

When testing reveals that ground beef may contain *E. coli*, the product is **recalled** from the market to protect consumers.

10. Prior to this survey, were you aware that hamburgers or ground beef could be contaminated with *E.coli* bacteria that could cause food poisoning. (Check only one).

_____ Yes, I was aware that hamburgers or ground beef might contain *E.coli.*

_____ No, I was not aware that hamburgers or ground beef might contain *E.coli*.

11. If a large quantity of ground beef had recently been recalled from supermarkets in your area because of the risk of contamination with *E.coli*, how do you think this might influence your purchasing decisions? (Check only one).

_____ I would probably stop purchasing ground beef/burgers for a few weeks
_____ I would probably stop purchasing ground beef/burgers for several months
_____ I would probably switch from supermarket ground beef to a locally produced source
_____ I would probably not change my purchasing habits
_____ Other. Please explain: _____

Even though the risk of illness from ground beef is very low, a process called food irradiation can decrease it even further.

Food Irradiation: *Food irradiation is a process that uses electro-magnetic radiation to kill bacteria in hamburger. It has been shown to kill 100% of the E.coli bacteria that may be present in ground beef. The process of food irradiation has been approved by the USDA.*

12. Which of the following best describes your knowledge of food irradiation before receiving this survey? (Check only one).

_____ I had never heard of food irradiation until now
_____ I had heard of food irradiation, but did not know much about it
_____ I knew something about food irradiation
_____ I knew quite a lot about food irradiation

13. Imagine that you are in your local grocery store to purchase ground beef. You can choose between two types of ground beef that **both cost the same**. One is **regular ground beef** that has **not** been treated with irradiation. The chance that this ground beef contains *E.coli* is about 1 in 1,000, and the risk of becoming ill if it has *E.coli* is about **1 in a million**. The other ground beef was **treated with irradiation**. The irradiation treatment killed all of the *E.coli* bacteria that may have been in the meat. The meat is **guaranteed not to contain *E.coli.***.

Which ground beef would you buy? If both cost the same, I would buy (Check only one).

_____ Regular ground beef _____ Irradiated ground beef

14. My willingness to accept food safety risk when eating food products, I am….

1	**2**	**3**	**4**	**5**
not at all willing		a little willing		very willing

15. I rarely think about food safety when eating food products

1	**2**	**3**	**4**	**5**
Strongly disagree		Neutral		Strongly agree

INSTRUCTIONS, Stage 1 I.D. # _____

Please examine the Package of Trail Mix and Package of Dried Fruit and indicate which one you prefer.

I prefer the Package of Trail Mix _____

I prefer the Package of Dried Fruit _____

I like them both equally well _____

We will now conduct an auction for both goods. Only one of the goods, determined using a coin-toss, will actually be sold: heads - Trail Mix; tails - Dried Fruit. The randomly selected item will be sold to the highest bidder for an amount equal to the 2nd highest bid for that item.

For example, let's say that Trail Mix are chosen, and the top 3 bids for Trail Mix are $3.85, $2.00, and $1.80. The Trail Mix will be sold to the high bidder and he/she will pay $2.00. Note that this is **not a hypothetical exercise** – an exchange will be made and **money will change hands**.

First, let's practice with an auction for this small candy bar. I will sell it to the highest bidder, for an amount equal to the 2nd highest bid. In case of a tie for the high bid, we will toss a coin to determine the high bidder, and the 2nd high bid will be the same as the high bid. For example, if the top 3 bids are 20c, 20c, and 15c, we will toss a coin to determine the winning bidder and they will pay 20c for the candy bar.

Note that in this type of auction you are better off if you bid an amount that exactly equal to the maximum amount you would be willing to pay (WTP) for the good. Let's say your maximum WTP is 25c – if you bid only 20c you might lose the chance to buy the candy bar at a price you would have been happy to pay. On the other hand, if you bid more than your maximum WTP you may end up buying the candy bar and paying too much for it.

Submit your bid for the candy bar below. Don't forget to put your ID number on the sheet above.

My bid for the small candy bar is _____

Stage 1 **I.D. #** _____

Your bids for the Package of Trail Mix and the Package of Dried Fruit
Remember – only one of the 2 items will be sold. Price will be the 2nd highest bid.

My bid for the Package of Trail Mix is _____

My bid for the Package of Dried Fruit is _____

INSTRUCTIONS, Stage 2 I.D. # _____

In the next set of auctions you will be given one good and asked how much you would be willing to pay (or how much you would be willing to accept) to exchange it for another good. Only one of the auctions will be binding – determined by drawing a number from an envelope. For example, we might conduct these 3 auctions:

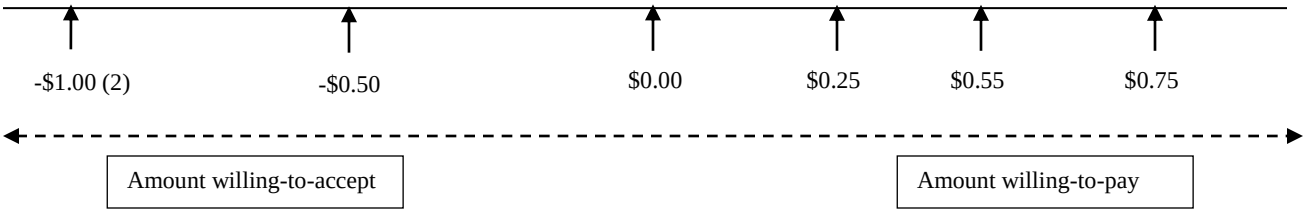
Auction A: You have an oven mitt and are bidding to exchange it for a coffee mug.
Auction B: You have a pen and are bidding to exchange it for a pencil.
Auction C: You have a calculator and are bidding to exchange it for a stapler.

If auction B is selected, everyone will own a pen, and the winning bidder(s) in the auction will then exchange it for a pencil. Nobody will receive an oven mitt or a calculator.

In our earlier candy bar auction, the winning bidder paid the 2nd highest price. In the next set of auctions the top N bidders will pay the N+1st highest price (e.g., if N is 2, then the two high bidders will pay the 3rd highest price). N may or may not be known to you before you make your bid.

Example:

Assume Auction A was conducted with 7 bidders. N was 4, so the top 4 bidders would make the exchange and pay the 5th highest price. Let's say that 3 of the 7 bidders preferred the coffee mug and their bids were $0.75, $0.55 and $0.25 to exchange the oven mitt for the coffee mug. One person liked the oven mitt and coffee mug equally well – they didn't care which one they ended up with, so they bid zero. The remaining 3 bidders all preferred to keep the oven mitt and would need to be paid to make the exchange. Their bids were -$0.50, -$1.00, and -$1.00 – i.e., 2 of them would need to be paid $1.00 to make the exchange, the other $0.50. Bids are shown below.



Result. The top 4 bidders, which includes the zero bid, exchange the oven mitt for the coffee mug and they each **receive** $0.50 for the exchange.

Questions: What if N = 2? What if N = 5?

Next, we'll have another practice auction using candy bars.

Practice auction: Milky Way → Snickers **I.D. # ___**

You have a Milky Way and an opportunity to exchange it for a Snickers bar. **N will be 4**, so the top 4 bidders will make the exchange, and will pay the 5th highest price.
The top N bidders will make the exchange, and will pay the N + 1st highest price. As in the earlier candy bar, a real exchange will take place – this is not a hypothetical exercise.

Again, you will be better off bidding the maximum amount you would be willing to pay (WTP) for the exchange, or, if you prefer to keep the Milky Way, the minimum you would accept to make the exchange. For example, let's say you prefer the Milky Way and the minimum you would accept to exchange it for a Snickers is 30c. If you bid -$1.00 you may lose the chance to make the exchange at 30c. But if you bid -$0.10 you may end up making the exchange and receiving less than 30c.

Submit your bid below. Write either:

a) the **maximum you would pay** to exchange the Milky Way for the Snickers (if you prefer the Snickers)
b) the **minimum you would accept** to exchange the Milky Way for the Snickers (if you prefer the Milky Way)
c) ZERO – if you like the Milky Way and Snickers equally well.

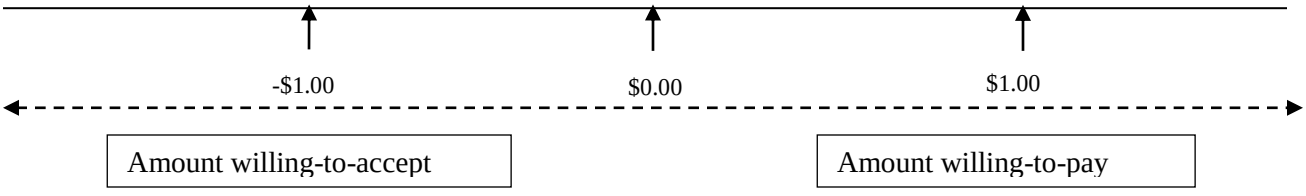
The **most I am willing to pay** to exchange the Milky Way for the Snickers is _____
OR

The **minimum I would accept** to exchange the Milky Way for the Snickers is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Please **also** mark your bid on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.



Remember, that in the auctions that follow, only one auction will be binding. The binding auction will be determined by drawing a number from an envelope.

Auction A: Package of Trail Mix → Package of Dried Fruit I.D. # _____

You have a Package of Trail Mix and an opportunity to exchange it for a Package of Dried Fruit. **N will be 4**, so the top 4 bidders will make the exchange, and will pay the 5th highest price. If this auction is selected to be binding, you will receive a package of Trail Mix, but may then end up exchanging it for Dried Fruit.

Submit your bid below. Write either:

a) the **maximum you would pay** to exchange the Package of Trail Mix for the Package of Dried Fruit (if you prefer the Dried Fruit)
b) the **minimum you would accept** to exchange the Package of Trail Mix for the Package of Dried Fruit (if you prefer the Trail Mix)
c) ZERO – if you like the Trail Mix and Dried Fruit equally well.

The **most I am willing to pay** to exchange the Package of Trail Mix for the Package of Dried Fruit is _____

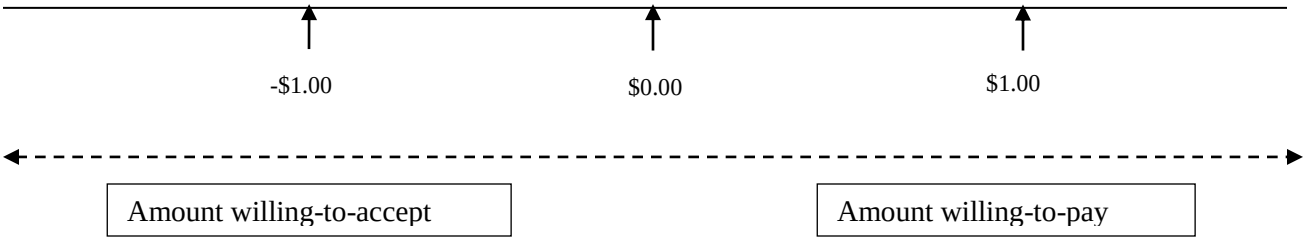
OR

The **minimum I would accept** to exchange the Package of Trail Mix for the Package of Dried Fruit is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Please **also** mark your bid on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.



Auction B: Package of Dried Fruit → Package of Trail Mix I.D. # _____

You have a Package of Dried Fruit and an opportunity to exchange it for a Package of Trail Mix. **N will be 4**, so the top 4 bidders will make the exchange, and will pay the 5th highest price. If this auction is selected to be binding, you will receive a package of Dried Fruit, but may then end up exchanging it for Trail Mix.

Submit your bid below. Write either:

a) the **maximum you would pay** to exchange the Package of Dried Fruit for the Package of Trail Mix (if you prefer the Trail Mix)
b) the **minimum you would accept** to exchange the Package of Dried Fruit for the Package of Trail Mix (if you prefer the Dried Fruit)
c) ZERO – if you like the Dried Fruit and Trail Mix equally well.

The **most I am willing to pay** to exchange the Package of Dried Fruit for the Package of Trail Mix is _____

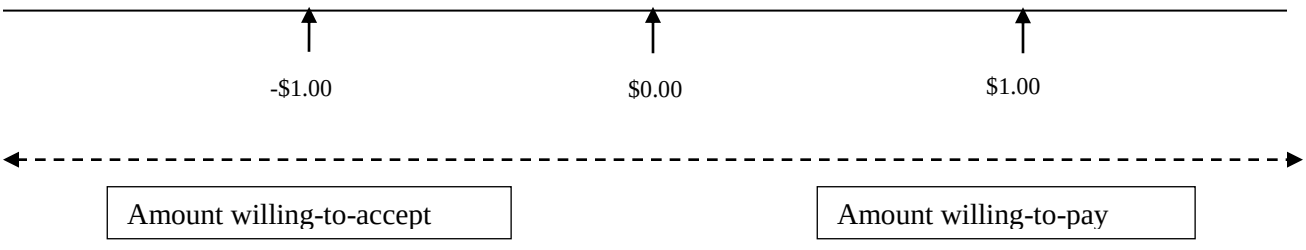
OR

The **minimum I would accept** to exchange the Package of Dried Fruit for the Package of Trail Mix is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Please **also** mark your bid on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.



INSTRUCTIONS, Stage 3 I.D. # _____

In this part of the auction we will give you an opportunity to **sell the product** that you have just acquired – either the package of Dried Fruit or the package of Trail Mix.

Please check here to indicate which item you have:

I own a Package of Dried Fruit _____

I own a Package of Trail Mix _____

Please indicate below the minimum amount you would accept in exchange for the product you now possess. We will draw a random price between zero and $3.00. **If the amount you are willing to accept is below that random number you will sell your item for the random price.** If the amount you are willing to accept is above the random number you will keep your item.

For example, if you are willing to accept $2.10 and the randomly drawn price is $2.50 you will sell your item for $2.50. If the randomly drawn price is $1.70, you would not sell your item.

The **minimum I am willing to accept** for my item is _____

Appendix B - Experimental Design for Chapter 3 and 4[22]

Introduction and Consent Form

You are about to participate in an experimental auction. You will also be asked to complete a short survey. Please follow all instructions carefully.

You will receive $ 50 for participating. During the experiment you may purchase or sell goods. Accordingly, your take home income may be greater or less than $ 50.

When bidding in an auction, you are requested not to reveal your bids to any other participant. Any communication between bidders will result in a request to withdraw from the experiment.

You will be provided with an I.D. number. Please write this number where requested on the survey instrument and on all bidding sheets.

CONSENT FORM

We need your signed consent if you are to participate in this experiment. Your participation is completely voluntary and you may withdraw from the experiment at any time without prejudice to you. Results from the experiment will be reported in aggregate form and will not be associated with any individual participant. Any names associated with the experiment will be deleted upon completion.

If you consent to participate, please sign and date the consent form below. On the following page, your address and SSN is required to account for our distribution of funds.

I have read the consent form statement and agree to participate in this experiment, with the understanding that I can withdraw at any time without prejudice to me.

_____ ____/____/____

Signature Date

[22] We only present the experimental design for treatment 3. Designs for treatment 1 and 2 are equivalent to treatment 3 except the number of alternatives presented in the text.

This information is required to account for our distribution of funds

Name: _____

SSN: _____

Street Address: _____

City: _____

State: _____ ZIP Code: _____

Phone _____ **OR** E-mail:_____

I hereby certify that I have received a $ 50 payment for my participation in an Economic Experiment at Kansas State University.

Signature: _____ Date: _____

I.D. # _____

We appreciate your participation in this survey. We are interested in your perceptions and opinions about meat. This survey is being conducted as part of a graduate student research project at Kansas State University. This survey is in multiple-choice and fill-in-the-blank format.

Any information you provide will be kept strictly confidential and used only for the purposes of this research. **Your individual responses are anonymous and you are in no way identified in the survey**. If you feel any question is too personal, you do not have to answer it.

1. **What best describes your gender?** *Male* ____ *Female* ____

2. **In what year were you born?** 19_____

3. **What is the highest level of education you have completed?** (*Circle one*).

Some high school	College graduate
High school graduate	Some post graduate
Some college	Graduate degree

4. **How many people in your household are in the following age categories?** *(Including yourself)*

Age categories	Number
Age 5 and younger	____
Age 6 to 17	____
Age 18 to 39	____
Age 40 to 54	____
Age 55 and above	____

5. We recognize that income is private information. We ask about it because **income influences food purchases and it is important for us to be able to categorize responses by income ranges.** This information will be kept strictly confidential and will never be linked to your name, nor made available to anyone outside the research team.
What was your **household's total pre-tax income from all sources in 2014?**
(*Circle one*).

1. Less than $20,000
2. $20,001 – 30,000
3. $30,001 – 40,000
4. $40,001 – 50,000
5. $50,001 – 75,000
6. $75,001 – 100,000
7. $100,001 – 125,000
8. $125,001 – 150,000
9. More than $150,000

6. Approximately how much does your household spend on food consumed <u>at home and away from home</u> during a typical week? (*Circle one*).

1. Less than $60 per week
2. $61 - $90 per week
3. $91 - $120 per week
4. $121 - $150 per week
5. More than $150 per week

7. Approximately how often does your household consume the following products? (*Check one bubble for each product*).

	At least once a week	2-3 times a month	About once a month	Less than once a month	Never
Ground beef/ Hamburger	○	○	○	○	○
Steak	○	○	○	○	○
Chicken	○	○	○	○	○
Pork	○	○	○	○	○
Fish	○	○	○	○	○

8. On a scale of 1 to 5, with 1 being "least considered" and 5 being "most considered", <u>what level of consideration</u> do you give to the following factors when purchasing meat?
(*Circle one number for each factor*)

	Least considered				Most considered
Price	1	2	3	4	5
Food Safety	1	2	3	4	5
Brand	1	2	3	4	5
Fat/Cholesterol	1	2	3	4	5
Quality grade	1	2	3	4	5
Freshness	1	2	3	4	5

9. Have you, or has anybody in your household ever had food poisoning?
(*Circle one*)

1. Yes
2. No
3. Maybe, unsure
4. Don't know

<u>If yes</u>, check which, if any, of the following foods you suspected caused food poisoning:

____Pork
____Poultry
____Beef
____Lamb/Mutton
____Fish/seafood
____Fruit
____Vegetables
____Other. Please list: _____

10. On a scale of 1 to 5, with 1 being "not at all concerned" and 5 being "very concerned", how concerned are you about the safety of the following foods?

	Not at all concerned				Very concerned
Ground beef /Hamburger	1	2	3	4	5
Steak	1	2	3	4	5
Chicken	1	2	3	4	5
Pork	1	2	3	4	5
Fish	1	2	3	4	5

11. On a scale of 1 to 5 with 1 being 'not at all concerned' and 5 being 'very concerned', indicate your level of concern about how each of the following affects the safety of meat products.

	Not at all concerned				Very concerned	
Spoilage	1	2	3	4	5	Don't know
Pesticides/Herbicides	1	2	3	4	5	Don't know
Vaccination of food animals	1	2	3	4	5	Don't know
Additives/Preservatives	1	2	3	4	5	Don't know
Food processing technologies (e.g. heat or pressure treatment)	1	2	3	4	5	Don't know
Bacteria (e.g. *Salmonella, E.coli*)	1	2	3	4	5	Don't know
Use of antibiotics in animal agriculture	1	2	3	4	5	Don't know
Irradiation of food	1	2	3	4	5	Don't know
Animal growth enhancers (e.g. artificial hormones)	1	2	3	4	5	Don't know
Genetic engineering /biotechnology/cloning	1	2	3	4	5	Don't know

12. When you purchase meat, you may take several things into consideration <u>to assess safety</u>. For meat purchases, please select the <u>3 most important factors</u> you consider as indicators of food safety.
(**1** = most important, **2** = 2nd most important, **3** = 3rd most important)**.**

____Brand name
____Visual inspection of product (e.g. color, freshness)
____Labelled organic
____Food safety assurance (e.g. government inspected)
____Purchased from reputable store
____Product smell
____Labelled natural
____Labelled traceable to farm
____Price level
____Past experience with the product
____"Sell by" or "Best by" date
____Others. Please list: _____

According to The Centers for Disease Control and Prevention (CDC), 1 in 6 Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases every year. In 2014, there were 94 food recalls involving beef, pork, and poultry, of which 16 were a result of contamination with bacteria such as *E.coli.*

E.coli. can cause food poisoning if meat is not properly handled and cooked. Scientists estimate that perhaps one hamburger in every thousand may contain *E.coli*. But, because proper cooking kills bacteria, less than one hamburger in every million causes an illness from *E.coli*.

13. Prior to this survey, were you aware that hamburgers or ground beef could be contaminated with *E.coli* bacteria that could cause food poisoning. (*Check only <u>one</u>*).

___ Yes, I was aware that hamburgers or ground beef might contain *E.coli.*
___ No, I was not aware that hamburgers or ground beef might contain *E.coli*.

14. How concerned are you about contracting harmful bacteria such as *E.coli* when consuming hamburgers or ground beef?

1	**2**	**3**	**4**	**5**
not at all concerned				very concerned

15. If a large quantity of ground beef had recently been recalled from supermarkets in your area because of the risk of contamination with *E.coli*, how do you think this might influence your purchasing decisions? (*check only <u>one</u>*)

_____ I would probably stop purchasing ground beef/burgers for a few weeks

_____ I would probably stop purchasing ground beef/burgers for several months

_____ I would probably switch from supermarket ground beef to a locally produced source

_____ I would probably not change my purchasing habits

_____ Other. Please explain: _____

16. On a scale of 1-10, where 1 is 'strongly disagree' and where 10 is 'strongly agree', please indicate the degree to which you agree with the following statements?

Consuming meat products always involves some level of risk from harmful bacteria.

1 2 3 4 5 6 7 8 9 10
Strongly Disagree Strongly Agree

Bacteria such as E. coli pose a great risks of illness to my family and me.

1 2 3 4 5 6 7 8 9 10
Strongly Disagree Strongly Agree

Meat processors need to implement additional safeguards to reduce the risk of foodborne disease to consumers.

1 2 3 4 5 6 7 8 9 10
Strongly Disagree Strongly Agree

My family and I need to be careful when preparing meat products at home in order to reduce the risk of foodborne disease.

1 2 3 4 5 6 7 8 9 10
Strongly Disagree Strongly Agree

17. How much ability does each of the following parties have to influence and assure the safety of meat products?

(1 = very low influence on safety, 5 = very high influence on safety)

	Very low				Very high	
Rancher/Cattle feeder	1	2	3	4	5	No opinion
Meat processor (slaughter plant)	1	2	3	4	5	No opinion
Wholesaler/Distributor	1	2	3	4	5	No opinion
Retail grocer	1	2	3	4	5	No opinion
Restaurant	1	2	3	4	5	No opinion
Consumer	1	2	3	4	5	No opinion
Government inspectors	1	2	3	4	5	No opinion

Some animal production processes can reduce the risk of illness associated with meat products.

18. On a scale of 1 to 5 with 1 being 'Nothing' and 5 being 'A great deal', how much do you know about the following?

	Nothing				A great deal
Livestock Vaccines	1	2	3	4	5
Direct-Fed Microbials (Probiotics)	1	2	3	4	5
Food Irradiation	1	2	3	4	5
High Pressure Processing (HPP)	1	2	3	4	5

19. <u>Where</u> have you heard about production processes such as animal vaccines, direct-fed microbials, food irradiation, and high pressure processing? *(Circle any that apply)*

1. News media outlets (e.g. newspapers, radio/television news)
2. Government agencies (e.g. USDA, FDA, etc)
3. Non-government organizations (e.g. Greenpeace, Humane Society)
4. Private food companies (e.g. Tyson, Smithfield, Hormel)
5. University publications
6. Others (please specify) _____

20. On a scale from 1 to 5, please indicate your level of <u>trust in the following sources</u> for providing accurate information about production processes such as animal vaccines, direct-fed microbials, food irradiation, and high pressure processing.
(1 = very low level of trust, 5 = very high level of trust)

	Very low				Very high	
News media outlets (e.g. newspapers, radio/television news)	1	2	3	4	5	No opinion
Government agencies (e.g. USDA, FDA)	1	2	3	4	5	No opinion
Non-government organizations (e.g. Greenpeace, Humane Society)	1	2	3	4	5	No opinion
Private food companies (e.g. Tyson, Smithfield, Hormel)	1	2	3	4	5	No opinion
Academic Universities	1	2	3	4	5	No opinion

In this section we provide brief descriptions of some <u>food production processes</u> that can reduce the risk of illness from ground beef. Descriptions are based on information from the U.S. Department of Agriculture.

- Food Irradiation

Food is irradiated in special processing facilities where it is exposed to an electron beam or X-rays generated using electricity, or to gamma rays emitted by cobalt-60. Food irradiation controls spoilage and eliminates harmful foodborne bacteria. The result is similar to pasteurization. The fundamental difference between food irradiation and pasteurization is the source of the energy used to destroy the bacteria. While conventional pasteurization uses heat, irradiation uses energy from ionizing radiation.

- Direct-Fed Microbials (Probiotics)

The terms direct-fed microbial and probiotic are used interchangeably. They are animal feed additives that contain microbial species that are considered to be non-pathogenic normal flora. A probiotic is defined as "*a live microbial feed supplement which beneficially affects the host by improving its intestinal microbial balance*" Direct-fed microbials or probiotics can potentially improve resistance to disease, reduce shedding of pathogens, increase intestinal immunity, reduce disease symptoms, and improve animal health.

- High Pressure Processing (HPP)

High Pressure Processing (HPP) is an antimicrobial treatment for meat and poultry products. HPP subjects food to elevated pressures, with or without the addition of heat, to inactivate microorganisms and extend microbiological shelf life. Product processed with HPP is placed in a sealed flexible container. The flexible container is placed in a basket or barrel and moved to a high-pressure chamber filled with a pressure-transmitting fluid (usually water) that does not come in contact with the food product. The high pressure kills or damages harmful foodborne bacteria.

- Vaccination

Vaccinations are widely used to prevent disease and maintain health in livestock. Vaccinations can improve overall herd health resulting in decreased death loss and improved productivity. Vaccination has also been proven to be effective in reducing harmful bacteria in cattle. Optimum vaccination programs vary by region, disease exposure, facilities, and other herd-specific variables.

21. On a scale of 1 to 5 with 1 being 'Totally unacceptable' and 5 being 'Perfectly acceptable', please indicate your <u>level of acceptance</u> of the following …..

	Totally unacceptable				Perfectly acceptable
Use of vaccines in animal production	1	2	3	4	5
Use of direct-fed microbials in animal production	1	2	3	4	5
Use of irradiation in meat processing	1	2	3	4	5
Use of high pressure processing for meat	1	2	3	4	5

22. On a scale of 1 to 5 with 1 being 'Very unsafe' and 5 being 'Very safe', how would you <u>rate the safety</u> of....

	Very Unsafe				Very Safe
Meat from cattle vaccinated against *E.coli*	1	2	3	4	5
Meat from cattle treated with direct-fed microbials	1	2	3	4	5
Meat treated with irradiation	1	2	3	4	5
Meat treated with high pressure processing	1	2	3	4	5

<u>Please carefully read</u> the following paragraphs before answering the remaining questions.

The experience from surveys is that people often state a higher willingness to pay for an item than the amount they would truly be willing to pay for it in an actual purchasing situation. For instance, in a recent study, 80% of people said they would buy a new food product, similar to those you will be asked about below, but when a grocery store actually stocked the product, only 43% of people actually bought the new product when they had to pay for it. This difference (43% vs 80%) is what we refer to as hypothetical bias.

Accordingly, it is important that you respond to the following questions as if you were actually facing these exact choices in a restaurant, i.e., keeping in mind that paying more for a product means that you would have less money available for other purchases.

Imagine that you are in a restaurant and you are about to purchase a beef burger from the lunch menu. <u>Four types of beef burgers are available</u> to you in this restaurant.
The choices are:

a) **A regular beef burger – the menu price is $3.95**
b) **A beef burger that was treated with irradiation.**
c) **A beef burger from animals treated with direct-fed microbials (DFM)**.
d) **A beef burger that was treated with high pressure processing (HPP)**.

All treatments (i.e. irradiation, DFM, and HPP) were used to kill/reduce any *E.coli* bacteria that may have been present in the meat.

<u>We would like to know that maximum you would be willing to pay for each of the alternatives to the regular burger</u>. For any alternative that you like better than the regular burger, the highest price you would pay should be above $3.95, and for any alternative that you like less than the regular burger, the highest price you would pay should be less than $3.95.

23.1 With the regular burger costing $3.95, **the most I would pay for the burger that was treated with irradiation** would be $_____

23.2 With the regular burger costing $3.95, **the most I would pay for the burger from animals treated with DFM** would be $_____

23.3 With the regular burger costing $3.95, **the most I would pay for the burger that was treated with HPP** would be $_____

I.D. # _____

In this exercise you have **an opportunity to earn some extra money.**

Below, you are asked to make 9 decisions between **Lottery A** and **Lottery B**.

At the end of the experiment we will use drawings from two envelopes to randomly pick up **one person** from the group and **one decision** from rows 2 to 10 in the table.

The winner will receive their choice of Lottery A or Lottery B for the selected row.

To illustrate, in decision row 1, Lottery A provides a 100% chance of winning $8.00 while Lottery B provides a 100% chance of winning $1.00. Because most people would prefer to win the larger amount, they would choose Lottery A. Similarly, in question 11, most people would choose Lottery B.

For rows 2, 3, etc, please indicate which lottery, A or B, you would prefer.

Decision Row	Lottery A	Lottery B	Your preference
1	0% chance of $10.00, 100% chance of $8.00	0% chance of $19.00, 100% chance of $1.00	**A**
2	10% chance of $10.00, 90% chance of $8.00	10% chance of $19.00, 90% chance of $1.00	
3	20% chance of $10.00, 80% chance of $8.00	20% chance of $19.00, 80% chance of $1.00	
4	30% chance of $10.00, 70% chance of $8.00	30% chance of $19.00, 70% chance of $1.00	
5	40% chance of $10.00, 60% chance of $8.00	40% chance of $19.00, 60% chance of $1.00	
6	50% chance of $10.00, 50% chance of $8.00	50% chance of $19.00, 50% chance of $1.00	
7	60% chance of $10.00, 40% chance of $8.00	60% chance of $19.00, 40% chance of $1.00	
8	70% chance of $10.00, 30% chance of $8.00	70% chance of $19.00, 30% chance of $1.00	
9	80% chance of $10.00, 20% chance of $8.00	80% chance of $19.00, 20% chance of $1.00	
10	90% chance of $10.00, 10% chance of $8.00	90% chance of $19.00, 10% chance of $1.00	
11	100% chance of $10.00, 0% chance of $8.00	100% chance of $19.00, 0% chance of $1.00	**B**

I.D. # _____

In the survey you completed before the lottery preference exercise you were asked about your willingness to pay for different burgers. We will now repeat that question, but in a slightly different way.

Imagine you had a regular beef burger and had the opportunity to <u>exchange</u> it for one of three alternatives:

a) A beef burger that was treated with *irradiation*.
b) A beef burger from animals treated with *direct-fed microbials* (DFM).
c) A beef burger that was treated with *high pressure processing* (HPP).

For any alternative you **<u>like better</u>** than the regular burger, indicate the **<u>maximum you would be willing to pay</u>** to **<u>exchange</u>** the regular burger for that preferred burger.
For any alternative you **<u>like less</u>** than the regular burger, indicate the **<u>minimum you would be willing to accept</u>** to **<u>exchange</u>** the regular burger for that less preferred burger.

Note, you are not being asked how much you would pay for a burger, but how much you would pay (or need to be paid) **<u>to exchange</u>** one for another. **If you like the regular and alternative burger equally, check zero as the amount you would be WTP/WTA for an exchange**.

1) <u>Irradiated beef burger</u>

The **<u>most I would pay</u>** to exchange the regular burger for the *irradiated burger* is _____
<u>OR,</u> the **<u>minimum I would accept</u>** to exchange the regular burger for the *irradiated burger* is _____
<u>OR,</u> I like both equally so my WTP/WTA for an exchange is ZERO. (Check here) _____

2) <u>Burger from animals treated with direct-fed microbials (DFM)</u>

The **<u>most I would pay</u>** to exchange the regular burger for the *DFM burger* is _____
<u>OR,</u> the **<u>minimum I would accept</u>** to exchange the regular burger for the *DFM burger* is _____
<u>OR,</u> I like both equally so my WTP/WTA for an exchange is ZERO. (Check here) _____

3) <u>High pressure processed (HPP) burger</u>

The **<u>most I would pay</u>** to exchange the regular burger for the *HPP burger* is _____
<u>OR,</u> the **<u>minimum I would accept</u>** to exchange the regular burger for the *HPP burger* is _____
<u>OR,</u> I like both equally so my WTP/WTA for an exchange is ZERO. (Check here) _____

Auction instructions

In what follows we will be conducting a series of **auctions**.

In these auctions you will be given one good and asked how much you would be willing to pay (or how much you would be willing to accept) to exchange it for another good, or for one of several other goods.

Only one auction will be binding – determined with a random draw from an envelope, and,
Only one good will be sold – also determined with a random draw.

For example, we might conduct these 2 auctions:

Auction A: You have a Milky Way candy bar and can exchange it for a Snickers.
Auction B: You have a Milky Way candy bar and can exchange it for a Snickers or a KitKat.

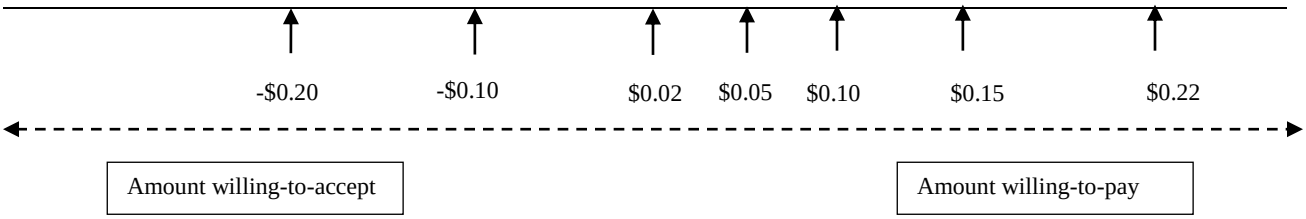
If Auction B is selected, everyone will own a Milky Way, and the winning bidder(s) in that auction will exchange it for either a Snickers or a KitKat.

In these auctions there will be 3 winning bidders. Those top 3 bidders will pay an amount equal to the 4^{th} highest bid.

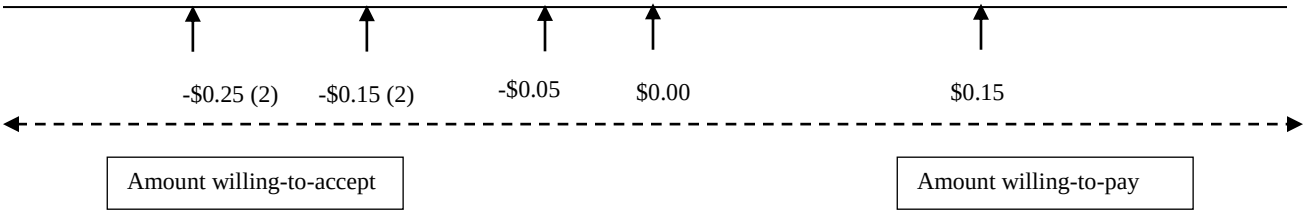
Illustration

Auction B was conducted with 7 bidders. Participants had a Milky Way and could exchange it for a Snickers or a KitKat. The top 3 bidders made the exchange and paid the 4th highest bid.

Bids for the Snickers: Let's say that 5 of the 7 bidders preferred the Snickers to the Milky Way and their bids were $0.22, $0.15, $0.10, $0.05 and $0.02. The other 2 bidders preferred the Milky Way and would need to be paid to exchange it for a Snickers. Their bids were -$0.10, and -$0.20 – i.e., one would need to be paid $0.20 to make the exchange, the other $0.10. Bids to exchange the Milky Way for the Snickers are shown below.



Bids for the KitKat: Only 1 of the 7 bidders preferred the KitKat to the Milky Way and their bid was $0.15. One person liked the Milky Way and KitKat equally well, so they bid zero. The other 5 bidders preferred Milky Way. One bid -$0.05, two bid -$0.15, and two bid -$0.25. Bids to exchange the Milky Way for the KitKat are shown below.



Outcome. Remember – only one of the two candy bars being auctioned, either the Snickers or the KitKat, will be selected to be sold. If the Snickers is selected to be sold, the top 3 bidders for the Snickers will exchange their Milky Way for a Snickers and each would **pay** $0.05 (the 4th highest bid) for the exchange.

Question: What if the KitKat is selected to be sold?

Next we will have a practice auction. Even though it is a practice auction, there will be an actual payment – the winning bidders **will pay** money for any exchange.

How should you bid?

It is best to bid an amount equal to the maximum you would **truly** be willing to pay (WTP) for an exchange, or, if you prefer Milky Way, the minimum you would accept to make an exchange.

Let's say you prefer Snickers to Milky Way but the maximum you would pay for the exchange is 15c. If you bid only 5c you may lose the opportunity to make the exchange at a price you would have been happy to pay. But if you bid 50c you may end up making the exchange and paying more than 15c.

On the other hand, assume you prefer Milky Way to KitKat and the minimum you would accept to exchange the Milky Way for a KitKat is 30c. If you bid -$1.00 you may lose the chance to make an exchange in which you would be happy to get 30c. But if you bid -$0.10 you may end up making the exchange and receiving less than 30c.

Let's look at one person's bids in the auction from the previous page. Let's say the person had a slight preference for Snickers over Milky Way and was willing-to-pay $0.02 for that exchange. But they prefer Milky Way to KitKat and would need to be paid $0.05 to make that exchange. Their bids would look like this:

1) Snickers

The **most I am willing to pay** to exchange the Milky Way for the Snickers is **0.02**

OR, the **minimum I would accept** to exchange the Milky Way for the Snickers is _____

OR, I like both equally so my bid is ZERO. Check here. _____

2) KitKat

The **most I am willing to pay** to exchange the Milky Way for the KitKat is _____

OR, the **minimum I would accept** to exchange the Milky Way for the KitKat is **0.05**

OR, I like both equally so my bid is ZERO. Check here. _____

This person is not a top 3 bidder for the Snickers and, if Snickers is selected to be sold, will not end up making that exchange. But, what if they bid 15c for the Snickers instead of the 2c they were truly willing to pay? They would then make the exchange and have to pay 10c to do so – more than the 2c they were willing to pay.

With a bid of -5c this person is a top 3 bidder for KitKat. If KitKat is selected to be sold they will make the exchange and get paid 15c to do so (the 4th highest bid is -15c). But, what if they bid -50c instead of the -15c they were truly willing to accept? Now they are no longer a top 3 bidder, and they lose the chance to make the exchange at what would be a favorable price.

Thus, **overbidding or underbidding is not in a person's best interest in this auction**.
Before we proceed – are there any questions about this example?

Candy bar auction bids I.D. # _____

Milky Way → Snickers, KitKat

You have a Milky Way and an opportunity to exchange it for a Snickers bar or a KitKat. The candy bar to be sold, either Snickers or KitKat will be determined using a random draw. The top 3 bidders will make an exchange, and **will pay** an amount equal to the 4th highest bid. **A real exchange with payment will take place – this is not a hypothetical exercise**

Record your bids below

1) Snickers

The **most I am willing to pay** to exchange the Milky Way for the Snickers is _____

OR

The **minimum I would accept** to exchange the Milky Way for the Snickers is _____

OR

I like both equally so my bid is ZERO. Check here. _____

2) KitKat

The **most I am willing to pay** to exchange the Milky Way for the KitKat is _____

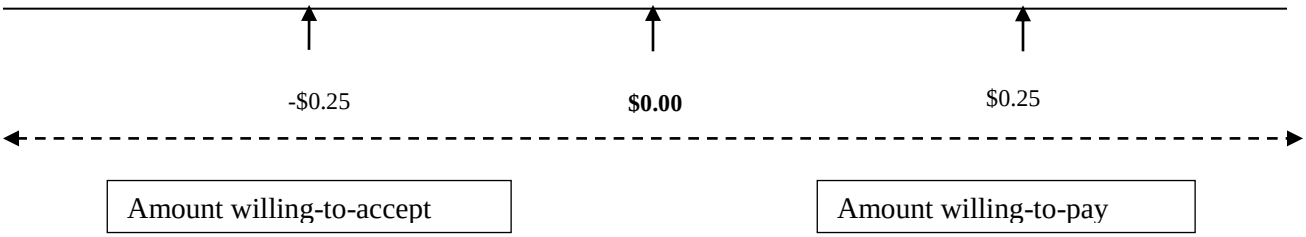
OR

The **minimum I would accept** to exchange the Milky Way for the KitKat is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Mark your bid for each candy bar on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.



Auction 1 Instructions

Please carefully read the information provided before submitting your bids.

You have a regular beef burger. You have an opportunity to exchange it for **either**:

1) an *irradiated* beef burger,

   OR

2) a beef burger from animals treated with *direct-fed microbials* (DFM burger)

   OR

3) a *high pressure processed* beef burger (HPP burger)

If this auction is selected to be binding, and if you are a winning bidder, you will end up exchanging the regular beef burger for one of the auctioned products. The product that will be sold (either the *irradiated beef burger*, the *DFM beef burger or HPP burger*) will be determined using a random draw.

The top 3 bidders will make an exchange, and pay an amount equal to the 4th highest bid.

NB: You must consume your burger to complete your participation in the experiment.

Submit your bids on the following page. **For each** of the available products, write **either**:

a) the **maximum you would pay** to exchange your regular burger for the auctioned product
   OR
b) the **minimum you would accept** to exchange your regular burger for the auctioned product
   OR
c) ZERO – if you like the regular burger and the auctioned product equally well.

Auction 1 Bids I.D. # _____

1) **Irradiated beef burger**

The **most I am willing to pay** to exchange the regular burger for the *irradiated burger* is _____

OR

The **minimum I would accept** to exchange the regular burger for the *irradiated burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

2) **Burger from animals treated with direct fed microbials**

The **most I am willing to pay** to exchange the regular burger for the *DFM burger* is _____

OR

The **minimum I would accept** to exchange the regular burger for the *DFM burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

3) **High pressure processed burger**

The **most I am willing to pay** to exchange the regular burger for the *HPP burger* is _____

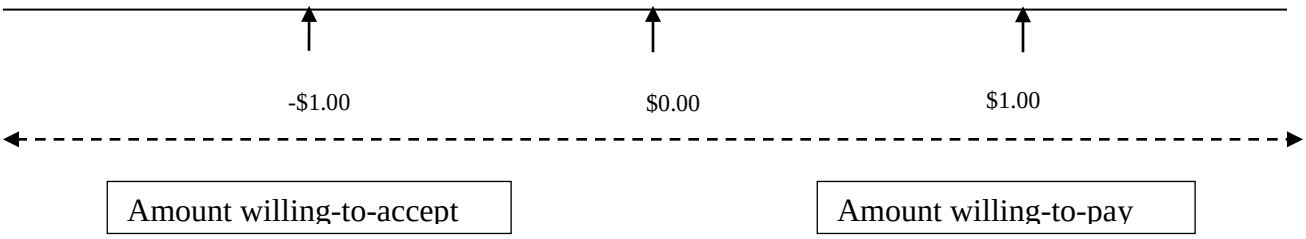
OR

The **minimum I would accept** to exchange the regular burger for the *HPP burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Please mark your bids for each product on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.



Information Auction I.D. # _____

In this auction, we will provide you an opportunity to obtain additional information about food irradiation. One of two types of information will be available – a pro-food irradiation perspective from *The American Council on Science and Health* or an anti-food irradiation perspective from a consumer advocacy group called *Food and Water*.

The additional information about food irradiation will be made available in an auction. The price will be determined in a random draw from an envelope containing 25 price tickets.
Participants who bid an amount equal to or greater than the randomly drawn price will pay that price, and will be provided with the additional information prior to submitting their next bid in the beef burger auction.

Participants whose bid is less than the randomly drawn price will not obtain any additional information. If you purchase additional information you must not share it with other participants.

Note that it is in your best interest to bid an amount equal to the true value you place on obtaining this information. Overbidding your true value increases your odds of making the purchase, but potentially at a price above what you are truly willing-to-pay. Underbidding reduces the odds of making a purchase, potentially at a price that you would have been willing to pay.

You can submit a bid to obtain only one type of information – either the pro-food irradiation information or the anti-food irradiation information. Please submit your bid for **ONE TYPE OF INFORMATION** below.

The **most I am willing to pay** for the Pro-Food Irradiation information is _____

OR

The **most I am willing to pay** for the Anti-Food Irradiation information is _____

Auction 2 Instructions

Please carefully read the information provided before submitting your bids.

You have a regular beef burger. You have an opportunity to exchange it for **either**:

2) an *irradiated* beef burger,

   OR

2) a beef burger from animals treated with *direct-fed microbials* (DFM burger)

   OR

3) a *high pressure processed* beef burger (HPP burger)

If this auction is selected to be binding, and if you are a winning bidder, you will end up exchanging the regular beef burger for one of the auctioned products. The product that will be sold (either the *irradiated beef burger*, the *DFM beef burger or HPP burger*) will be determined using a random draw.

The top 3 bidders will make an exchange, and pay an amount equal to the 4th highest bid.

NB: You must consume your burger to complete your participation in the experiment.

Submit your bids on the following page. **For each** of the available products, write **either**:

a) the **maximum you would pay** to exchange your regular burger for the auctioned product
   OR
b) the **minimum you would accept** to exchange your regular burger for the auctioned product
   OR
c) ZERO – if you like the regular burger and the auctioned product equally well.

Auction 2 Bids I.D. # _____

1) Irradiated beef burger

The **most I am willing to pay** to exchange the regular burger for the *irradiated burger* is _____

OR

The **minimum I would accept** to exchange the regular burger for the *irradiated burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

2) Burger from animals treated with direct fed microbials

The **most I am willing to pay** to exchange the regular burger for the *DFM burger* is _____

OR

The **minimum I would accept** to exchange the regular burger for the *DFM burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

3) High pressure processed burger

The **most I am willing to pay** to exchange the regular burger for the *HPP burger* is _____

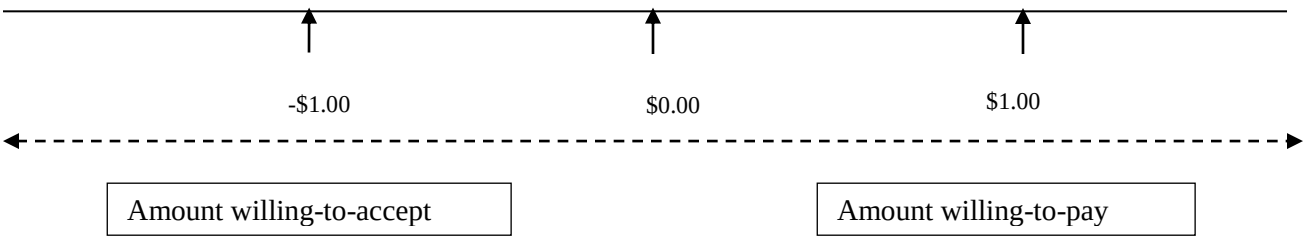
OR

The **minimum I would accept** to exchange the regular burger for the *HPP burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Please mark your bids for each product on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.



Auction 3 Instructions

Please carefully read the information provided before submitting your bids.

You have a regular beef burger. You have an opportunity to exchange it for **either**:

3) an *irradiated* beef burger,

   OR

2) a beef burger from animals treated with *direct-fed microbials* (DFM burger)

   OR

3) a *high pressure processed* beef burger (HPP burger)

If this auction is selected to be binding, and if you are a winning bidder, you will end up exchanging the regular beef burger for one of the auctioned products. The product that will be sold (either the *irradiated beef burger*, the *DFM beef burger or HPP burger*) will be determined using a random draw.

The top 3 bidders will make an exchange, and pay an amount equal to the 4th highest bid.

NB: You must consume your burger to complete your participation in the experiment.

Submit your bids on the following page. **For each** of the available products, write **either**:

a) the **maximum you would pay** to exchange your regular burger for the auctioned product
   OR
b) the **minimum you would accept** to exchange your regular burger for the auctioned product
   OR
c) ZERO – if you like the regular burger and the auctioned product equally well.

Auction 3 Bids I.D. # _____

1) Irradiated beef burger

The **most I am willing to pay** to exchange the regular burger for the *irradiated burger* is _____

OR

The **minimum I would accept** to exchange the regular burger for the *irradiated burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

2) Burger from animals treated with direct fed microbials

The **most I am willing to pay** to exchange the regular burger for the *DFM burger* is _____

OR

The **minimum I would accept** to exchange the regular burger for the *DFM burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

3) High pressure processed burger

The **most I am willing to pay** to exchange the regular burger for the *HPP burger* is _____

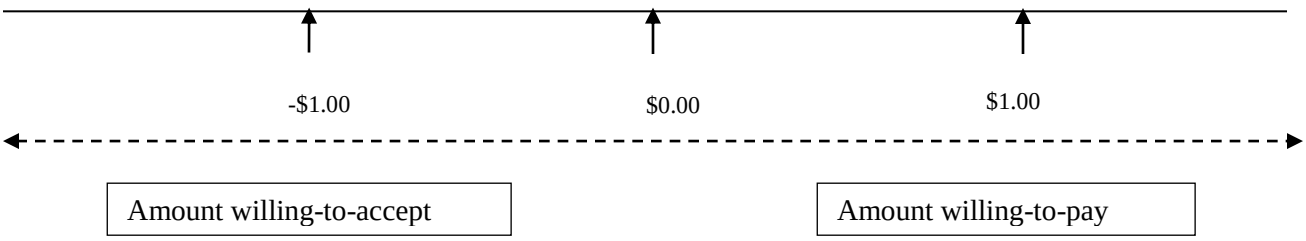
OR

The **minimum I would accept** to exchange the regular burger for the *HPP burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Please mark your bids for each product on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.



Auction 4 Instructions

Please carefully read the information provided before submitting your bids.

You have a regular beef burger. You now have an opportunity to exchange it for **either**:

1) an *irradiated* beef burger,

   OR

2) a beef burger from animals treated with *direct-fed microbials* (DFM burger)

   OR

3) a *high pressure processed* beef burger (HPP burger)

   OR

4) a *chicken sandwich*

If this auction is selected to be binding, and if you are a winning bidder, you will end up exchanging the regular beef burger for one of the auctioned products. The product that will be sold (either the *irradiated beef burger*, the *DFM burger*, the *HPP burger*, or the *chicken sandwich*) will be determined using a random draw.

The top 3 bidders will make an exchange, and pay an amount equal to the 4th highest bid.

NB: You must consume your burger to complete your participation in the experiment.

Submit your bids on the following page. For each of the available products, write either:

a) the **maximum you would pay** to exchange your regular burger for the auctioned product
   OR
b) the **minimum you would accept** to exchange your regular burger for the auctioned product
   OR
c) ZERO – if you like the regular burger and the auctioned product equally well.

Auction 4 Bids I.D. # _____

1) **Irradiated beef burger**

The **most I am willing to pay** to exchange the regular burger for the *irradiated burger* is _____
OR

The **minimum I would accept** to exchange the regular burger for the *irradiated burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

2) **Burger from animals treated with direct fed microbials**

The **most I am willing to pay** to exchange the regular burger for the *DFM burger* is _____
OR

The **minimum I would accept** to exchange the regular burger for the *DFM burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

3) **High pressure processed burger**

The **most I am willing to pay** to exchange the regular burger for the *HPP burger* is _____
OR

The **minimum I would accept** to exchange the regular burger for the *HPP burger* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

4) **Chicken sandwich**

The **most I am willing to pay** to exchange the regular burger for the *chicken sandwich* is _____
OR

The **minimum I would accept** to exchange the regular burger for the *chicken sandwich* is _____

OR

I like both equally so my bid is ZERO. Check here. _____

Please mark your bids for each product on the line below. You may bid any amount. It doesn't need to be one of the prices marked on the line.