Test Marketing New Food Products Using a Multitrial Nonhypothetical Experimental Auction

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ABSTRACT

A nonhypothetical experimental auction is used to replicate point-of-purchase decisions made by consumers encountering new food products in retail stores. Several applications of the procedure are discussed, with emphasis on the case-specific adjustments required to make the auction work. Participants in the experiments paid their own money to consume or avoid consuming livestock products produced with four yet-to-be-commercialized technologies. The results show promise for widespread adoption of nonhypothetical auctions for evaluating new food products prior to test marketing.

Much of the existing literature on experimental economics is confined to testing the validity of economic theory and valuing nonmarket goods in hypothetical situations (see Plott, 1989; V. L. Smith, 1982). The auction process described in this article has much broader

potential in that it can be used to elicit honest and well-thought-out opinions and values about market goods in marketlike situations. Experiments can be used to evaluate the behavior of consumers faced with a realistic trade-off between money and consumption within the confines of a reproducible and objective setting (see Bohm, 1984; Hoffman, Menkhaus, Chakravarti, Field, & Whipple, 1993). This combination of attributes has implications for new product marketing, some of the more interesting of which are discussed in this article.

The article describes an experimental design that comes close to replicating the decision-making process undergone by consumers faced with new food products in retail stores. We developed this process to test market some new food products under circumstances in which it was not feasible to conduct more traditional new-product evaluations.[1] The advantage of our approach is that it is more realistic than surveys, taste panels, or focus groups and less expensive than a new-product launch. We view the process as a substitute for focus group studies and as a way of evaluating new products before actual test marketing begins.

The first section of this article describes the auction process. The second section discusses some of the marketing issues we faced during this research and the ways in which we adapted the auction procedure to deal with these issues. Finally, the article explores additional uses of nonhypothetical experimental auctions in new product marketing.

THE MULTITRIAL VICKERY AUCTION

The auctions used in the experiments discussed in this article are based on a second price auction mechanism (Vickery, 1961) and were conducted as follows. Adult participants were chosen at random from a representative sample. After answering several questions over the telephone, participants were invited to attend an auction. Each participant was offered between $15 and $30 (depending on the experiment) and a free lunch. The financial incentive was used to attract a broad range of participants. The auctions took place in a taste panel room with a fully fitted kitchen and with tables that were partitioned to discourage communication among participants. The size of the room limited group size to 15 participants.

The auctions began with a test run in which we endowed participants with a Mars™ candy bar and asked them to bid to upgrade to a Snickers™ candy bar (or vice versa).[2] For this test run, we asked each

[1]None of the products we evaluated had been commercially launched, and we did not have sufficient funds to pay for packaging approvals and small-scale commercial production.

[2]During the course of the pre-trial work, we discovered that it was important to provide subjects with a product that was similar to the one on offer and then to ask them to bid to upgrade to the newer or improved product. In pretrials where we did not endow participants with a similar product, we found it impossible to separate out the value of the upgrade from the value of the product itself.

of the participants to tender an offer to upgrade their candy bar and explained that they would have five opportunities to do so. The monitor collected the sealed bids and announced the control numbers of both the highest bidder and the second-highest bidder. Because the winning bidder pays only the second-highest bid in a Vickery auction, there is nothing to be gained from strategic bidding. Bidding less than one's true value only reduces the probability of winning at what otherwise may have been a fair price. Bidding more than one's true value increases the chance of winning, but at a price that is higher than one's true value (Shogren, Fox, Hayes, & Kliebenstein, 1994; Shogren, Shin, Hayes, & Kliebenstein, 1994).

In all the experiments, the participants were required to eat the product they ended up with. The monitor announced that only one trial would be binding and that the binding trial would be chosen randomly at the end of the auction. This eliminated wealth effects (i.e., changes in bids caused by winning an earlier trial). Once the binding trial was determined, the winning bidder of that trial paid the second-highest price and consumed the upgraded product. The other participants consumed the product they were originally given.

We conducted multiple bidding trials at all the auctions. We used five bidding trials for the candy bar and 10 or 20 trials for the test products. In theory, a single-shot Vickery auction should cause participants to reveal their true value, but we found that this was not the case. Many of the test products we auctioned were products such as irradiated (safer) pork, about which participants had yet to make up their minds. The purpose of the multiple trials was to give the participants time to discover for themselves what they thought about these products. By revealing the second-highest price from the previous auction, we allowed the participants to discover how the market felt about the test product and to gain an indication of what it would take to win the next bidding trial.

By revealing the second-highest price, we also imposed market discipline. Participants who bid low in the hope of getting good value were given an incentive to increase their bids, whereas those who bid low because they did not value the upgrade had no incentive to change their bids. The realism introduced by using real food, real money, multiple trials, and market discipline is the principal advantage of this procedure. 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. Another advantage of the auction over focus group studies is that the auction eliminates the possibility of one or two individuals or discussion points dominating the results.

The test product experiments were identical to the candy bar experiments with one minor exception. In the test product experiments, we

usually incorporated an information shock to evaluate how different labels or product descriptions would influence bids. Typically, we allowed 5 or 10 bidding trials, introduced the information, and conducted 5 or 10 more trials.

The information shock was presented in several different forms. Sometimes we simply told participants more about the upgrade (e.g., that the upgrade was safe, unsafe, or approved by the Food and Drug Administration). In one set of experiments, the participants were given a tour of the lab in which the product was made. In another set of experiments, we presented information with the use of favorable and unfavorable written descriptions (together and separately).

At the conclusion of each experiment, the subjects completed a questionnaire that updated us on their attitudes toward the test product.

RESULTS

We focused our experiments on new food products. These included milk from cows treated with bovine somatotropin (bST), a biotechnological replicate of a naturally occurring hormone that increases milk yields in cows; pork from pigs treated with porcine somatotropin (pST), a product that increases feed efficiency in pigs and reduces the fat content of the pork; *Salmonella*-free poultry (chicken) meat; and irradiated trichinella-free pork. Funding restrictions limited the number of participants per product to 100–200, and experiments were conducted on a regional basis for three of the four products.

pST Pork

The pork used in these experiments was harvested from pigs injected with pST, a relatively new product of the biotechnology industry. pST pork has 30%–60% fewer calories and is 10%–20% leaner than pork from untreated animals. To many, this product has both negative and positive attributes, and initially we were unsure how to structure the auction (to date, we have not permitted negative bids). To solve this problem, the participants were randomly split into two groups. Participants in one group bid to upgrade *to* pST pork, and participants in the second group bid to upgrade *away from* pST pork.[3] The instruc-

[3]Note that the change in reference points in this split-valuation technique facilitates an investigation of framing effects as described by Tversky and Kahneman (1981). They note that "shifts of reference can change the value difference between outcomes and thereby reverse the preference order between outcomes." Earlier versions of the split-valuation experiments did, in fact, produce the types of inconsistencies associated with framing effects—that is, average bids were similar in both treatments. However, some features of these experiments conditioned subjects to submit positive bids, and when these artifacts were eliminated the inconsistencies disappeared. See Buhr et al. (1993) for a full discussion of these effects. In the experiment reported here, 13 of 15 participants bid zero to upgrade away from pST pork and 2 of 14 bid zero to upgrade to pST pork. This pattern provides no evidence to support a framing effect.

tions for the experiment in which participants bid to upgrade to pST pork are shown in Table 1. After 10 trials, we described the growth enhancer as shown in Table 2.

The results of the pST pork experiment are shown in Figure 1. (A full description of this experiment can be found in Buhr, Hayes, Shogren, & Kliebenstein, 1993.) The upper line in Figure 1 shows the average bids to upgrade to a pST pork sandwich and the lower line

Table 1. Instructions for Trials 1–10 in Experiment To Bid To Upgrade to pST Pork.

GENERAL INSTRUCTIONS

You are about to participate in an experiment about decision making. Please follow the instructions carefully.

SPECIFIC INSTRUCTIONS

In this experiment you will be asked to decide how much you would be willing to pay for leaner meat. The experiment has two stages.

Your starting income will be $3 in stage one. Your income will be $15 for stage two. Your take-home income will consist of your initial income ($3 + $15) minus the value of goods purchased.

You will submit your bidding price on a recording card. Note only one of the five trials in stage one will be binding and only one of the 20 trials in stage two will be binding (i.e., determine actual take-home pay). A number will be randomly selected to identify these binding trials.

You can not reveal your bids to any other participant. Any communication between bidders during a trial will result in an automatic penalty of $3.

Step 1. There are two types of meat. The features of each are described below.

Product I	**Product II**
This meat is typical of meat currently available at restaurants and grocery stores.	This meat is 10–20% leaner and contains 30–60% fewer calories than Product I meat. It was produced by animals treated with a growth enhancer.

Step 2. You own the **Product I** meat in front of you. Everyone has the same **Product I** meat. You also have an initial income of $15.

Step 3. Let's say you are willing to pay $y for the Product I meat and $z for the **Product II** meat. The *difference* ($z − $y) is what you are willing to pay to consume the **Product II** meat. Please indicate your willingness to pay to consume **Product II** meat. Only state the difference ($z − $y) that you are willing to pay. The highest bidder will exchange his/her **Product I** meat for the **Product II** meat. He/she will pay *the second-highest bidder's price.*

Step 4. There will be 20 trials.

Step 5. After all 20 trials are complete, we will randomly select *one* binding trial to determine who buys the **Product II** meat.

Step 6. The meat will have to be consumed to leave with the take-home income.

Table 2. Instructions for Trials 11–20 in Experiment To Bid To Upgrade to pST Pork.

Instructions for Trials 11–20

Product I

This meat is typical of meat currently available at restaurants and grocery stores.

Product II

This meat is 10–20% leaner and contains 30–60% fewer calories than Product I meat. It was produced by animals treated with a growth enhancer.

Description of Growth Enhancer:

The growth enhancer administered to the animals is known as a somatotropin. It has the effect of not only increasing daily gain and improving feed efficiency, but also increases the amount of lean meat produced and reduces the amount of fat produced. This is referred to as a partitioning effect of nutrients. Scientists assure us that other than the lean/fat changes, the composition of meat produced by treated animals is unchanged. Further studies have shown that there is no change in the taste, tenderness, or palatability characteristics of the meat.

shows the average bids (from a different set of participants) to upgrade away from a pST pork sandwich.

Several observations can be made. First, the bids to upgrade to a pST pork sandwich were relatively high. This effect may be due to the leanness induced by pST or to the fact that participants wanted to taste this product, which is not yet available in grocery stores. Also interesting is the reduction in bids to upgrade away from the pST pork

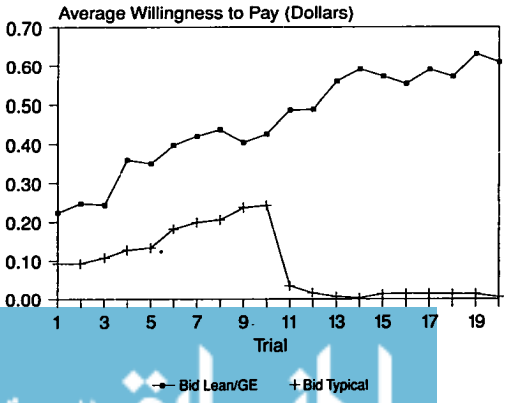

Figure 1 Squares, bid lean/GE; plus signs, bid typical.

sandwich once the participants received a more detailed description of the grown enhancer.

Based on this experiment, we can conclude that many consumers encountering pST pork in a grocery store for the first time would purchase it at a small premium. We are currently unable to tell how much of this premium is a new-product effect and how much is a leanness effect. To help make this determination, we plan to conduct a series of experiments with participants who have tasted pST pork in previous experiments.

bST Milk

The purpose of the experiments involving bST milk differed somewhat from the pST pork experiments in that there is no improvement in product quality as a result of using bST to offset any negative connotations associated with biotechnology or perceptions about violating animal rights. bST milk is also further along in the marketing channel than is pST pork, and the product name is already being used on milk cartons (e.g., labeling milk as "bST free") and in the media (e.g., Ben & Jerry's "stop bST" campaign) (United Press International, 1989).

The purpose of this series of experiments was to determine (a) the overall acceptability of the product, both before and after information about the hormone bST was provided to participants, and (b) whether the required discount, if any, to entice consumers to purchase bST milk would be large enough to offset the decrease in production costs associated with a 10%–25% increase in milk yields.

The preexisting media exposure associated with bST also meant that we would encounter strong opinions even before we provided additional information about bST after bidding Trial 10. Our sense was that the negative media exposure would be more apparent in urban areas than in rural areas. We were particularly interested in urban areas in the Northeast, where the anti-bST theme was strongest. We arbitrarily decided to conduct experiments in Berkeley, California (urban), Davis, California (rural/urban), Iowa (rural), Massachusetts (urban), and Arkansas (rural). A full description of the experiments is available in Fox, Hayes, Kliebenstein, and Shogren (1994).

For this experiment, participants were endowed with a glass of bST milk and asked to bid for a more typical glass of milk. The following information was provided after Trial 10:

> Bovine somatotropin is a protein produced in the pituitary gland of a dairy cow that regulates and stimulates milk production. Through advances in genetic engineering, synthetic bST can now be manufactured using recombinant DNA technology. The bST is injected into cows to increase milk yields. The frequency of these injections may range from once a day to once every 14 to 28 days.

Dairy cows treated with artificial bST have produced from 10% to 25% more milk in experimental trials. They have also shown an increase in feeding efficiency. The amount of bST in milk from treated cows has not been shown to differ from that found naturally in milk. However, there is concern by some people that too little research has been conducted to ensure the safety of milk and dairy products from cows treated with bST. Bovine somatotropin is currently under regulatory review and is expected to be approved soon by the Food and Drug Administration.

The results from the bST milk experiments are shown in Figure 2. Opposition to the product was initially highest among the Berkeley, California, group, but the information provided after Trial 10 had a surprisingly large calming effect. Our pre-trial interviews indicated that this group had the least prior information of any group and our information was the only information any of the participants had encountered. The Massachusetts results are in direct contrast to the Berkeley results in that the information presented after Trial 10 had little effect on the bids from the Massachusetts participants. This group came in with a firm anti-bST bias, and they retained this bias throughout the auction. More than 50% of this group bid more than $1.00 to avoid consuming the bST milk, and they showed little interest in information that the Food and Drug Administration was about to approve the product. From these results, we inferred that the Northeast would probably not be a good location to test market bST milk and that a pro-bST advertising campaign might be insufficient to dislodge existing biases in that region.

The results from Davis, California, were a surprise in that approximately 75% of the participants bid zero to upgrade from bST milk to

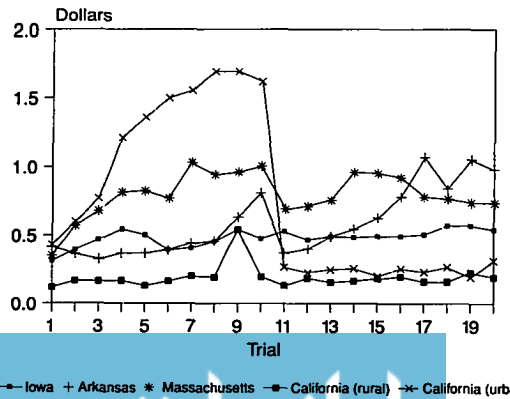

Figure 2 Small squares, Iowa; plus signs, Arkansas; asterisks, Massachusetts; large squares, California (rural); crosses, California (urban)

the more typical milk. In hindsight, these results make sense. Davis is located near the agricultural center of the number one U.S. dairy state and the Davis participants all had ties with a land-grant research university.

Our results are intriguing in that they show that about 60% of the respondents would not require a discount to purchase bST milk. This suggests a much higher level of acceptability than surveys on the issue (see B. J. Smith & Warland, 1992, for a review). We also concluded that if bST milk became available nationally, a profitable market niche would emerge for bST-free milk. We did this work early in 1993, and it has been interesting to observe the growth in the bST-free milk market during the past 18 months since the widespread adoption of bST by dairy farmers.

Salmonella-Free Chicken

It is relatively easy to eliminate *Salmonella* by proper cooking; yet the Center for Disease Control and Prevention estimates that there are about two million outbreaks of food-borne salmonelloses per year (Bennett, Holmberg, Rogers, & Solomon, 1987; Hayes, Shogren, Shin, & Kliebenstein, 1995). The existing mechanism for controlling *Salmonella* is educating consumers on the proper handling of meat. This method implicitly acknowledges that *Salmonella* exists in some meats purchased at retail stores.

At least three alternatives exist to the current U.S. practice. In Sweden, *Salmonella* has been eliminated at the farm level; thus, it does not enter the food chain. Alternatively, one could reduce cross-carcass contamination at poultry slaughter plants or treat carcasses with an electron beam. All three alternatives are expensive, and none can provide an absolute guarantee of safety.

We were interested in (a) how much consumers would pay for a one-log reduction in *Salmonella* contamination and (b) how much consumers would pay (per meal) for a guarantee that the food was completely safe. To satisfy objective (a), participants bid to avoid eating poultry with different levels of *Salmonella* (expressed in terms of the probability that the participants would get sick). For objective (b), participants bid to upgrade from a typical restaurant-purchased chicken sandwich to a sterile chicken sandwich. Because some participants had strong feelings about eating some of the highly contaminated products, we also ran a series of experiments in which we endowed participants with a safe sandwich and asked them how much it would take to get them to eat a less safe sandwich. The results of these experiments are discussed in detail in Shogren, Fox, et al. (1994); Shogren, Shin, et al. (1994); and Hayes et al. (1995).

Figure 3 shows one of the more interesting results. For each one-log reduction in *Salmonella* infection, participants were willing to pay

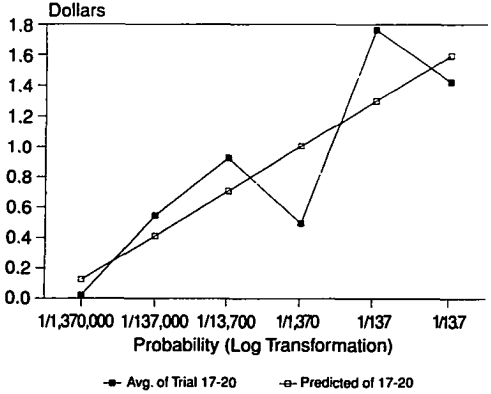

Figure 3 Closed squares, Average of Trials 17–20; open squares predicted of trials 17–20.

approximately 30¢. This result allowed us to place a value on the existing U.S. food safety system (vs. countries with lower safety standards) and to estimate the value of specific improvements to the system. We also discovered that participants would pay 70¢ more for a meal that was guaranteed safe than for the existing restaurant product. This value seems large until one realizes how important perceptions about hygiene can be when choosing a restaurant.

We extended these experiments to four other pathogens. We discovered that the instrument was too blunt to place a value on eliminating or controlling specific pathogens. This finding suggests that participants in the *Salmonella* experiments were bidding on safer chicken, not on *Salmonella*-free chicken. The participants appeared to have reached the (correct) conclusion that the methods we used to reduce *Salmonella* also control other pathogens on the meat.

Irradiated Trichinella-Free Pork

We have access to a meat irradiator that can kill or sterilize all known pathogens. However, the irradiation process, although approved for pork and poultry, is still controversial. We were interested in whether perceptions of the positive effects (safer food) of the process would outweigh perceptions of the negative effects (the process itself). We were also interested in how different descriptions of irradiation would influence the bidding activity and whether people would respond differently in a hypothetical telephone survey than in the auction. These experiments are described in detail in Fox, Shogren, Hayes, & Kliebenstein (1994a, 1994b).

The results of the experiments show that most participants perceive

that the positive effects outweigh the negative effects of the irradiation process. As might be expected, we also discovered that participants exposed to a negative, though accurate, description bid less for the irradiated meal than did participants exposed to a positive accurate description. An important result showed that when participants were given both positive and negative descriptions, the negative description completely dominated, despite information that the irradiation process is approved by the Food and Drug Administration and that the source of the negative description was a consumer advocacy group.[4] Finally, when we compared bids in the hypothetical pre-experiment survey with bids from the auction experiment, we discovered that participants who favored the irradiated product reduced their bids by approximately 10%, whereas participants who expressed a dislike for irradiation reduced their bids by about 50%.[5]

Table 3 shows the summarized information from all of the experiments described above. It is interesting to note the similarity between the bST (line 1) and pST (line 2) results. Also interesting are the relatively large bids for the leaner pork. This is something we have seen in other experiments; reducing the fat content of food without altering its flavor seems to be the most valuable thing that the food industry can do to increase acceptability of its products.

OTHER POSSIBLE APPLICATIONS

The relevance of the previous discussion for the purposes of this article is that the experiments worked. The structure of the Vickery auction was easily adapted to suit the purpose of each experiment, and the participants quickly understood the auction process and bid in a reasonable and understandable way. It became obvious during the experiments that the bids were the product of serious thought. The participants treated the auctions seriously because they had to eat the product or the alternative and pay the bid amount from personal funds. Also, the length of time involved in each auction allowed market discipline to work and gave participants time to make up their minds and absorb information.

The auctions are designed such that neither the organizers of the

[4]See Viscusi and Magat (1987) for a discussion on the framing of information and consumer responses to risk information.

[5]There was a noticeable absence of very large bids in the auction experiments. For example, during a pre-experiment telephone interview one participant said that she would pay $20 extra per meal to avoid eating an irradiated meal. In the auction experiment, this participant's bid fell to 50¢. This effect appeared in all the trials where we replicated the telephone survey/auction experiment process (see Fox, Shogren, Hayes, & Kliebenstein, 1994b). In all cases, the variance of the bids declined dramatically in the auction. Because very large bids can influence averages, we noticed a much greater similarity between the median and average bids in the auction experiments than in the telephone survey.

Table 3. Summary of Bids in Experimental Auctions.

Auctioned Product	Number of Bidders	Trial No. 1	Pre-Info Trial	Post-Info Trial	Final Trial
Regular milk (from bST milk)	75	0.32 (0.53)	0.82 (1.13)	0.40 (0.77)	0.55 (0.96)
Regular pork (from pST pork)	58	0.34 (0.47)	0.82 (1.02)	0.49 (0.76)	0.58 (0.91)
Lean (pST) pork (from regular pork)	56	0.31 (0.40)	0.57 (0.52)	0.65 (0.52)	0.83 (0.70)
Irradiated pork I (positive description)	18	0.27 (0.46)	0.21 (0.26)	0.34 (0.32)	0.56 (0.68)
Irradiated pork II (negative description)	19	0.22 (0.25)	0.15 (0.22)	0.03 (0.09)	0.02 (0.07)
Irradiated pork III (pos. & neg. descriptions)	50	0.26 (0.36)	0.32 (0.39)	0.20 (0.36)	0.19 (0.40)

Note: Table entries are mean bid in dollars and standard deviation.

auctions nor the participants can inject their personal bias (other than through the market) into the results, and the process is reproducible and verifiable. We recruited some participants at the meat counter of a local grocery store and see no reason why we could not conduct the experiments within or close to a retail store. The variable cost per participant was between $30 and $60, which is double that of a survey and about equal to that of a focus group study. This cost is well within the range that companies in the process of developing new products can afford.

HOW A PRACTITIONER OF MARKETING CAN USE THIS METHOD

Suppose a marketing manager wants to, evaluate the viability of a new product, measure the premium (or discount) at which it could be sold, or see how different product labels and advertisements would influence the product's premium or acceptability. Suppose also that funds are not available to introduce the product into test supermarkets, and that the manager needs more concrete evidence than can be achieved from a telephone survey. We suggest the following solution. First, gather some in-store consumers with the use of some inducement of the manager's choosing. Show them how a second price auction works. (Note that this second price concept is extremely important because it tells you *each* person's true willingness to pay, whereas first price auctions tell you only the maximum that one person will pay.) Then introduce some test samples of the product in as close to final form as is technically and financially possible.

If one wants to measure the premium (or discount) over existing products then endow participants with a typical version and ask them to bid or to trade upwards for the improved product. Alternatively, if one is interested only in overall acceptability, have the consumers bid the full amount (i.e., do not give them a typical product).

After about five rounds of bidding one can introduce information. This may be a taste test, a detailed product description, a product label, or a video of a proposed television ad. Then have participants continue for five more rounds of bidding. Changes in bidding after the information shock will allow inferences to be made about the information itself. Once the experiment is over, we suggest that a competent statistician be employed to make sure that any inferences drawn are in fact statistically significant.

Perhaps one of the most promising applications of this process is to prescreen new products on a regional or national basis before the products are commercialized. Companies could also use a labeling or information shock component to evaluate different advertising or promotional measures. The auction bids could be used to decide on

premiums for new products (or acceptable discounts on less preferred alternatives).

The goods we examined were all in the public domain; however, the process would work at least as well with privately developed products. One option would be to endow participants with a case of an existing product (to take home), have them taste both the new and existing products, and bid to upgrade the existing product. The average bid might indicate a reasonable premium that could be charged for the new (upgraded) product, and the distribution of bids would indicate the proportion who thought the improvement was worthwhile.

Also, the opportunity to conduct this type of experiment on a regional basis could be utilized in commercial applications. For the experiments described in this article, the only thing that changed across regions was the participants; we used the same incentives, instructions, and monitors in all the experiments. To further this research, we plan to conduct experiments to determine the acceptability of hormone-treated meat products in the United States and in Europe. (The European Union bans the use of artificial growth promotants in domestic livestock; the United States does not.) This type of regional experimentation could provide direction on where and possibly when to test market new products, as well as on how representative test market results are.

The greatest test for this work has yet to come. Eventually, experimental economics will be used to set price premiums and launch new products. Once this occurs, the market will decide on the accuracy of this auction technique. If experimental economics can pass this ultimate test, the technique will compete very effectively with surveys and focus group studies and could become more important than either alternative in terms of dollars spent on market intelligence.

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