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## Food-safety economics: consumer health and welfare

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### Introduction

Eating offers pleasure at the risk of future pain. This truism holds today more than ever with our increasing ability to detect and identify food-borne illness. Well-publicized outbreaks of cholera, *Salmonella*, *Listeria monocytogenes*, and *E. Coli O157:H7* have made people aware that food-borne disease makes a lot of us sick every year. An estimated 76 million illnesses annually in the United States alone, with over 300,000 hospitalizations and 5,000 deaths, imposing an estimated cost in the tens of billions of dollars (Crutchfield et al. 1997; Mead et al. 1999). For example, Buzby and Roberts (Buzby and Roberts 1996) estimated that for six bacterial pathogens, the costs of human illness are estimated to be US\$ 9.3 - 12.9 billion annually. Of these costs, US\$ 2.9 - 6.7 billion are attributed to food-borne bacteria. One estimate suggests 1 out of 3 consumers in industrialized nations suffers from known and newly recognized food-borne diseases each year (*Food safety - a worldwide public health issue* 2000). And if one looks globally we might also note that: “hundreds of millions of people around the world fall sick as a result of consuming contaminated food and water.... Children under five still suffer an estimated 1.5 billion annual episodes of diarrhea, which result in more than three million premature deaths” (Brundtland 2001).

Many experts anticipate that the risks posed by food-borne disease will increase before they fall. Risks worsen as environmental and demographic conditions change. Sources of new risks include the climate, microbial systems, drinking-water supplies, sanitation, aging, urbanization, migration, consumption habits, tourism, and the mass production and international trade in food and feed (Kaferstein and Abdussalam 1999). The risks are prompting people to demand additional investment, both in the private and public sector, in processes and technologies that will continue to produce inexpensive food but with fewer food-borne risks (e.g., HACCP; irradiation, e.g. (Buzby and Roberts 1996; Lutter 1999; Unnevehr and Jensen 1999; Shogren et al. 1999). Policy experts stress the need to protect the vulnerable – infants and children, pregnant women, the undernourished, the elderly, and the immuno-compromised.

Policymakers in many developed nations have responded to these concerns by publicly committing to strengthen existing programs and to create new policies for safer food. In the United States for example, the Clinton Administration through Executive Order 13100 reinvigorated the question of food safety by introducing the President’s Food-safety Initiative (FSI) in 1997, and the President’s Council on Food Safety in 1998. The US\$ 43-million FSI program focused on reducing the number of illnesses caused by microbial contamination through improved identification and control, enhanced surveillance, and better risk communication and education (Miller and Altekruze 1998). The Council recently unveiled its 2001 Food-safety Strategic

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Plan, which promotes science-based systems, prevention, public participation, and setting priorities based on comparative risk analysis. Objective #5 of their plan explicitly calls attention to prioritizing efforts based on the risk-benefit trade-offs: “with limited resources and time, the scientific community must prioritize its efforts to realize its fullest potential. The most significant food-safety problems must be identified and addressed in a manner that enhances public health. Research must be focused and coordinated to avoid duplicative efforts and maximize its benefits” (*Food safety strategic plan 2001*).

Constrained budgets and increased fiscal accountability prevent a policymaker from reducing all food-borne risk to all individuals. Deciding which risks to reduce and by how much requires evaluation of each new or revised regulation. Comparability of value across all sectors of the economy requires that policymakers rank regulatory alternatives in terms of a common unit. Arguably, the most common denominator is money, or monetary equivalence. Risk valuation systematically evaluates each regulation by estimating the monetary value – both benefits and costs – of a reduction in risk from unsafe food. Herein we briefly explore issues in how rational people might value a reduction in risk from food-borne pathogens and other food technologies, and economic methods to measure this value.

### **Valuing the costs and benefits of risk**

Valuing the costs and benefits of reduced risk is formidable and controversial. While measuring the costs to control risk is relatively straightforward, the benefits are a challenge to quantify. Problems arise because goods associated with reduced risk – death and injury – remain unpriced by collective agency action. Stores and restaurants often do not like to market “safer food” because to do so would suggest that their food might otherwise be “unsafe”.

Valuing risk reductions requires that we value death and illness. These efforts give rise to the loaded term: “the value of life”. The idea of a monetary value of life, or more correctly the value of reduced mortality risk, raises more than a few eyebrows (Schelling 1984; Viscusi 1992). Ethical and moral beliefs often force a person to balk at the idea. But our everyday choices put a value on life, whether we explicitly quantify it or not. Whenever a policy change is enacted or whenever the status quo remains, life and limb are implicitly valued. For example, a North Carolina hospital once refused to spend US\$ 150 per healthcare worker for an inoculation against hepatitis B. Given the workers odds of catching the disease, the hospital had implicitly placed a relatively low value on life. Making explicit what we do implicitly provides information about the economic value of reduced statistical risk.

How do we value the welfare gains from a reduction in risk? Holding the level of self-protection constant, the traditional answer is that the value of risk reduction equals:

$$\text{Value of risk reduction} = \frac{\text{Willingness to pay for risk reduction}}{\text{Exogenous Change in risk}}.$$

Rational risk policy says that a person’s value for a risk reduction equals his or her maximum willingness to pay to increase the chances to stay healthy, conditional of his or her previous private actions to reduce risk. For example, suppose a person was willing to pay US\$ 6 to reduce the risk of death to 1 life in 1,000,000 from 4 lives in 1,000,000 – a 3 in 1 million-risk reduction. The value of life is then

$$\text{US\$ } 2,000,000 = \frac{\text{US\$ } 6 \cdot 1,000,000}{3}.$$

If the person is willing to pay US\$ 0.60, the implied value of life would be US\$ 200,000; if the person paid US\$ 60, the value is US\$ 20 million. This *ex ante* willingness to pay has been called the *option price*. The option price is the maximum a person is willing to pay that keeps him indifferent between the gamble and the next best alternative.

What methods exist to measure actually the value of risk reduction? The literature on rational risk valuation has developed two general approaches to measuring the economic benefits of reduced risk: the human-capital and willingness-to-pay approaches. *The human-capital approach* values risk reductions by examining a person's lifetime earnings and activities. The value of a risk reduction is the gain in future earning and consumption. The value of saving a life is often calculated as what the individual contributes to society through the net present value of future earnings and consumption. The human-capital approach has an advantage in that it is actuarial, i.e., it uses full age-specific accounting to evaluate risk reductions. A major drawback of the approach is that it assigns lower values to the lives of women and minorities, and zero value to retired individuals. The approach also lacks justification based on traditional economic welfare theory. For this reason, economists have downplayed the human-capital method in favor of the willingness-to-pay approach (Buzby et al. 1999).

Economists have advocated the *willingness-to-pay approach* since it is based on the theory of welfare economics. Welfare economics lays the foundation for estimating the value of risk reduction. People value risk reduction if it leads to a greater level of utility or welfare. The welfare change is measured by the maximum that the average person would be willing to pay to reduce risk or the minimum compensation he or she would be willing to accept for an increase in risk. Economists then use this willingness to pay or accept to estimate the implied value of life and limb. Although far from perfect, economists argue that the willingness-to-pay approach is preferable to the alternative – many believe it is better to have a rough estimate of a well-grounded theory than a precise estimate of a questionable one (Kuchler and Golan 1999). One can reveal this value indirectly by teasing out the implied willingness-to-pay values from real choices within market settings or one can directly estimate values by asking people what they would be willing to pay for a change in risk. See Freeman (Freeman 1993) for a good general overview on non-market valuation and see Caswell (Caswell 1995) for specific case studies using standard valuation methods for food-safety work.

One method we have developed over the last decade to value the willingness to pay for reductions in food-borne illness risk is experimental auction. Over a decade ago, Dermot Hayes, Sean Fox and I became interested in how consumers would react to food safety and new food technologies (Shogren et al. 1994; Shogren et al. 1999). We designed a series of laboratory experiments that asked people to reveal their preferences in a real auction in which they spent money and consumed the actual food products. We chose the lab approach to valuation after carefully considering and excusing the more standard methods. One alternative we considered was to use econometric techniques to tease out preferences from aggregated data collected for some other purpose. We decided that this method did not provide results we considered robust for our purpose since many of these new food products did not have

a market to generate the needed data. We needed to create our own market. A second alternative was to conduct actual test-marketing of the food in a retail store. Apart from the obvious cost of this exercise we were also concerned we would lose control of the scientific setting. We needed to keep control of the many attributes of the goods, their quantity and quality, and the flow of information so we knew exactly what attributes the participants were valuing. The final alternative we shelved was to survey consumers in person by mail or by phone. The absence of a reasonable reality check in these surveys, however, caused some concern that participants might respond in unrealistic and biased manner. We wanted people to make real economic commitments, albeit in a setting more stylized than a retail store (also see (Hoffman et al. 1993)).

After ten years of work, these experimental procedures have passed a critical test. We have learned things about consumer behavior and welfare gains toward food safety that would have been impossible to discover from any of the alternative procedures we might have used. This paper describes some of what we learned about consumer attitudes about food safety, and about what insight can and cannot be learned in consumer experiments in the lab.

## Food-borne Pathogens

*Participants underestimate the objective risk of food-borne pathogens, but experience with the market and information on probabilities of illness and death influence their final assessment and valuation of these risks.*

Evidence from laboratory auctions consistently suggests that people initially underestimate the risk of illness from food-borne pathogens (Hayes et al. 1995). In these auctions, participants indicated their willingness to pay to reduce the individual and combined risks of five different food-borne pathogens: *Campylobacter*, *Salmonella*, *Staphylococcus aureus*, *Trichinella spiralis*, and *Clostridium perfringens*.

Results generally indicate that people will pay significantly more for safer food after gaining auction experience and receiving the objective risk information. Figure 1 shows the average pre- and post-information bid by pathogen. People initially underestimated the risk associated with these pathogens, but adjusted upward their estimate after experience and objective information. Research suggests that marginal willingness to pay decreases as risk increases – indicating that people place more weight on their prior beliefs than on the objective information. While this general result appears to contradict the common finding that people overestimate the risks of low-probability events, the observation may be consistent with the broader interpretation that people underestimate extremely low levels of risk and overestimate less extreme low risks.

*Participants seem to possess general preferences and values for food safety – rather than pathogen-specific preferences.*

Since the risks from food-borne pathogens are relatively low compared to driving a car or other everyday activities, it is not completely surprising that the lab results suggest that people do not significantly differentiate pathogens when valuing food safety. In general, food-safety risks are relatively low on a daily basis and people might not distinguish between the risks posed by specific pathogens. If people do differentiate between specific pathogens, the values elicited for the combined risk from all pathogens should significantly differ from the values elicited for each individual pathogen. Results however suggest otherwise. Combined and pathogen-

specific values were similar whether the person was acting on his or her own subjective perception of risk or on the objective risk level provided by experts (see Figure 1). The general values arising from the laboratory auctions indicate that the average participant was willing to pay approximately US\$ 0.70 per meal for safer food. If one could transfer these values to the U.S. population, the value of food safety could be at least three times the largest previously available estimates. These participants had a significant demand for safer food, enough perhaps to justify the costs of current and future food-safety regulations.

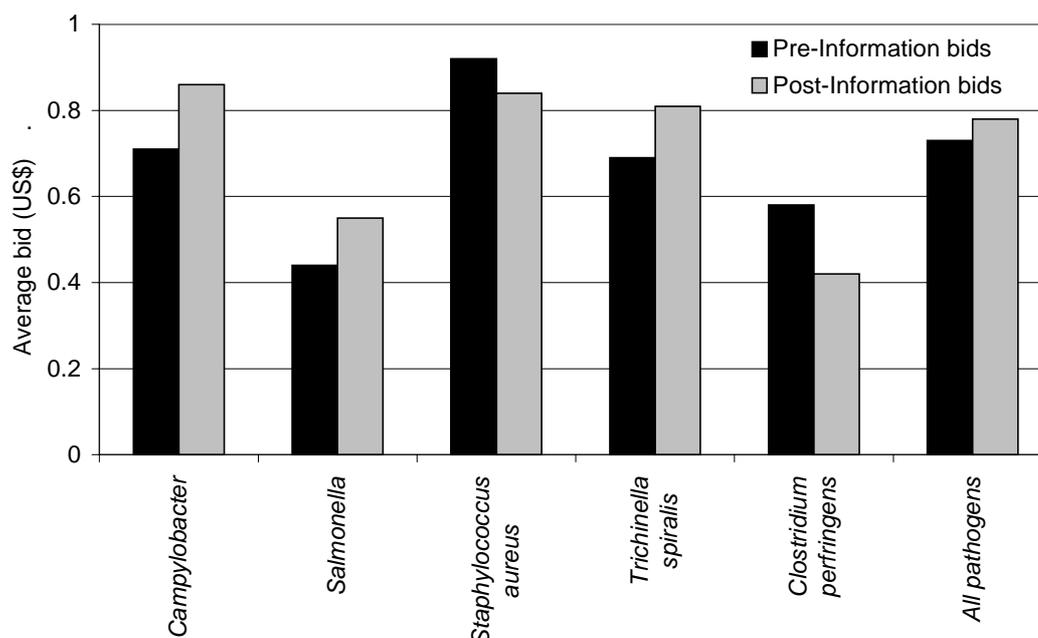


Figure 1. Average bid to exchange a risky sandwich for a less risky sandwich

*Participants were willing to pay a price premium for new food products that they had not tried before.*

But the US\$ 0.70 food-safety premium exceeded some experts' expectations of what people would pay in retail markets. One explanation might be the novelty of the experimental experience. The open question is whether the act of bidding in a lab auction in a unique lab environment might have inflated the demand for food safety. Lab auctions are usually a one-time experience, and the concern is that people might experiment with their bids, bidding high because the costs of doing so are low. Theory, however, suggests an alternative explanation for the high price premia – the novelty of the food product. Many bidders have never experienced the goods up for auction, e.g., irradiated meat. In this case, theory says that a bid should reflect two elements of value – the consumption value of the good and the information value of learning how the good fits into his or her preference set. This idea of preference learning would exist if people bid large amounts for a good because they wanted to learn about an unfamiliar good they had not previously consumed, because it was unique, or because it was unavailable in local stores.

We tested these competing explanations by auctioning off three goods that vary in familiarity – candy bars, mangos, and irradiated pork, in four consecutive experimental auctions over two weeks. Their results suggest that preference learning, not novelty of the lab, seems to explain some of the price premia. No statistical change in bids was measured for candy bars and mangos, whereas the price premia

for irradiated pork dropped by 50 percent over the four sessions. These findings suggest participants will pay a price premium for new products to learn how these goods might be an addition to their overall set of preferences. This suggests a premium of US\$ 0.35 per meal for safer food, an amount that still exceeds previous estimates.

## Growth Hormones

*Participants generally preferred low calorie hormone-treated pork to typical food, but a few consumers exhibit a strong and persistent aversion to hormone-treated food.*

Auctions in the lab suggest that genetically engineered, or hormone-treated, food products are acceptable to the majority of participants. Using a new experimental auction, we elicited the willingness to pay to consume (or avoid consuming) leaner pork due to genetically engineered growth enhancers (Buhr et al. 1993). The new auction is designed to separate the value of positive and negative attributes – the pros being leaner meat and the cons being hormone treatment. While results show the average participant will pay to avoid hormone treatments, he or she is also willing to pay a greater amount for the improved quality of the meat due to genetic engineering. Findings imply the typical participant has a positive net value for hormone-treated pork.

*Familiarity with new technology increases acceptance and this familiarity can be learned locally, or taught during the experiment.*

We used the lab auctions to examine consumer preferences for somatotropin, either PST in pork or BST in milk, in different regions in the United States: Iowa, Arkansas, Massachusetts, and California (Fox et al. 1994; Fox et al. 1995)). The results for the pork valuation auctions suggest that the average participant had a significant preference for the leaner pork yielded from the PST hormone treatment (Figure 2).

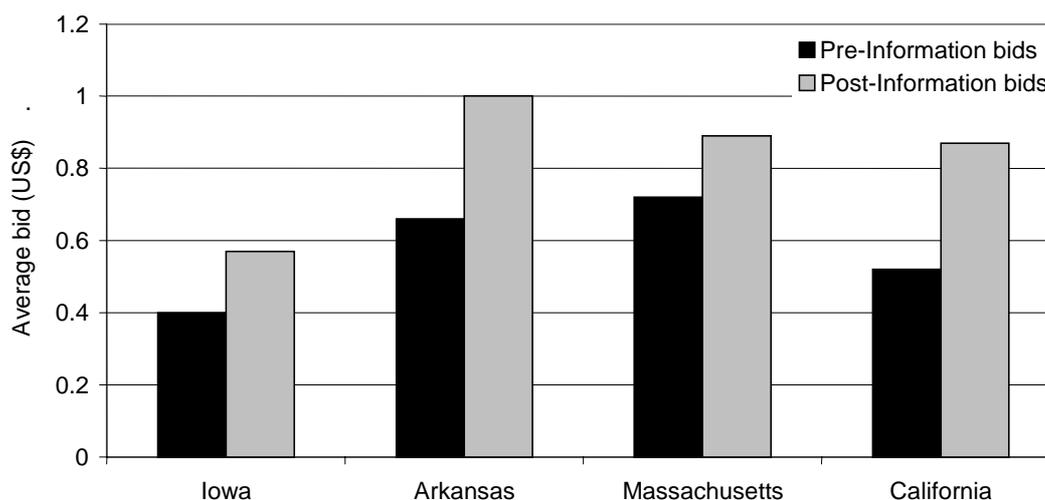


Figure 2. Average bid to exchange PST pork to NON-PST pork

We find similar results when eliciting consumer preferences for milk produced by cows treated with somatotropin. More than 60 percent of subjects indicated they

would be willing to buy hormone-produced milk at little or no discount (see Figure 3). Two additional results emerge. First, preferences for hormone-treated products increased significantly as people became more informed about the treatment process. Second, rural Californians were very familiar with the technology and were willing to try it. Urban Californians, however, knew little about the technology, but they quickly accepted and valued the process once it was explained.

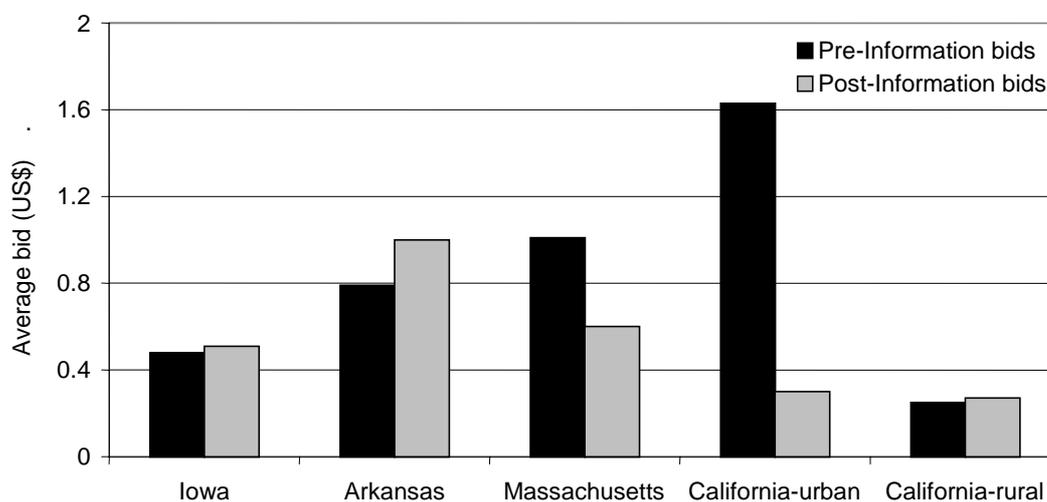


Figure 3. Average bid to exchange BST milk for NON-BST milk

## Irradiation

*Irradiation appears to be acceptable. Most participants were willing to pay a premium for irradiated food. Laboratory auctions indicate that participants are not averse to using irradiation as a risk-reduction technology.*

For a comparative baseline, we used the lab auctions to elicit participant willingness to pay for safer chicken breasts without disclosing the risk-reduction technology. We then compared these baseline results to equivalent auctions in which the technology was disclosed to be irradiation with standard USDA information. Consumer willingness to pay was statistically equal in each case – approximately US\$ 0.80 per chicken breast. We also observed that nearly 80 percent of the laboratory consumers preferred the irradiated chicken to the non-irradiated chicken if it was available for the same price (Shogren et al. 1999). Thirty percent of the consumers were willing to pay a 10-percent premium for the irradiated chicken, and twenty percent were willing to pay a 20-percent premium (Figure 4). Results, therefore, strongly suggest that irradiation is an acceptable risk-reduction technology to informed consumers and estimates of willingness to pay for irradiation more than covers the cost of commercial-scale implementation.

*Negative reports concerning irradiation had a larger impact on participant preference and values than positive reports – even when the negative reports were unscientific.*

Some of the results we found were puzzling. Our participants in the lab appear to be very accepting of new technologies, whereas the average American is not. The key to this conundrum is that our experimental design controlled the flow of information about irradiation, and in most cases, our formal descriptions of the new technology

suggested that the process was safe and beneficial. The lab allowed us to address this issue directly, and one of our most surprising results came about when we experimented with negative descriptions taken from activist groups.

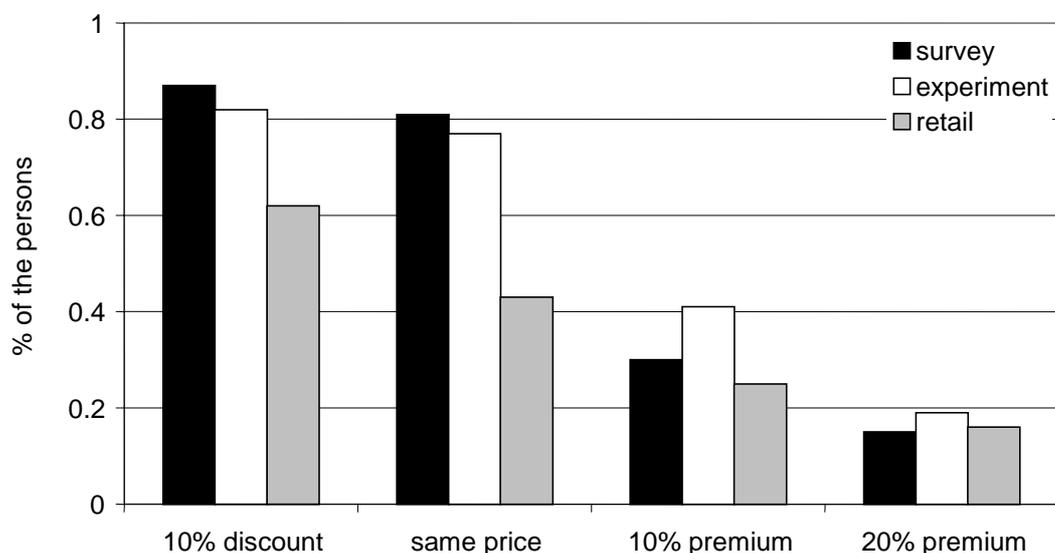


Figure 4. Percentage of persons who said 'yes' to stated price for irradiated chicken

In this set of auctions, we examined how consumer willingness to pay for safer pork sandwiches was affected by alternative descriptions of food irradiation (Fox, Hayes and Shogren 2002). Results follow intuition with favorable description of irradiation increasing willingness to pay and unfavorable descriptions decreasing willingness to pay. But when presented with both a favorable and an unfavorable description, the participants acted as if they had read only the negative information – indicating that the negative portrayal dominated the positive (see Figure 5).

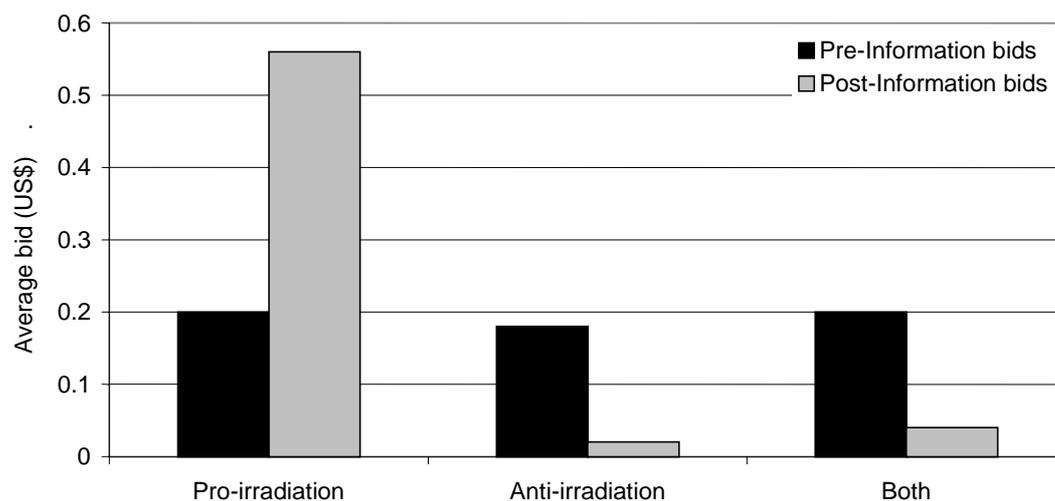


Figure 5. Average bid to exchange meat for irradiated meat before and after information

This relative impact of the unfavorable description was evident even when the negative representation was a non-scientific account written by a consumer advocacy group. This result illustrates the incentive that partisan groups have to promote

unscientific claims to advance an agenda that yields possible loss in general social welfare. It is always possible to describe a new food process in a way that suggests that it is unsafe. For example, one can make the statement that “scientists cannot be 100% sure this food does not cause cancer” about any food or food process. Our experimental work convinced us that when the media give equal billing to those who are prepared to make this kind of statement, public opinion can quickly turn against the food or food process. This result has immediate relevance to the ongoing debate about genetically modified foods. Negative information dominates, and it then becomes a question of whether a neutral third party exists to supply verifiable information written by concerned but neutral interests.

## Concluding remarks

Consumers value safer food. Understanding how they value less risk from food requires tools that can isolate food quality and quantity from food-borne risks. We have reviewed how experimental methods can be used as a tool to isolate and control the market setting to address specific questions on how people value new and controversial food products. One example stands out – when faced with both positive and negative information about new food technologies, participants reacted as if they had received only negative information. They seemed to react to only the bad news, irrespective of the source. We have also learned that limits exist to what can be achieved with lab experiments for valuation work. We had hoped to collect refined information about the value of reductions in individual pathogens, but we discovered that we could detect only general preferences about food safety. We found that subtle changes in the experimental procedure such as whether we paid the participants ahead of time, the choice of auction, asked for willingness to pay or willingness to accept, or posted market-clearing prices could significantly impact the results. Finally, we discovered that bids for new foods or food processes could be unrealistically high when participants viewed them as a novelty. But despite these limits, our experience leads us to conclude that over time as designs are refined, improved reality-based consumer experiments will become an increasingly important method for applied economists interested in the demand side of food safety.

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