Experimental Methods in Consumer Preference Studies

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Controlled experimental auctions can be used to elicit preferences for food products. We describe results from two series of experiments in which subjects revealed their willingness-to-pay for safer food. In one series, the risk reduction technology was not specified; in the other, it was identified as food irradiation. The results provide some evidence on the acceptability of food irradiation as a risk reduction technology.

Recently, considerable attention has been given to the issue of food safety (Caswell, 1995). The publicity given to outbreaks of foodborne disease causing death and serious illness has focused the attention of policymakers on means of improving food safety, particularly for meats. Naturally, such improvements will come at a cost, a cost that will ultimately be borne by the consumer. An interesting question, both from a public policy standpoint and for the food industry, is the extent to which consumers perceive that benefits from safety improvements outweigh their cost.

The methods for estimating consumer benefits from reductions in health risk can be broadly categorized as direct or indirect. Indirect methods use market data on costs of illness including medical costs and lost wages to derive values for reduced incidence of adverse health outcomes (Roberts, 1989; Buzby *et al.* 1995). Direct methods elicit respondents' subjective values for reductions of a specified risk and thus allow for additional factors such as the value of foregone leisure time, avoidance of pain and discomfort, and peace of mind.

Direct elicitation procedures usually employ contingent valuation type surveys in which a scenario involving choice between two risk states is presented to respondents. The actual value elicitation question can be either open-ended (how much would you pay?) or a discrete choice format requiring acceptance or rejection of the reduced risk state at a given cost. Open ended questions produce more data and the data are easier to interpret. Discrete choice questions correspond more closely to real world situations since, for the majority of food purchases, the decision is either to buy or not buy at the posted price.

But regardless of how well a survey is designed and executed, people still know they are valuing a hypothetical scenario. The absence of market discipline, applied in the real world by budget constraints and the availability of substitutes, creates an environment conducive to questionable responses. Values from contingent valuation surveys have exhibited inconsistencies such as a lack of responsiveness to the scale and scope of proposed benefits [see recent papers by Diamond and Hausmann (1994), and Hanemann (1994) for a discussion of the pros and cons of contingent valuation].

Recently, economists have developed experimental methods which can serve as a useful complement to surveys (Hayes *et al.*, 1995; Shin *et al.*, 1994; Shogren *et al.*, 1994). Experimental auction markets use real money and real goods to create a scenario in which the participants give undivided attention to the valuation task. While the laboratory situation is admittedly artificial, it is certainly no more so than the typical scenario presented in a survey. The experimental market should, in fact, have advantages over surveys because it involves real monetary payments and a situation wherein the respondent chooses between, and subsequently consumes, one or another food product (typical or new/improved). The choice of an appropriate auction mechanism (where the high bidder pays the 2nd highest bid price) can create additional incentives for partici-

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pants to reveal actual willingness to pay for the option to consume the improved product.

An additional advantage of the laboratory experiment is the option of having several rounds of bidding for the same product. This process creates an opportunity to inject additional information about the product being valued and to measure the effect of that information on the valuation by participants. When each round of bidding has an equal probability of being the binding round, incentives to reveal true values are preserved and wealth effects (an effect associated with being the winner in a previous round) are eliminated.

Experimental methods, however, do have considerable limitations. Variable cost per participant runs between \$30 and \$60, approximately double that of a survey. A significant time commitment - approximately two hours, is required of subjects, necessitating some level of financial compensation to reduce sample selection effects related to opportunity cost of time. The nature of the experiment also imposes geographic restrictions on sample selection, a restriction not generally faced by mail or telephone surveys. Compared to surveys, however, the effects of non-response bias can be minimized by providing a vague description of the experiment at the time of recruiting. Higher costs and the restrictions on samples suggest that experimental markets can best be used as a complement to other survey methods. Used in this manner, experiments can allow for calibration of survey values with a somewhat more reliable baseline.

This paper describes two series of experiments investigating consumer values for alternative methods of improving food safety. In one series, participants can upgrade from a "typical" food product (i.e. typical risk of illness) to a product described as having been screened for pathogens and whose consumption offers a considerably lower risk of producing the associated illness. The screening technology is not explicitly identified and thus could represent a quality control process such as Hazard Analysis and Critical Control Points (HACCP). In the second series, the safety enhancing technology is identified as food irradiation and a detailed description of the food irradiation process is provided.

The samples are limited and no claim is made that results can be extended to the general population. However, a comparison of bidding behavior in the two series of experiments gives some indication as to the relative acceptability of food irradiation as a means of enhancing safety.

The second section of this paper describes the laboratory experiment in more detail. The third section presents the results of the bidding process in both series of experiments.

Experimental Procedures

At the beginning of each experiment, subjects were given an I.D. number, assigned to a seat and asked not to communicate with other participants. Participation fees (\$15-\$20 for students; \$25-\$30 for adults) were paid in cash at the beginning of the experiment. Participants were then asked to sign a consent form and to complete a short questionnaire dealing with knowledge of food safety issues, demographic and socioeconomic characteristics (see Table 1).

Table 1. Demographic Characteristics of Participants.

	-----Food Safety Experiments-----		-----Irradiation Experiments-----	
	E.coli	*Salmonella*	Bidding for Irradiated	Bidding for Non-Irradiated
Number	53	60	44	44
Type	Student	Student	29 Student 15 Adult	29 Student 15 Adult
% Female	.43	.51	.39	.54
Average age	19.2	23.2	25.1	25.8
% had food poisoning	.19	NA	.29	.11

Each experiment began with a trial auction using candy bars, the objective being to familiarize participants with the 2nd price auction mechanism and multiple trials. Each participant was given a Mars™ candy bar and asked to submit a sealed bid for an upgrade to a Snickers™ candy bar (or vice versa). There were five rounds of bidding (trials). Participants were informed of the number of trials in advance. Following each trial, the monitors examined the bids and publicized both the I.D. number of the highest bidder and the amount of the second-highest bid.

We explained to participants that the winning bidder, i.e. the highest bidder in the binding trial, would pay an amount equal to the second highest bid in that trial (Vickrey, 1961). We explained the reasons for this auction structure using the following paragraph:

> *In this auction it is in your best interest to bid the amount that you are truly willing to pay to exchange one candy bar for the other. If you bid more than your true willingness-to-pay you increase your chances of purchasing the other candy bar but you may have to pay a price that is greater than what you are willing to pay. On the other hand, if you bid less than the amount that you are truly willing to pay then you may lose the chance to purchase the other candy bar at a price that you would be willing to pay.*

The binding trial was drawn from a hat at the end of the auction and the winning bidder paid in cash to exchange his/her original candy bar for the auctioned candy bar. All other participants kept the candy bar they were originally given. The random drawing of the binding trial ensures that participants have the same incentive structure throughout the auction, i.e. they should always bid their true willingness to pay. This feature also eliminates "wealth effects" (i.e., changes in bids caused by winning an earlier trial).

In theory, a single-shot Vickrey auction should cause participants to reveal their true value, but other researchers have found changes in bids over multiple trials (see for example, Coursey, 1987). Multiple trials give participants time to discover for themselves their values for unfamiliar products. As noted, multiple trials also provide an opportunity to inject new information about the product and to observe the resulting changes in bidding behavior (Fox, 1995).

Results

This section presents the information used in and the results from two series of experiments which we will refer to as the food safety experiments and irradiation experiments.

Food Safety Experiments

The food safety experiments dealt with two pathogens; *E.coli* and *Salmonella*. The *E.coli* subseries consisted of 4 experiments (N=53) conducted at the University of Washington in July 1993, approximately 6 months after an *E.coli* outbreak associated with undercooked hamburgers. The *Salmonella* subseries consisted of 4 experiments (N=60) conducted at different campus locations throughout the United States. All subjects were undergraduate or graduate students.

These experiments had 20 bidding trials with additional information provided about the pathogen and its incidence following trial 10. For the first 10 trials, therefore, subjects' bids were based on their own subjective assessment of the risk associated with the typical product. The descriptions of the products used in the *E.coli* experiments were as follows:

Trials 1-10:

Type I: This meat has a typical chance of being contaminated with the food-borne pathogen *E.coli* 0157:H7; i.e., it has been purchased from a local source.

Type II: This meat has been subjected to stringent screening for *E.coli* 0157:H7. Because of this screening we can state that this meat is 10,000 times safer than the other product.

Following trial 10, the following additional information was provided:

Trials 11-20:

Type I: If you eat this meat, there is approximately a 1 in 5,000,000 chance that you will become ill from *E. coli* 0157:H7.

Description of E. coli infection:

Symptoms are those of an intestinal disease with abdominal pains, nausea, vomiting, and diarrhea. The actual individual chance of getting an *E.coli* infection from food is about 1 in 4,800 annually. Of those individuals who get sick, 1 individual out of 500 will die.

The instructions used in the *Salmonella* experiments differed in the descriptions of the products and the chances of becoming ill.

Trials 1-10:

Type I: This meat has a typical chance of being contaminated with the food-borne pathogen *Salmonella*; i.e., it is purchased from a local source.

Type II: This meat has been subjected to stringent screening for *Salmonella*. There is a 1 in 100,000,000 chance of getting salmonellosis from consuming this food.

Trials 11-20:

Type I: If you eat this food, there is a 1 in 137,000 chance that you will become ill from Salmonella.[1]

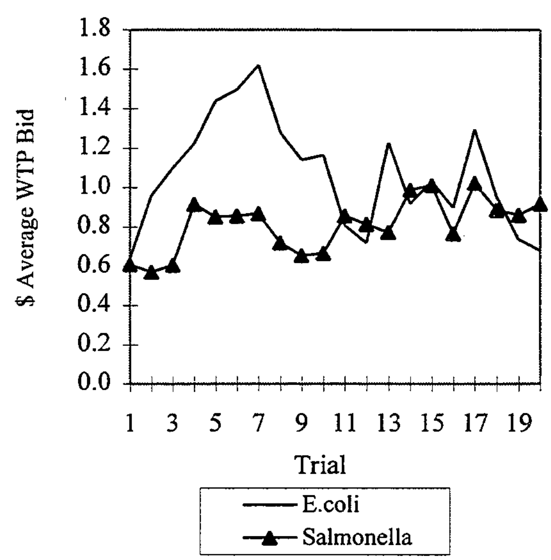
Description of Salmonellosis:

Symptoms are those of a mild "flu-like" intestinal disease of short duration with abdominal pains, nausea, vomiting, and diarrhea. The actual individual chance of infection of Salmonellosis is 1 in 125 annually. Of those individuals who get sick, 1 individual out of 1,000 will die.

Given these descriptions, clearly the experiments are not directly comparable; we have a different pathogen and a different description of the magnitude of the risk reduction. For *E.coli,* there is an explicit statement of the magnitude of risk reduction (10,000 times safer), while for *Salmonella* the risk reduction is implied. The important point is that in both experiments subjects were bidding for a risk reduction, not an elimination. In both experiments, subjects were informed up front that one or other product (Type I or Type II) would have to be consumed at the conclusion of the auction.

Figure 1 shows the average bid over all 20 trials in both experiments. It is interesting that the average bid starts out at just over 60 cents in both sets of experiments. Over the first 10 trials the average bid rises as high as $1.60 in the *E.coli* experiments before stabilizing at $1.20 in trials 9 and 10. In the *Salmonella* experiments, the bid rises to about 80 cents before falling to 66 cents in trials 9 and 10. Given that the bids start out so closely, it appears that proximity to the *E.coli* outbreak became a factor in the bids of the Seattle students as the experiment progressed.

Figure 1. Average willingness-to-pay to reduce the risk of *E.coli* (N=53) and *Salmonella* (N=60) using an unspecified screening technology.



[1] There is a generally acknowledged paucity of reliable data on the incidence and risk of foodborne disease. Our figures were based on incidence estimates reported in Bennett *et al.* (1987).

Following trial 10, participants are informed that the odds of contracting *E.coli* from their Type I product is 1 in 5,000,000. Most of the subjects had overestimated the risk (Figure 2), and the average bid falls. In the *Salmonella* experiments the opposite effect is encountered; most subjects underestimated the risk (Figure 3), and the mean bid for the safer product rises.

Figure 2. Subjective assessments of the risk of *E.coli.* Actual risk is less than one per thousand population per year.

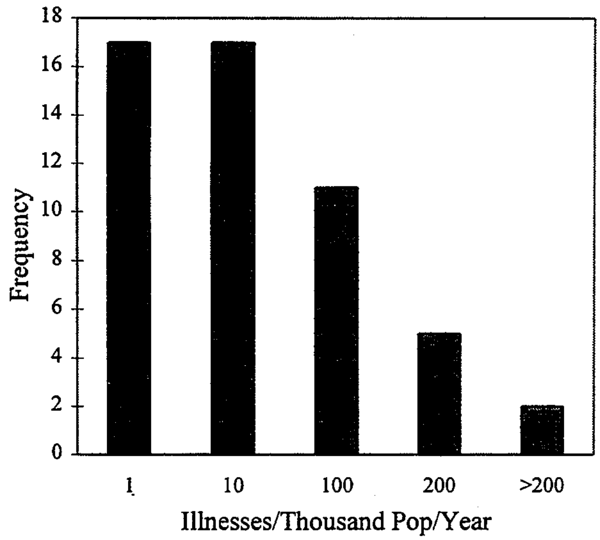
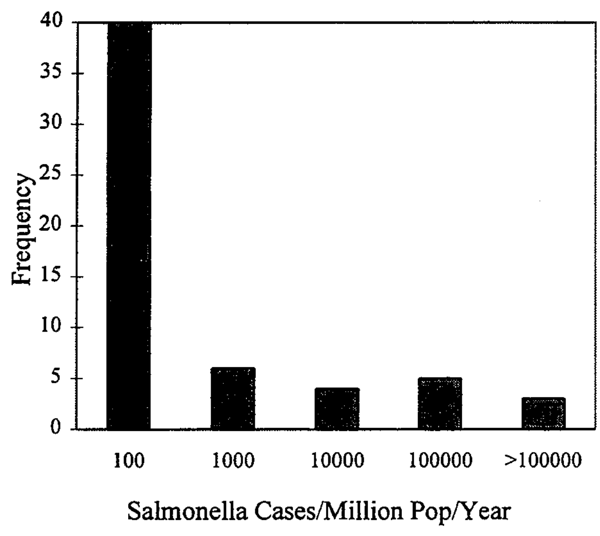


Figure 3. Subjective assessments of the risk of *Salmonella.* Actual risk is about 8000 cases per million population per year (source, Fox *et al.* 1995).



Irradiation Experiments

Food irradiation offers a means of significantly reducing or eliminating bacterial contamination on many food products. The process, although approved for pork and poultry, is still controversial. Scientists agree that products treated by irradiation are safe but opponents try to link food irradiation to cancer and say that more research is needed on potential harmful effects (Food & Water, Inc.). It is difficult to predict the effect of these contradictory messages on consumer behavior. A number of surveys (Bruhn; Schutz *et al.*; Malone Jr.; American Meat Institute;) and market trials (Bruhn and Noell; Giddings; Marcotte; Terry and Tabor), have found high levels of acceptability for irradiation among consumers. However, the major food companies, often under threat of boycott, have decided to forego on this technology. These experiments were designed to investigate whether perceptions of the positive effects (reduced pathogen risk) of the process would outweigh perceptions of the negative effects (the process itself).

The irradiation experiments were conducted at Iowa State University which has a food irradiation facility (linear accelerator) on campus. Participants were four groups of undergraduate students and two groups of adult subjects. There were two treatments: one in which subjects bid to upgrade to an irradiated pork sandwich (N=44, 29 students, 15 adults), and the other in which they bid to upgrade *from* irradiated pork *to* non-irradiated pork (N=44, 29 students, 15 adults). The structure of the experimental auctions was identical to those described above except that the pathogen of interest was *Trichina* in pork, and that the benefit was described as an elimination of the pathogen risk instead of a reduction. The information provided was as follows:

Trials 1-10:

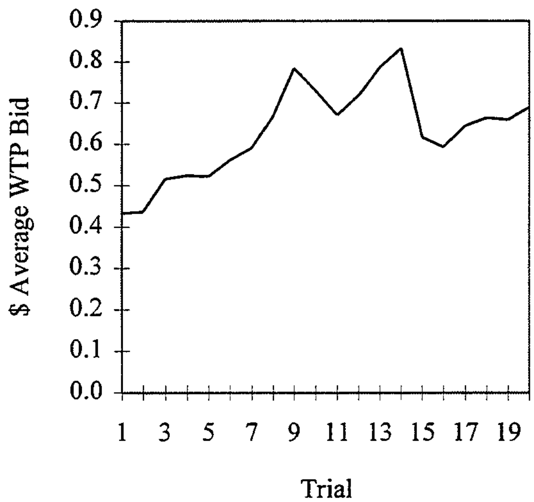
Type I: This is a typical pork sandwich. The pork in this sandwich has a typical chance of being contaminated with *Trichina.*

Type II: This pork in this sandwich has been treated by irradiation to control *Trichina.* Because of this treatment, we can guarantee that this pork will not cause Trichinosis.

Following trial 10, subjects were informed that the risk of contracting trichinosis from the Type I (typical) pork sandwich was approximately 1 in 2.6 million. They were also given a guided tour of the irradiation facility and provided with additional information about irradiation and a description of the symptoms of trichinosis.

Figure 4 shows the results of the experiments in which subjects bid for the irradiated pork. The average bid started at 44 cents and rose steadily over the first 9 trials. At trial 10, the average bid was 73 cents. The range of bids was very similar to that of the groups bidding for meat screened for *Salmonella*. In that group, the trial 10 mean bid was 66 cents.

Figure 4. Average willingness-to-pay to eliminate *Trichina* risk in pork using food irradiation (N=44; 29 students, 15 adults).



Following trial 10, the average bid fell but turned upwards again in trials 12 to 14. One of the groups did not receive information about the risk from the typical pork product until after trial 14. On receiving that information, their bids dropped considerably. Presentation of this information was delayed in order to separate the effects of information about irradiation and information about trichinosis. The mean bid in the final trial is 69 cents, almost identical to that recorded in the *E.coli* experiment described above.

Given the negative connotations associated with irradiation, it is interesting to look at the number of subjects who did not bid (bid zero) for the upgrade. Of the 44 subjects, 38 submitted positive bids for the irradiated product. Four of the zero bidders were adults, two were students. In a telephone survey conducted shortly after these experiments, 137 of 182 adults (75%) chose irradiated pork over non-irradiated given that choice. Thus, having 4 in a group of 15 preferring non-irradiated seems fairly representative of the larger population.

In the experiments in which subjects bid for the non-irradiated pork, a similar overall pattern emerged. Of 29 students, only five submitted bids to upgrade to non-irradiated pork, and all of these bids were under 15 cents. In the adult group, however, a surprisingly high number (11 of 15) bid for the non-irradiated pork, with some bids in excess of $2.00. Again, it is impossible to draw any general conclusions based on these sample sizes, but one can speculate that the students, many of whom were science and engineering majors, were more accepting of the technology given their training.

Conclusions

A number of experimental auctions have been described in which subjects bid their own money to exchange a typical meat product for one described as having a lower chance of causing a food borne illness. The participants treated the auctions seriously because they had to eat their endowed product or pay for an upgrade from personal funds.

When the risk reduction technology was unspecified, the average bids by undergraduate students for reductions in *Salmonella* and *E.coli* risk ranged between 70 and 90 cents per meal. Similar values were found for an elimination in *Trichina* risk from a mixed group of students and adults when the technology was identified as irradiation. Between 16 and 36 percent of subjects did not bid for or bid against the irradiated product, indicating a potential aversion to the technology. However, with close to 70 percent willing to pay a premium for irradiated products, the technology certainly seems viable. Cost estimates for commercial food irradiation are between 1 and 3 cents per pound (Morrison, 1989).

The realism introduced by using real food, real money, multiple trials, and market discipline is the principal advantage of the experimental method. In surveys or focus group studies, participants may provide a value before they have fully thought through the issue. Alternatively, participants may knowingly provide an incorrect value for strategic purposes or simply to please the interviewer. Such strategic behavior is costless in a survey; it may not be in an auction.

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