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Consumer Demand for Potato Products and Willingness-to-Pay for Low-Acrylamide, Sulfite-Free Fresh Potatoes and Dices: Evidence from Lab Auctions

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We assess consumer demand for traditional fresh potatoes and processed potato products and willingness to pay for new experimental low-acrylamide and sulfite-free potato products. Demand for fresh potatoes, potato chips, and fries is unaffected by household income or education, but demand for chips and fries is affected by consumer age and exercise habits. Subjects display increased willingness to pay for new potato products after receiving a private company perspective about the technology and risks associated with exposure to acrylamide, a carcinogen, in fried conventional potatoes and a new product, potato dices. We find that consumers are willing to pay for enhanced food safety in fresh potato products achieved using biotechnology.

Key words: consumer-oriented GMOs, experimental auctions, food labels, fresh-cut potato dices, information effects, low-acrylamide potatoes, potato products, sulfite free, willingness-to-pay

Introduction

White potatoes remain a key vegetable in the American diet, whether consumed boiled, steamed, baked, or as hash browns, French fries, and potato chips. Per capita consumption of white potatoes in 2013 was approximately 115 lbs per year, about the same as in 1980, but the share going to processed foods increased from 53% to 69% during that time. However, since some of the potato is lost to waste during processing, per capita consumption of white potatoes has actually declined over this period (Rasmussen, Latulippe, and Yaktine, 2015). Richards, Kagan, and Gao (1997) summarize factors affecting the aggregate demand for potatoes, but very limited up-to-date research exists on factors that affect individual household demand for fresh or processed potatoes in the United States.

In 2002, acrylamide was first identified in starchy foods cooked at high temperatures (Tareke et al., 2002), including high-temperature cooking of traditional white potatoes, such as frying, baking, or roasting to make French fries, hash browns, and chips.[1] Acrylamide occurs naturally when the amino acid asparagine and reducing sugars (fructose and glucose) are heated to above 250°F, as in frying, baking, and roasting. Once formed, acrylamide is a stable compound. The Maillard reaction, which produces acrylamide, also produces the dark-colored pigments or browning

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[1] Acrylamide does not exist in fresh, boiled, or steamed potatoes.

of French fries, chips, and hash browns (Bethke and Bussan, 2013). In general, the acrylamide content rises as these pigments darken. In addition, retail fresh-cut white potatoes are treated with sodium bisulfite to retard bruising and blackening when exposed to oxygen.

Both acrylamide and sulfites raise food safety concerns. Based largely on animal studies, acrylamide is a neuro-toxin and potential carcinogen in humans (Bethke and Bussan, 2013). Moreover, as a result of a broad 2005 lawsuit brought by the State of California under Proposition 65 against the U.S. potato industry, many California restaurants are required to post signs that potato products that have browned in the cooking process contain acrylamide, a cancer-causing agent (California Office of Environmental Health Hazard Assessment, 2014). In addition, the U.S. potato industry has a mandate to largely eliminate acrylamide from potato products sold in California (California Department of Justice, 2008) and is working to lower acrylamide formation in processed potato products. Sodium bisulfite is a controversial preservative because some people are allergic to sulfides (Rangan, 2010).

Biotech methods have been used to eliminate these two health risks in white potatoes.[2] Changes in potato growing and storage practices and conventional breeding of potatoes have been unsuccessful in significantly reducing acrylamide content in high-temperature cooked potato products or darkening of fresh-cut potatoes. However, scientists have successfully used genetic engineering to significantly reduce acrylamide formation in potato products (Bethke and Bussan, 2013). In addition, the new low-acrylamide potatoes have the advantage of low bruising and blackening when cut, which reduces potato waste associated with manufacturing processed potato products. As a result, treatment with sodium bisulfate is no longer needed to reduce bruising and blackening in the new fresh-cut biotech potatoes. Hence, the new biotech potatoes reduce two types of food safety concerns—a major accomplishment.

In earlier lab auctions of genetically modified (GM) foods potentially carrying traits for herbicide tolerance and/or insect resistance, Huffman et al. (2003) and Rousu et al. (2007) found significant labeling and information treatment effects on willingness-to-pay (WTP) for GM foods. Huffman et al. (2003) found that most participants consistently bid less for products carrying GM food labels compared to products with conventional labels. However, the authors did not test for information treatment effects. In a later study, Rousu et al. (2007) examined both the effects of food labels and prepackaged information on WTP for conventional GM types and found positive effects of pro-biotech information and negative effects of anti-biotech information on WTP differences. Colson, Huffman, and Rousu (2011) found that subjects were willing to pay more for fresh vegetables enhanced with antioxidants and vitamin C (consumer-oriented traits) using biotech methods.

This study assesses consumer demand for traditional whole, fresh white potatoes and processed potato products and WTP for new, experimental whole, fresh potatoes and potato dices with low acrylamide-forming and browning/bruising potential due to biotech advances. In addition, we examine the effects of food labeling and pre-packaged information on WTP for new potato products. To do this, we design a random *n*th-price experimental lab auction (Shogren et al., 2001) and recruit a sample of 102 adult consumers from three different regions of the United States to participate in experimental auctions.

Our empirical results show that the demand for traditional fresh potatoes and processed potato products is not responsive to subjects' household income. However, households with more adults are more likely to consume fresh potatoes and French fries but not chips. This result may be driven by falling per capita household income as the number of adults per household increases. Education has no significant effect on potato demand, and age has a significant quadratic effect on demand for chips and fries but not for fresh potatoes. *Ceteris paribus*, Boston and Los Angeles households are more likely to regularly consume processed potato products (chips and fries) than Des Moines households.

[2] No food safety problems have arisen in two decades of human consumption of GM foods.

Our empirical results show that WTP differences for new experimental biotech fresh white potatoes and dices are also not significantly affected by the income of subjects' households. Male subjects, relative to females, are willing to pay less for biotech potato products after receiving an industry perspective on using biotechnology to reduce acrylamide and sulfide exposure relative to WTP pre-information. Other sociodemographic factors do not explain these WTP differences. However, subjects who are informed about biotech foods before the experiment are willing to pay more for the new experimental potato products than others. Additionally, subjects who receive the company perspective on using biotechnology to create low-acrylamide, sulfite-free fresh potatoes and fresh dices are willing to pay significantly more than those that receive the environmental group perspective. Hence, subjects are willing to pay for improved food safety achieved using biotechnology to improve the consumer attributes of fresh potatoes, traditionally consumed in large quantities in the United States, and on fresh potato dices, a totally new test food product.

Experiment Design

Experiments were conducted in the Boston, Masschusetts; Des Moines, Iowa; and Los Angeles, California in April and May 2014. Survey and Behavioral Research Services (SBRS) at Iowa State University developed the recruitment protocol. The target subjects were eighteen to sixty-five years of age.[3] Potential participants were told that an Iowa State University project was recruiting subjects to participate in sessions on how households select food and household products. In particular, they were told that the sessions involved a food preference experiment set up like an auction, the sessions would take about seventy-five minutes of their time, and they would be paid $65 for participating in the project. Also, they needed to be able to follow instructions and write in English and be willing to come to a common location in their area at a specified time.[4]

At each location, the lab was laid out classroom-style with a display table in the front of the room. Practice-round and experimental products were placed on the table before subjects were admitted to the lab. Experimental potato products were placed in clear plastic bags with experimental food labels. No trademark, brand, or other information was on the bags. Experimental products were covered by blue bins placed on the table in the front of the lab.

Two concurrent sessions took place at a time, and subjects were alternately assigned to either Session A or Session B. Each session was conducted by a session monitor (who remained the same for each location) and one assistant. The sessions consisted of ten steps. See figure 1 for a quick summary and sequence of the steps.

Step One

The subjects were greeted and asked to read and sign an informed consent form. Subjects were then assigned an ID number, handed a packet of project materials, and told to enter the lab and take a seat.[5] While waiting for the experiment to start, subjects were asked to complete a pre-auction questionnaire that collected socioeconomic information and information about their use of labels while shopping for food products. In addition, subjects were asked to rate their knowledge about biotech foods, non-biotech foods, and acrylamide before the experiments.[6] To relieve subjects'

[3] The IRB requires special procedures for subjects younger than eighteen or older than sixty-five.

[4] To recruit subjects in the Boston and Los Angeles areas, we worked with Answer Quest and Focus & Testing, food marketing and testing companies with databases of more than 50,000 and 120,000 individuals, respectively, who had participated in earlier marketing research projects and agreed to be contacted for future projects. Individuals from these databases were called by employees of Answer Quest or Focus & Testing and read the common protocol for recruitment and follow up.

[5] Individuals who arrived together (e.g., a husband and wife. mother and daughter, etc.) were assigned to different sessions.

[6] By asking about knowledge in more than one area, we believe that any one of these questions is unlikely to bias our experimental results. Also, those subjects that indicate that biotechnology and GMs are different are anticipated to be more informed about this area of science than others.

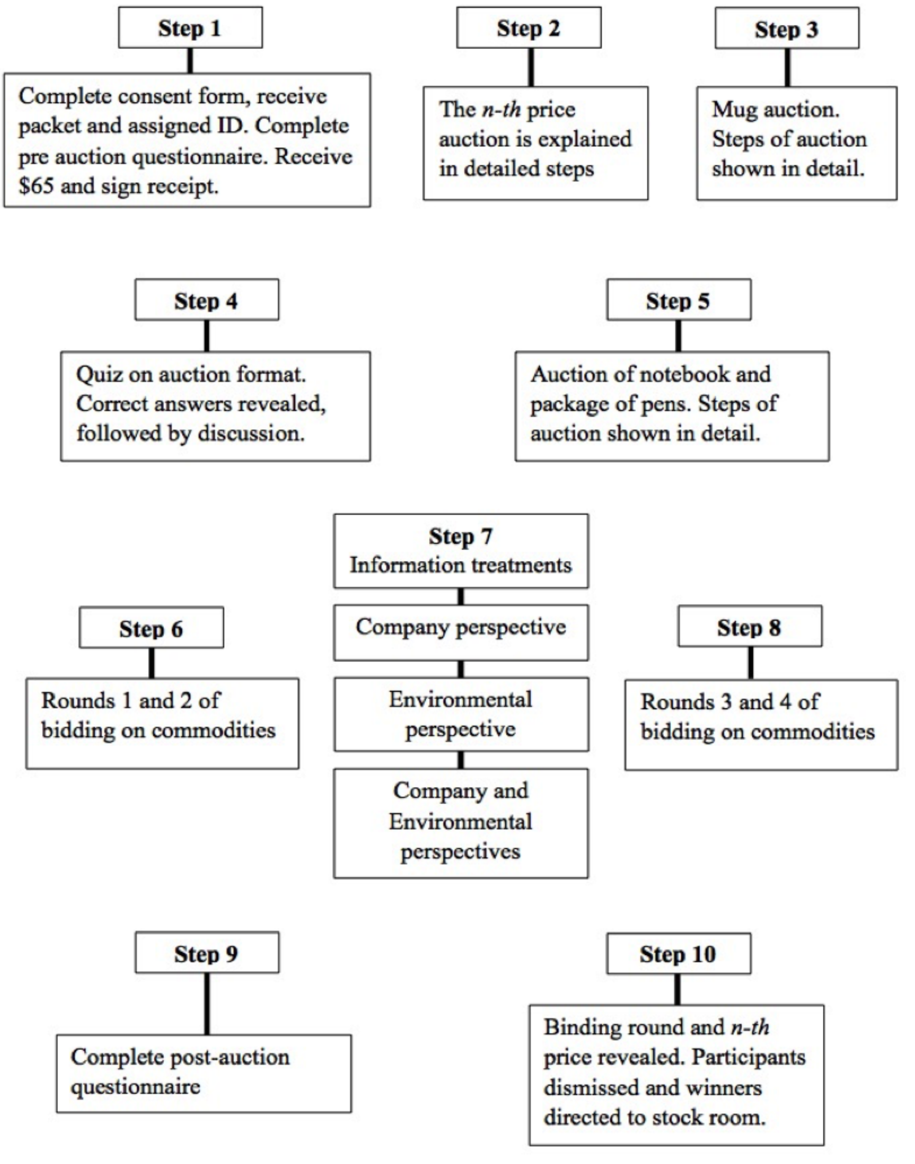

Figure 1. Steps in the Experiments

concerns about a credit constraint in the experiment, each subject was paid $65 for participating in the experiments at this point.

Step Two

Subjects were informed that they would be participating in an auction and that there would be two practice rounds of bidding to allow them to become familiar with the auction mechanism. Subjects were told that it was always in their best interest to bid their true preferences. Subjects were asked to direct all questions to the monitor and refrain from communicating with other subjects.

Next, the session monitor read through an explanation of the random nth-price auction and addressed any questions raised by the subjects. The auction was explained to the participants.

Step Three

Bidding on a single product, a generic ceramic coffee mug, was conducted to familiarize the subjects with the auction mechanism. Subjects were asked to come up to the front of the room, one by one, to view the product and then return to their seats.[7] After making their bids, the monitor and assistant collected the bid sheets and recorded the bids and ID numbers. The bids were then ranked from highest to lowest. The rank of the winning bid was determined by randomly drawing a number from a uniform distribution over 2 to k, where k is the number of subjects in a session. The random number, n, determined the rank of the random price. For example, if $k = 16$ and the random n is 4, the 3 subjects that bid strictly higher than the random price were the winners, and they paid the random price (fourth-highest price). These ranked bids with ID numbers and random nth price were displaced on a screen in front of the room.

Step Four

Subjects were asked to complete a short, four-question quiz on the auction format, and the session monitor reviewed the answers and addressed questions.

Step Five

The second practice round helped partipants become familiar with bidding on two products—a notepad and a package of pens—simultaneously.

Step Six

Subjects placed bids on real experimental products: two rounds of bidding on a five-pound bag of traditional and biotech Russet Potatoes and a twelve-ounce bad of fresh-cut potato dices. To ease budget constraint issues, subjects were told that winners of these auctions would purchase at most one unit of each product (a five-pound bag of potatoes, a twelve-ounce bag of dices). In round 1, the products carried either a conventional or biotech food label (see figure 2).[8] The order in which subjects saw either conventional or biotech products was randomized to minimize order effects in bidding. Subjects were asked to come to the front of the room, view the products, return to their seats, and place their bids. The bid sheets were then collected. In round 2, the participants were asked to bid on the same type of products as round 1, but this time the products were conventional if they had been biotech in round 1 and vice versa.

Step Seven

Subjects were given about ten minute to read the information statement(s) included in their packet. Each subject was randomly assigned to an information treatment group, which determined the information statements they received. The information treatments consisted of two different perspectives: a (positive) company perspective on using biotechnology to reduce bruising of potatoes in storage and processing and acrylamide levels in processed potato products and a (negative) environmental group perspective on biotechnology. See the appendices for both information treatments. A third information-treatment group was provided with both perspectives.[9] In the experiments, 35% of subjects received the company perspective, 33% received the environmental perspective, and 31% received both perspectives.

[7] Following Nunes and Boatwright (2004), we used nonfood items in our practice rounds to reduce impacts on later bids on experimental products.

[8] A private food company supplied experimental products for the lab displays so that the product in the bag matched the attributes of the product stated on the food label.

[9] Greenpeace and Friends-of-the-Earth are two environmental groups that have active and strong negative perspectives on biotechnology and GMs.

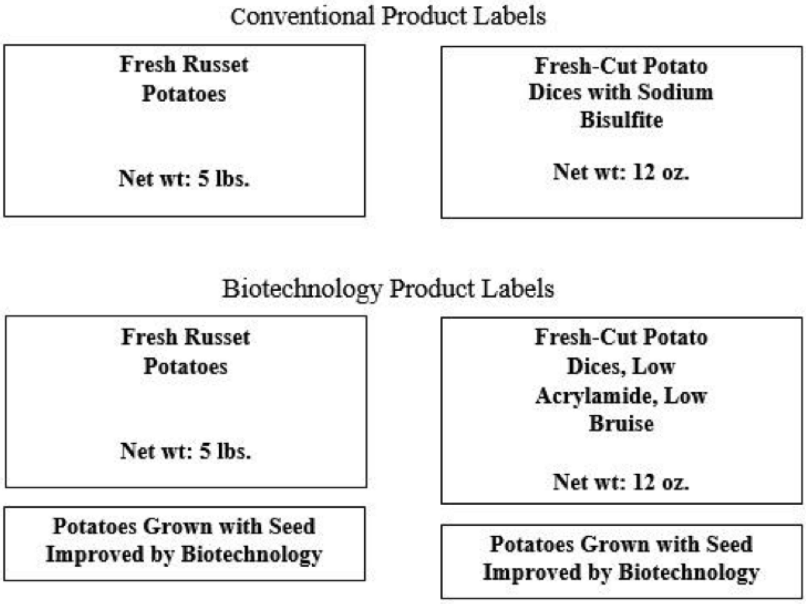

Figure 2. Auction Labels

Step Eight

Subjects placed bids for rounds 3 and 4 on experimental products. As in step six, the only difference between rounds 3 and 4 was whether the subjects saw food labels showing conventional products or biotechnology products first (which was randomized).

Step Nine

After all bids were collected, subjects were asked to complete a short post-auction questionnaire that included questions about household consumption patterns for potatoes and potato products, how well the subject understood the information treatment that they received and read, and how well the subject was informed about biotechnology and acrylamide after participating in the auction and reading the information treatment included in their packet.

Step Ten

Subjects were informed that the biotechnology products were not currently available in grocery stores and that winners would receive conventional potato products obtained from a local grocery store. The monitor then randomly chose the binding round from the two rounds of bidding on the conventional products, displayed the ranked bids for this round for both products, and chose the random price or random n.[10] Winners were then identified. The winners were escorted to the stock room to purchase the products and the other subjects were dismissed.

Results

Table 1 presents the summary statistics for socioeconomic characteristics of the 102 subjects and potato-consumption frequency for subjects' households. The average subjects was forty-three years old, and 39% of the subjects were male.[11] The mean education of subjects was fourteen years, which

[10] Winners of fresh-cut potato dice auctions received a twelve-ounce package of a close substitute, Simply Potatoes™, a product available in the dairy case of major grocery stores and supermarkets.

[11] Approximately 60% of grocery-store shoppers are women.

Table 1. Sample Summary Statistics

Variables	Mean	St. Dev.
Potato Consumption Weekly (=1)	0.931	0.254
Potato Chip Consumption Weekly (=1)	0.824	0.383
French Fry Consumption Weekly (=1)	0.598	0.493
Household Income ($1,000)	72.30	47.04
Number of Adults	2.19	1.07
Number of Children < 8yrs	0.196	0.508
Number of Children ≥ 8yrs	0.559	0.874
Rural (=1)	0.059	0.237
Anyone on Diet (=1)	0.353	0.480
Gender (1=Male)	0.392	0.491
Age	43.32	13.13
Education (yrs)	14.38	2.00
Married (=1)	0.510	0.502
White (=1)	0.873	0.335
Reads Food Labels (=1)[a]	0.882	0.324
Exercises Weekly (=1)	0.931	0.254
Good Health (=1)[b]	0.794	0.406
Smokes Cigarettes (=1)	0.088	0.285
Blue Collar Occupation (=1)[c]	0.128	0.335
Boston (=1)	0.314	0.466
Los Angeles (=1)	0.333	0.474

Notes: [a] =1 if responded "Some of the time," "Often," or "Always" reads food labels when buying a food product for the first time and = 0 otherwise.
[b] = 1 if respondent is in good or excellent physical health and = 0 otherwise.
[c] = 1 if respondent is in an occupation of "building and grounds cleaning and maintenance," "construction/installation/repair," "farming/fishing/forestry," "production /manufacturing," or "transportation" and = 0 otherwise.

is equivalent to a two-year college degree. Eighty-seven percent of the subjects were white and 50% were married.[12] The average household had 2.2 adults 0.20 children under the age of eight, and 0.56 children eight years or older. Mean household income was $72,300, and 13% of subjects reported being blue-collar workers.[13] Also, 93% reported that they exercise weekly, 9% smoked cigarettes, and 79% indicated that they were in good to excellent health; 35% indicated that someone in their household was on a diet.

Regarding potato consumption, 93% of the subjects reported that their household consumed potatoes weekly, 82% reported consuming potato chips regularly, and 60% reported consuming French fries regularly. Given that we did not screen subjects for household potato product consumption, this high frequency of potato consumption indicates that our results are generalizable—at least to the population of people who can communicate in English. In the pre-auction questionnaire, 6% of the subjects reported that they were informed about acrylamide and 38% reported that they were informed about biotechnology.

Table 2 provides summary statistics of the subjects' bids by product and information treatment. In bidding rounds 1 and 2 (before the information treatment was included), the average bid for a five-pound bag of conventional potatoes was $2.71 and the average bid for a five-pound bag of biotechnology potatoes was $2.87, a difference of 16 cents. After each subject read his or her information treatment, the average bid for conventional potatoes was $2.69 per bag and the average bid for biotechnology potatoes was $2.50 per bag, a difference of 19 cents. After receiving an information treatment, the average bid for a bag of conventional potatoes was 2 cents lower

[12] The unusually large share of white subjects, even for the Boston and Los Angeles areas, can be explained by the fact that recruiters screened for ability to communicate in English.

[13] A blue-collar worker was defined as anyone with an occupation of "building and grounds cleaning and maintenance," "construction/installation/repair," "farming/fishing/forestry," "production/manufacturing," or "transportation."

Table 2. Bid (WTP) Summary Statistics for Participants

Commodity	N	Mean Bid	St. Dev.	Min.	Max.
A. All Bids: Pre-Information					
Conventional Potatoes	102	2.71	1.43	0.01	6.75
Conventional Potato Dices	102	1.82	1.26	0	6.00
Biotech Potatoes	102	2.87	1.52	0	6.95
Biotech Potato Dices	102	2.13	1.34	0	5.95
B. All Bids: Post Information					
Conventional Potatoes	102	2.69	1.45	0.01	6.00
Conventional Potato Dices	102	1.77	1.36	0	6.99
Biotech Potatoes	102	2.50	1.84	0	7.95
Biotech Potato Dices	102	1.78	1.31	0	6.00
A1. Bids Pre-Information: Before B1					
Conventional Potatoes	36	2.84	1.53	0.25	6.75
Conventional Potato Dices	36	1.94	1.12	0.10	4.89
Biotech Potatoes	36	2.92	1.60	0	6.00
Biotech Potato Dices	36	2.17	1.12	0	4.50
B1. Bids Post-Information: Company Perspective Only					
Conventional Potatoes	36	2.93	1.57	0.30	5.99
Conventional Potato Dices	36	1.98	1.14	0.10	5.00
Biotech Potatoes	36	3.11	1.77	0.01	7.00
Biotech Potato Dices	36	2.21	1.25	0.01	6.00
A2. Bids Pre-Information: Before B2					
Conventional Potatoes	34	2.75	1.29	0.89	6.00
Conventional Potato Dices	34	1.99	1.43	0.25	6.00
Biotech Potatoes	34	2.95	1.40	0.99	6.00
Biotech Potato Dices	34	2.19	1.42	0.49	5.95
B2. Bids Post-Information: Environmental Perspective Only					
Conventional Potatoes	34	2.73	1.29	0.75	6.00
Conventional Potato Dices	34	1.77	1.39	0	5.65
Biotech Potatoes	34	1.89	1.77	0	7.00
Biotech Potato Dices	34	1.46	1.29	0	5.00
A3. Binds Pre-Information: Before B3					
Conventional Potatoes	34	2.51	1.49	0.01	5.99
Conventional Potato Dices	34	1.51	1.19	0	4.25
Biotech Potatoes	34	2.74	1.59	0.01	6.95
Biotech Potato Dices	34	2.03	1.49	0	4.99
B3. Bids Post-Information: Company and Environmental Perspectives					
Conventional Potatoes	34	2.37	1.46	0.01	5.99
Conventional Potato Dices	34	1.56	1.54	0	6.99
Biotech Potatoes	34	2.45	1.82	0	7.95
Biotech Potato Dices	34	1.63	1.31	0	4.65

and the average bid for a bag of biotech potatoes was 37 cents lower. These results imply that the negative information treatment had a stronger effect on bidding behavior than the positive information treatment.

The conventional fresh potato dices were treated with sodium bisulfide to prevent them from turning an unattractive brown color, and "sodium bisulfide" content was clearly presented on the label (see figure 2). Before information treatment, the average subject's bid for a twelve-ounce bag of conventional potato dices treated with sulfites was $1.82 and the average bid for a twelve-ounce bag of biotechnology potato dices was \$2.13, a difference of 31 cents. After information treatment, the average bid for a bag of conventional potato dices was \$1.77 and the average bid for a bag of biotechnology potato dices was \$1.78, a difference of 1 cent. After the information treatment, the average bid for a bag of conventional potato dices was 5 cents lower and the average bid for a bag of biotechnology dices was 35 cents lower.[14]

Regression Models

First, a model of a household's decision to consume potato products is presented, followed by a model of a household's WTP for low-acrylamide potato products. We specify a reference (no potato products consumed) household random indirect utility function:

$$U_{i0} = \boldsymbol{X}_{i0}\boldsymbol{\beta}_0 + \mu_{i0}, \tag{1}$$

where U_{i0} is the utility of the ith household when it does not consume a potato product, $\boldsymbol{X}_{i0}$ is a row vector and includes household income and prices of products purchased for consumption and socioeconomic variables that affect preferences, μ_{i0} represents other individually small effects on U_{i0} (and has a zero mean), and $\boldsymbol{\beta}_0$ is a column vector of unknown coefficients.

In contrast, the household's random indirect utility when its members choose to consume at least one unit of a potato product is

$$U_{i1} = \boldsymbol{X}_{i1}\boldsymbol{\beta}_1 + \mu_{i1}, \tag{2}$$

where U_{i1} is the utility of a household, given a decision to consume a potato product; $\boldsymbol{X}_{i1}$ is a row vector and includes household income and prices of potato products and other good purchased for consumption and socioeconomic attributes that affect tastes; μ_{i1} represents other individually small effects on U_{i1}, (and has a zero mean); and the coefficient vector $\boldsymbol{\beta}_1$ is a column vector of unknown coefficients.

A household consumes one unit of a potato product when its indirect utility is larger for consuming than for not consuming them. We define $D_i = 1$ if $U_{i0} < U_{i1}$, and 0 otherwise. Hence, the probability that $D_i = 1$ can be represented as

$$\begin{aligned} P_r(D_i = 1) &= P_r(\boldsymbol{X}_{i0}\boldsymbol{\beta}_0 + \mu_{i0} < \boldsymbol{X}_{i1}\boldsymbol{\beta}_1 + \mu_{i1}) \\ &= P_r(\mu_{i0} - \mu_{i1} < \boldsymbol{X}_{i1}\boldsymbol{\beta}_1 - \boldsymbol{X}_{i0}\boldsymbol{\beta}_0) \\ &= P_r(\mu_i < \boldsymbol{X}_i\boldsymbol{\beta}) \\ &= F(\boldsymbol{X}_i\boldsymbol{\beta}), \end{aligned} \tag{3}$$

where $F(\cdot)$ is a distribution function evaluated at $\boldsymbol{X}_i\boldsymbol{\beta}$. Equation (3) provides the conceptual framework for a model explaining the probability that a subject's household consumes a potato product over some time interval, say a week, which is one indication of the demand for a potato product. Equation (3) is fitted using the probit estimation routine, and then we calculate the marginal effect for each regressor.

In addition to household income, socioeconomic variables included as regressors are number of adults, children under age eight, and children eight years of age and older in the subject's household; whether anyone in the subject's household is on a diet; and the subject's gender, age, education, marital status, and racial-ethnic background. In addition, the regressors include dummy variables for whether the subject reads food labels on new purchases, exercises weekly, is in good health, and smokes cigarettes. We expect those subjects with more education and who read food labels

[14] We had very few zero bids and no cases where a subject bid zero on both products—whole potatoes and dices, GM or conventional.

when making new purchases will in general be more health conscious and less likely to consume processed potatoes and potato products. We don't have direct price data that the subject's household faces for potato products, but we expect prices of potatoes, chips, and fries to differ between (be higher in) rural and urban areas and between Boston and Los Angeles areas versus the Des Moines area. Hence, X also includes dummy variables for a subject's rural-urban residence and location in the Boston area (versus Des Moines) or Los Angeles area (versus Des Moines).

Next, we consider a model of willingness-to-pay for the gth commodity, vth variety, by the ith subject receiving the jth information treatment, W_{ij}^{gv}. The commodities are a five-pound bag of fresh whole potatoes and a twelve-ounce bag of fresh-cut potato dices. For fresh potatoes, the varieties (v) are conventional and low-acrylamide (achieved using potatoes grown with seed improved by biotechnology). For fresh-cut potato dices the varieties are conventional (with sodium bisulfite) and low-acrylamide/sulfite-free (achieved using potatoes grown with seed improved by biotechnology).[15] Each subject bid on a set of products before receiving a packaged information treatment and then again after reading an environmental group perspective on biotechnology (anti-biotech), a (positive) biotech company perspective on using biotechnology to lower bruising and acrylamide potential, or both perspectives.

We write WTP for the gth commodity, vth variety for the ith subject receiving the j-type of information as

$$W_{ij}^{gv} = \boldsymbol{X}_i \boldsymbol{\beta}_j^{gv} + \tau_1^{gv} I_{ij} + \varepsilon_{ij}^{gv}, \tag{4}$$

where $\boldsymbol{X}_i$ is a row vector and includes a set of socioeconomic attributes of the subject and his or her household, I_{ij} is 1 for information treatment of "a company perspective on low bruising and low acrylamide potential using biotechnology" (treatment 2) and 0 for receiving "an environmental group perspective on biotechnology" (treatment 1) or both perspectives (treatment 3). The last term of equation (4), ε_{ij}^{gv}, represents other individually small effects on W_{ij}^{gv} and has a zero mean. The baseline model is achieved when the ith individual engages in the first round of bidding (before information treatment):

$$W_{i0}^{gv} = \boldsymbol{X}_i \boldsymbol{\beta}_0^{gv} + \varepsilon_{i0}^{gv}. \tag{5}$$

In our experiments, each of the i subjects bid first on commodity g of variety v before information treatment and then a second time after receiving an information treatment. Following earlier studies (e.g., Hoffman et al., 1993; Rousu et al., 2007)), we convert the WTP model into one of WTP differences—WTP before relative to WTP after information treatment:

$$W_{i0}^{gv} - W_{i1}^{gv} = \boldsymbol{X}_i(\boldsymbol{\beta}_0^{gv} - \boldsymbol{\beta}_1^{gv}) + \tau_1^{gv} I_{i1} + \varepsilon_{i0}^{gv} - \varepsilon_{i1}^{gv} = \boldsymbol{X}_i \boldsymbol{\beta}^{gv} + \tau_1^{gv} I_{i1} + \varepsilon_i^{gv}, \tag{6}$$

where $\boldsymbol{\beta}^{gv} = \boldsymbol{\beta}_0^{gv} - \boldsymbol{\beta}_1^{gv}$ and $\varepsilon_i^{gv} = \varepsilon_{i0}^{gv} - \varepsilon_{i1}^{gv}$ and the last disturbance terms has a zero mean. The advantages to this specification include that the new dependent variable in equation (4) can be positive, zero, or negative; hence, the disturbance of the random disturbance term ε_i^{gv} is more likely to be normally distributed than for ε_{ij}^{gv}. Taking differences also removes any common individual fixed or random effects, including individual idiosyncrasies, which would otherwise be a possible source of biases in the estimated coefficients of the WTP equation (Greene, 2003).

Socioeconomic variables included in $\boldsymbol{X}_i$ are a subject's household income; number of children under age eight in subject's household; subject's gender, age, and years of completed schooling; whether subject indicated that they were informed about acrylamide and biotechnology in the pre-auction survey, read food labels when purchasing new food items, viewed biotech and GM foods as different, or indicated that their household regularly consumes potatoes; and a dummy variable for city location of subject (Des Moines, Boston or Los Angeles area). Subjects in households with children under eight years of age may be more concerned about the food safety of the food that

[15] Sodium bisulfite is a preservative used in conventional dices to limit product discoloration when exposed to air.

they purchase in grocery stores, especially foods containing sulfites, than others. Because there is no scientific evidence of biotech foods being unsafe for human consumption, it is uncertain what effect the words "Made using potatoes grown with seed improved by biotechnology" in a food label will have. Although the perspective about genetically modified organisms (GMOs) presented by Greenpeace and Friends-of-the-Earth is negative, Colson, Huffman, and Rousu (2011) show that consumers are willing to pay more in experimental lab auctions of GM products with enhanced antioxidants and vitamin C when those traits were achieved using genes from within the species (intragenic). Women are more intensely involved in food shopping than men, and this difference in experience could affect the size of WTP differences, but we do not know in what direction. A subject's age is included to control for life-stage effects and to permit differences in WTP to occur by age. Individuals with more education are better able to read and digest consumer and food safety information (Schultz, 1975; Huffman, 1974) and hence may show larger responsiveness to information treatments. The effect of a subject being informed about biotechnology could have a positive or negative effect on how they bid, but Rousu et al. (2007) found that those who were informed bid more for GM products. Those that read food labels may be more conscious shoppers, but it is unclear how this attribute will affect bidding behavior. Households that regularly consume potatoes may behave differently in bidding on potato products than other households because they have more information about their tastes.

The locations of our food experiments are more than 1,300 miles apart and in vastly different parts of the country, where the daily attention to food production differs considerably. Iowa and California are large producers of food and agricultural products, while farmers in Massachusetts are engaged in small-scale farming, including agro-tourism. Massachusetts is heavily urbanized and far from centers of large-scale food production. Hence, we expect Boston subjects to be most strongly anti-biotech. In addition, three New England states have recently voted to require some type of mandatory labeling of GM foods. All state-level votes in other regions of the United States have failed (Huffman and McCluskey, 2014).

Regression Results for Potato Product Demand

Table 3 reports the results from fitting the empirical probit model explaining the probability of a subject's household consuming traditional potatoes and processed potato products weekly. A general model for equation (3) with fifteen regressors, including city fixed effects and intercept term, is first fitted. Then, variables having coefficients with unusually small z-values (implying that they are not significantly different from zero at even the 10% level) are deleted, except for a few core variables—household income, number of adults in household, and city dummies—and the model is re-fitted. The expectation is that the size of the estimated coefficients with large z-values at the first stage will be relatively unaffected when insignificant regressors are excluded but that their z-values may increase in size due to less near-multicollinearity among the remaining regressors.[16]

Fresh Potatoes

Regression (1) of table 3 includes fifteen regressors, largely socioeconomic variables, five of which are excluded from regression (2).[17] The probit results and marginal effects are in table 3. In regression (2), a $1,000-per-year increase in household annual income reduces the probability of a subject's household consuming fresh potatoes slightly but not significantly. Adding one adult to a subject's household or a subject being married increases the probability of a subject's household consuming potatoes by 3.0 and 5.2 percentage points, respectively. Male subjects are 4.3 percentage points less likely to be in a household that consumes potatoes than female subjects. The marginal

[16] Although we might test for information order effects, we do not expect them to be significant.

[17] The excluded regressors are whether a child age eight or older lives in the household, subject's gender, subject is white, exercises weekly, and in good health.

Table 3. Probit: Probability of Household Consuming Commodities Weekly ($N = 102$)

	Potatoes		Potato Chips		French Fries	
Regressors	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Household Income ($1,000)	−0.00002	−0.00001	−0.00000	−0.00000	−0.00000	−0.00000
	(1.59)	(1.68)	(0.03)	(1.07)	(0.95)	(1.35)
	[−0.0000]	[−0.0000]	[0.0000]	[−0.0000]	[−0.0000]	[−0.0000]
Number of Adults	0.901	0.610	0.247	0.256	0.382	0.371
	(1.65)	(1.61)	(1.12)	(1.33)	(1.86)	(2.00)
	[0.017]	[0.030]	[0.047]	[0.053]	[0.144]	[0.140]
Number of Children $\geq$ 8yrs	0.618	–	−0.227	–	0.034	–
	(0.92)		(1.04)		(0.19)	
	[0.011]		[−0.043]		[0.013]	
Anyone on Diet (=1)	−0.841	−0.474	−0.047	–	−0.235	–
	(1.13)	(0.94)	(0.12)		(0.73)	
	[−0.024]	[−0.028]	[−0.009]		[−0.090]	
Gender (1=male)	−0.690	−0.706	−0.463	−0.420	0.731	0.699
	(1.14)	(1.40)	(1.31)	(1.23)	(2.33)	(2.33)
	[−0.017]	[−0.043]	[−0.094]	[−0.092]	[0.264]	[0.253]
Age	0.333	0.209	0.426	0.332	0.134	0.148
	(1.32)	(1.29)	(3.06)	(3.09)	(1.27)	(1.65)
	[0.006]	[0.010]	[0.081]	[0.069]	[0.051]	[0.056]
Age^2	−0.004	−0.002	−0.005	−0.004	−0.002	−0.002
	(1.37)	(1.40)	(3.03)	(3.02)	(1.30)	(1.66)
	[−0.0001]	[−0.0001]	[−0.001]	[−0.001]	[−0.001]	[−0.001]
Education (yrs)	−0.012	–	−0.146	–	0.003	–
	(0.07)		(1.38)		(0.03)	
	[−0.0002]		[−0.028]		[0.001]	
Married (=1)	1.030	0.928	−0.198	–	−0.124	–
	(1.34)	(1.40)	(0.49)		(0.34)	
	[0.024]	[0.052]	[−0.038]		[−0.047]	
White (=1)	0.755	–	−0.555	–	−0.067	–
	(0.76)		(0.84)		(0.14)	
	[0.029]		[−0.082]		[−0.025]	
Exercises Weekly (=1)	1.155	–	−0.829	0.668	−0.971	−1.102
	(1.12)		(1.57)	(1.38)	(1.81)	(2.15)
	[0.065]		[0.217]	[0.177]	[−0.301]	[−0.329]
Good Health (=1)	0.791	–	0.088	–	−0.389	–
	(0.88)		(0.17)		(0.95)	
	[0.028]		[0.017]		[−0.140]	
Boston (=1)	0.779	0.728	1.11	1.12	1.019	1.003
	(0.86)	(0.97)	(2.07)	(2.27)	(2.43)	(2.58)
	[0.011]	[0.029]	[0.169]	[0.186]	[0.345]	[0.340]
Los Angeles (=1)	0.751	0.701	0.756	0.830	1.047	1.020
	(0.97)	(1.03)	(1.75)	(2.04)	(2.60)	(2.77)
	[0.011]	[0.029]	[0.125]	[0.148]	[0.356]	[0.348]
Intercept	−7.587	−2.937	−6.583	−7.052	−2.525	−3.030
	(1.09)	(0.77)	(2.02)	(2.76)	(0.97)	(1.39)
Pseudo R^2	0.348	0.285	0.212	0.169	0.210	0.195

Notes: Absolute value of z-values in parentheses. t-values larger than 1.98 are significantly different from zero at the 5% level; larger than 1.65 are significant at 10% level. The marginal effects are in square brackets.

effects of a subject's age on the probability of the household consuming potatoes increases from age eighteen to forty, and then the probability of the household consuming potatoes decreases for subjects older than forty and continues to decrease as age increases. However, this age effect is statistically weak. If the subject reported that someone in the household was on a diet, then the probability of consuming potatoes decreases by 2.8 percentage points. Because most diets suggest reducing carbohydrate-intensive and high-starch foods, this result is not surprising. Households in the Boston and Los Angeles areas are slightly more likely to consume potatoes than Des Moines area households.

Potato Chips

Regression (3) starts with the same fifteen regressors as regression (1), six of which are then excluded in regression (4).[18] In regression (4), the most significant factor affecting the probability of a subject's household consuming chips is his or her age.[19] The marginal effect of a subject's age on the probability of his or her household consuming chips increases from eighteen to forty-three years; for subjects older than forty-three years, aging reduces the probability of the household consuming chips. Female subjects are 9.2 percentage point more likely to have a household that consumes potato chips than male subjects, and adding an additional adult to a subject's household increases the probability of the household consuming potato chips by 5.3 percentage points. If the subject reported he or she exercised regularly, then his or her household consuming chips is 17.7 percentage points more likely to consume chips than households with subjects reported not exercising regularly. Boston and Los Angeles households are 24.4 and 17.0 percentage points more likely to consume chips than Des Moines area households.

French Fries

Regression (5) includes the same fifteen regressors as regression (1), six of which are excluded from regression (6).[20] In regression (6), an additional $1,000 in a subject's household income slightly reduces the probability of his or her household consuming fries, but the effects are not statistically significant). An additional adult in the subject's household increases the probability of the household consuming fries by 14 percentage points. The probability of a household consuming fries increases as the subject's age increases from eighteen to forty-six years of age and then declines as subject's age increases further. When the subject is a woman, the household is 14 percentage points more likely to consumes fries than if the subject is a man. Also, if the subject reported exercising regularly, then the household was 33 percentage points less likely to consume fries than when the subject reported not exercising regularly. Boston and Los Angeles area households are 34.3 and 29.6 percentage points more likely to consume fries that Des Moines area households.

There are major differences across the three potato products with regard to how the regressors affect the probability of a household consuming fresh versus processed potato products (i.e., chips and fries). A subject's marital status and whether someone in the household is on a diet are important variables for explaining fresh potato consumption but not chip or fry consumption. Since people who consider themselves to be on a diet are usually more conscious about the foods they eat as well as the food everyone else in the household eats, it is surprising that dieting is not an important explanatory variable for chips and fries. In contrast, regular reported exercise is important for explaining consumption of chips and fries but not fresh potatoes. A subject's household income has no significant effect on the probability of his or her household consuming potato products. In addition, our empirical model of the probability of a subject's household consuming potato products has the highest explanatory power for fresh potatoes, pseudo $R^2 = 0.285$, but is significantly lower for processed potatoes (fries and chips), pseudo R^2 of 0.195 and 0.169, respectively.

Regression Results for Willingness to Pay

Results from fitting equation (4) for the two commodities (a five-pound bag of fresh potatoes and a twelve-ounce bag of fresh potato dices) are reported. For a given commodity, within-subject WTP

[18] These regressors are whether a child age eight or older lives in the household, anyone in the household is on a diet, subject's education, subject is married, white, and in good health.

[19] Additional household income has no economic effect on the probability of a subject's household consuming chips.

[20] These regressors are whether a child age eight or older lives in the household, anyone in household is on a diet, subject's education, subject is married, white, and in good health.

Table 4. WTP Differences and Other Summary Statistics

Variables	Mean	St. Dev.
WTP for improved biotechnology potatoes after information treatment less WTP for improved biotechnology potatoes before information treatment ($)	−0.38	$1.49
WTP for improved biotechnology potatoes after information treatment less WTP for conventional potatoes before information treatment ($)	−0.21	1.40
WTP for improved biotechnology dices after information treatment less WTP for improved biotechnology dices before information treatment ($)	−0.36	1.05
WTP for improved biotechnology dices after information treatment less WTP for conventional dices with sodium bisulfide before information treatment ($)	−0.05	0.98
Pre-auction, subject informed about:		
Acrylamide	0.059	0.236
Biotechnology	0.382	0.488
Subject received information treatment:		
Environmental group perspective	0.333	0.474
Company perspective	0.353	0.480
Company & environmental group perspectives	0.314	0.466

differences are expressed both within-variety and across-variety. Table 4 presents summary statistics for the dependent variables.

Fresh Potatoes

In regressions (1) and (2) in table 5, the variety of fresh potatoes is "biotech," (i.e., the food label on the front of the package displayed the phrase "Potatoes Grown with Seed Improved by Biotechnology"). Subjects bid twice on the biotech potatoes; first without information and a second time after receiving an information treatment. The dependent variable is a subject's WTP for biotech potatoes before information less WTP for biotech potatoes after receiving an information treatment. Hence, the estimated coefficients on regressors reflect how a variable impacts the way treatment information changes WTP behavior of subjects.[21] In our regressions, the dummy variable for a household being located in the Des Moines area is excluded and its effect is part of the intercept term.[22]

Regression (1) of table 5 includes fifteen regressors, largely socioeconomic variables, information treatment effects, and city dummy variables; regression (2) excludes five of the insignificant regressors.[23] For regression (2), an increase of $1,000 in a subject's household income reduced subjects' WTP for a five-pound bag of biotech potatoes post-information treatment relative to their pre-information treatment by 0.00006, which is very small. Male subjects had a $0.62 per bag lower WTP for biotech potatoes post-information treatment relative to pre-information treatment; or women had larger WTP post-information. If a subject reported being informed about biotechnology pre-experiment, he or she had a $0.74 per bag higher WTP for biotech potatoes post-information treatment than pre-information treatment. If a subject indicated in the pre-auction survey that he or she reads food labels when buying new foods for the first time or views biotech and GM foods as being different, his or her WTP for a bag of biotech potatoes post-information treatment was $0.75 lower than for the pre-information treatment WTP. However, if the subject received the "company

[21] One information treatment must be assigned to the intercept term to provide identification of the effects of the other treatment effects relative to the excluded one. Hence, in our results the intercept term absorbs the negative effect of the "environmental group perspective." This arrangement provides results that are easiest to interpret.

[22] There was no significant order effect (i.e., whether a subject first bid on biotech or conventional products).

[23] Excluded regressors are the number of children younger than eight in the subject's household, subject's age and education, whether the subject is informed about acrylamide, and an indicator for a subject's household consuming potatoes weekly. The null hypothesis that these five coefficients on the excluded variables are jointly zero yields a sample value of the F statistic of 0.001, but the tabled critical value of the F with 5 and 86 degrees of freedom at the 5% significance level is 2.33. Hence, we cannot reject the null hypothesis at the 5% significance level.

Table 5. Regression Analysis of WTP Differences: WTP after Information Treatment Less WTP before Treatment—Fresh Potatoes, 5lbs ($N = 102$)

	Biotech Potatoes		Biotech Potatoes vs. Conventional Potatoes	
Regressors	**(1)**	**(2)**	**(3)**	**(4)**
Household Income ($1,000)	−0.00006	−0.00006	−0.00004	−0.00003
	(1.69)	(1.73)	(1.06)	(1.16)
Number of Children < 8yrs	−0.042	–	−0.164	–
	(0.15)		(0.58)	
Gender (1=male)	−0.636	−0.621	−0.486	−0.461
	(2.32)	(2.34)	(1.79)	(1.75)
Age	−0.002	–	0.003	–
	(0.22)		(0.32)	
Education (yrs)	0.018	–	−0.002	–
	(0.23)		(0.02)	
Informed about Acrylamide (=1)	−0.192	–	0.498	–
	(0.32)		(0.82)	
Informed about Biotechnology (=1)	0.782	0.738	0.584	0.583
	(2.64)	(2.67)	(2.00)	(2.18)
Reads Food Labels (=1)	−0.774	−0.748	−0.398	–
	(1.77)	(1.78)	(0.92)	
Biotech and GM Foods Are	−0.727	−0.732	−0.536	−0.493
Different (=1)	(2.56)	(2.72)	(1.91)	(1.85)
Company Perspective	1.424	1.423	1.249	1.200
	(4.34)	(4.51)	(3.84)	(3.86)
Company Perspective ×	0.808	0.845	0.874	0.898
Environmental Group Perspective	(2.36)	(2.61)	(2.59)	(2.82)
Household Consumes Potatoes	−0.358	–	−0.243	–
Weekly	(0.65)		(0.45)	
Boston (=1)	0.143	0.144	−0.99	−0.093
	(0.38)	(0.42)	(0.27)	(0.27)
Los Angeles (=1)	0.684	0.654	0.241	0.215
	(1.93)	(2.01)	(0.69)	(0.67)
Intercept	0.164	−0.090	0.058	−0.532
	(0.11)	(0.18)	(0.04)	(1.55)
R^2	0.318	0.312	0.241	0.223

Notes: Absolute value of t-values in parentheses. Coefficients with t-values larger than 1.98 are significantly different from zero at the 5% level; larger than 1.65 are significant at 10% level. Environmental group perspective on biotechnology is the excluded information treatment.

perspective" information treatment, his or her WTP for a bag of biotech potatoes was $1.43 higher post-information treatment than pre-information treatment. Hence, the "company perspective" is influential in modifying subject's WTP for improved food safety using biotechnology. If a subject received the third information treatment (the company perspective and the environmental group perspective), his or her WTP for a bag of biotech potatoes was $0.85 higher post-information treatment than pre-information treatment. Hence, the positive "company perspective" continues to weigh heavily on WTP differences relative to the negative environmental group perspective. Subjects from the Los Angeles area were willing to pay $0.65 more per bag of biotech potatoes post-information than pre-information treatment relative to Des Moines area subjects. There was no difference in WTP for a bag of biotech potatoes post- versus pre-information treatment for Boston area subjects than Des Moines subjects. Hence, Los Angeles subjects were most favorably impacted by the company information treatment.

Regressions (3) and (4) of table 5 present a different perspective on WTP for biotech potatoes. It is a comparison of WTP for a five-pound bag of biotech potatoes post-information treatment with WTP for a five-pound bag of conventional potatoes pre-information treatment—a type of comparison that a consumer might face in a marketing campaign for new biotech potatoes appearing in grocery stores and supermarkets. Hence, both the variety type and information treatments are different in this comparison, and it is similar to the framing of WTP differences in the econometric analysis presented by Rousu et al. (2007). Regression (3) contains the same set of regressors as regression (1). The regressors that are much less significant in regression (3) than in regression (1) are a subject's household income, whether a subject reads food labels, and whether a subject resides in the Los Angeles area. Regression (4) excludes six regressors with small z-values.[24] For the remaining estimated coefficients, it is surprising that all of them are 30–50% smaller than for regression (2), except for the coefficient of the Boston area dummy variable, which is not significantly different from zero in both regressions.

Fresh Potato Dices

In regressions (1) and (2) in table 6, the variety of fresh potato dices is "biotech" (i.e., the food label on the front of the package displayed the phrase "Potatoes Grown with Seed Improved by Biotechnology"). Subjects bid twice on the biotech dices; first before receiving the information treatment and a second time after receiving an information treatment. The dependent variable is a subject's WTP for a twelve-ounce bag of biotech dices before information less WTP for biotech dices after receiving an information treatment.

Regression (1) includes fifteen regressors, largely socioeconomic variables, information treatment effects, and city dummy variables; regression (2) includes eight insignificant regressors.[25] In regression (2), if the subject indicated that he or she reads food labels, then his or her WTP post-information treatment declined by $0.43 per bag relative to the pre-information treatment WTP. Similarly, if the subject considered biotech and GM foods as being different, a subtle dimension, then his or her WTP was $0.44 less per bag post information than pre-information treatment. If the subject received the "company perspective" information treatments, his or her WTP for a bag of dices increased by $0.88 relative to his or her WTP pre-information treatment. As previously stated, this is not surprising since the "company perspective" provides positive information about biotechnology and biotech foods. If the subject received the "company perspective" and "environmental group perspective" in the information treatment, his or her WTP for a bag of dices increased by $0.38 relative to his or her WTP pre-information treatment. This is a decline of $0.50 per bag compared to just the "company perspective" and shows that the "environmental group perspective," where packaged with the "company perspective," only slightly reduces the positive effect of the "company perspective" only treatment on WTP for biotech dices. Hence, the environmental group perspective does little to moderate the effects of the company perspective.

Regressions (3) and (4) in table 6 present a different perspective on WTP for fresh-cut potato dices. The dependent variable in these regressions is a subject's WTP for fresh-cut potato dices made from "Potatoes Grown with Seed Improved by Biotechnology" post-information treatment relative to his or her WTP for a twelve-ounce bag of fresh cut potato dices made using sodium bisulfite. Hence, the "variety" of the commodity (dices) and available information are different in computing

[24] The excluded regressors are the number of children younger than eight in the subject's household, subject's age and education, whether subject was informed about acrylamide, whether subject reads food labels on new goods, and an indicator for a subject's household consuming fresh potatoes weekly. The null hypothesis that the estimated coefficients on these six regressors are jointly equal to zero yields a sample value of the F statistic of 0.34, but the tabled critical value of the F with 6 and 87 degrees of freedom at the 5% significance level is 2.20. Hence, we cannot reject the null hypothesis of no joint effects at the 5% significance level.

[25] The excluded regressors are a subject's household income; the number of children younger than eight in subject's household; subject's gender, age, and education; whether subject was informed about acrylamide; whether subject was informed about biotechnology; and an indicator for a subject's household consuming potatoes weekly. The null hypothesis that the coefficients of these 8 coefficients variables are jointly zero yields a sample value of the F statistic of 0.43, but the tabled critical value of the F with 8 and 87 degrees of freedom at the 5% significance level is 2.05. Hence, we cannot reject the null hypothesis of no joint effects at the 5% significance level.

Table 6. Regression Analysis of Willingness-to-Pay Differences: WTP after Information Treatment Less WTP Before Treatment—Fresh Cut Potato Dices, 12oz ($n = 102$)

	Low-Acrylamide Biotech Dices		Low-Acrylamide Biotech Dices vs. Dices w/ Sodium Bisulfite	
Regressors	**(1)**	**(2)**	**(3)**	**(4)**
Household Income ($1,000)	−0.00001	–	−0.00001	–
	(0.56)		(0.53)	
Number of Children < 8yrs	0.116	–	−0.112	–
	(0.56)		(0.55)	
Gender (1=male)	−0.074	–	−0.017	–
	(0.37)		(0.09)	
Age	0.008	–	0.003	–
	(0.98)		(0.33)	
Education (yrs)	0.018	–	0.023	–
	(0.32)		(0.42)	
Informed about Acrylamide (=1)	−0.310	–	−0.017	–
	(0.70)		(0.04)	
Informed about Biotechnology (=1)	0.261	–	0.279	0.291
	(1.23)		(1.32)	(1.51)
Reads Food Labels (=1)	−0.550	−0.432	−0.400	−0.413
	(1.75)	(1.46)	(1.28)	(1.39)
Biotech and GM Foods Are Different (=1)	−0.475	−0.441	−0.107	–
	(2.33)	(2.29)	(0.52)	
Company Perspective	0.863	0.876	0.830	0.816
	(3.65)	(3.89)	(3.53)	(3.70)
Company Perspective × Environmental	0.341	0.376	0.613	0.614
Group Perspective	(1.38)	(1.61)	(2.51)	(2.70)
Household Consumes Potatoes Weekly	−0.033	–	0.180	–
	(0.08)		(0.46)	
Boston (=1)	−0.428	−0.522	−0.233	−0.299
	(1.58)	(2.29)	(0.87)	(1.34)
Los Angeles (=1)	0.417	0.365	0.244	0.148
	(1.63)	(1.60)	(0.96)	(0.67)
Intercept	−0.614	−0.169	−0.729	−0.229
	(0.50)	(0.50)	(0.70)	(0.70)
R^2	0.287	0.256	0.199	0.187

Notes: Absolute value of t-values in parentheses. Coefficients with t-values larger than 1.98 are significantly different from zero at the 5% level; larger than 1.65 are significant at 10% level. Environmental group perspective on biotechnology is the excluded information treatment.

the WTP differences—fresh biotech dices without sulfites versus non-biotech dices with sodium bisulfite added. Regression (3) contains the same fifteen regressors as regression (1). The effect of a subject indicating in the pre-auction survey that he or she reads food labels when buying a food item for the first time is more significant in regression (3) than in regression (1), but the effect of a subject reporting in the pre-auction survey that biotech and GM foods are different is less significant in regression (3) than in regression (1). In regression (4), when a subject reports in the pre-auction survey that he or she is informed about biotechnology, his or her WTP for a bag of dices is $0.29 higher post-information treatment relative to pre-information treatment. When a subject indicates that he or she reads food labels, his or her WTP for a bag of biotech dices declines by $0.41 post-information treatment relative to a bag of dices containing sodium bisulfite pre-information treatment. If a subjects receives the "company perspective," he or she is willing to pay $0.82 more for a bag of biotech dices post-information treatment than for a bag of dices containing sodium bisulfite pre-information treatment. If a subject receives the "company perspective" and "environmental group perspective" information treatment, his or her WTP is $0.61 higher for a bag of biotech dices post-information than for a bag of sodium bisulfide dices pre-information treatment. Hence, the WTP difference per bag is only reduced by $0.20 when the "environmental group perspective" is added to the "company perspective." This is similar to the findings for fresh potatoes. Although subjects from the Boston area tend to pay less and for Los Angeles area to pay more for a bag of biotech dices relative to Des Moines residents, these city effects are not significantly different from zero at the 5% level.

The information treatment effects on WTP differences for fresh potatoes and dices are consistent with the information treatment effects obtained by Rousu et al. (2007) and Colson, Huffman, and Rousu (2011) for biotech foods. The explanatory power of the empirical models of WTP differences is largest for the comparisons of within-variety differences; R^2 being 0.312 for biotech potatoes and 0.256 for biotech dices. We lose about 0.10 from the R^2 in the comparisons of WTP for biotech product post-information treatment relative to conventional product pre-information. This suggests that there is additional unexplained noise in the cross-variety comparisons that does not exist in the within-variety comparisons.

Conclusion

This study provides new empirical evidence on household demand for traditional fresh and processed potato products and consumers' willingness to pay for a new variety of fresh biotech potato and new potato products—fresh potato dices, low-acrylamide potato products, and fresh potato dices that are also sulfite-free. The probability of a subject's household consuming traditional fresh potatoes, chips, and fries is not significantly related to household income. Hence, the results suggest that demand for potatoes in the United States will not change much as real household incomes rise over time. However, aging of the adult population is expected to decrease the probability of households consuming chips but not potatoes or fries. The probability of a household consuming potato products is unaffected by a subject's education. It is perhaps surprising that households in the Boston and Los Angeles areas were significantly more likely to consume processed potato products than households in the Des Moines area.

We find empirical evidence that some participants are willing to pay for food safety—fresh potatoes with low potential to produce acrylamide and white potato dices that are sulfite free—achieved using biotechnology, but not transgenic GMOs. However, WTP is conditioned by the information injected into the experimental auction. Retailers could segment their consumers into those that are receptive to GMOs and distribute information to them that shows the benefits of low-acrylamide potato products. In this way, they can increase the demand for these products. Retailers can retain consumers who have non-GMO preferences by carrying both GM and conventional varieties of potato products. In the long run, biotech potato products that have improved food safety are expected to achieve higher rates of consumer acceptance in the United States than those with earlier traits for herbicide tolerance and/or insect resistance.

Limitations to our study include small sample size and under-representation of rural subjects and households. However, none of our preliminary results showed that subjects from rural households responded differently from subjects in urban households.

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Appendix A: Environmental Group Perspective on Biotechnology

General Statement:

- Biotech plant breeding takes genes from one organism and places them into another. This process manipulates genes and alters genetic makeup and properties. The cutting of genetic material from one organism and inserting it into another is quite imprecise and can cause mutations. There has been inadequate testing of these products.
- Biotech methods frequently use antibiotic-resistant gene segments in soil bacteria or viruses and transfer them into plants. This process is risky, leading to unanticipated outcomes.
- Biotech plants are regulated by the federal government, but federal regulation relies heavily on data collected from field trials and other testing by the biotech industry.
- Biotech seeds were first marketed to U.S. farmers in the mid-1990s, and rapid farmer adoption occurred in field crops (corn, soybean, cotton and canola). Later developments have been in papaya and vegetables (sugar beet, squash and potato).
- In the United States, the sales of biotech foods have grown very rapidly. This growth is driven by self-interested producers and marketers seeking to maximize crop yields and minimize production costs.

Nutrition and Health:

- Of the laboratory plants that are successfully modified to express the “right” traits, genetic engineers select among those that look strong, healthy, and capable of further breeding. There is poor screening to eliminate varieties that produce harmful substances or low nutrient quality.
- New allergens are likely to be introduced into the food supply.
- Early research reported some health problems in laboratory animals consuming first-generation insect- resistant potatoes.
- Several scientific studies show that laboratory animals that have been fed biotech food developed one or more toxic effects on vital and/or reproductive organ functioning, relative to a control group.
- A recent Canadian study found a common protein from insect-resistant corn in the bloodstream of pregnant women and their fetuses. Another recent study found that high concentrations of this protein resulted in severe damage to human embryonic kidney cells.
- The nutritional content of biotech foods, relative to conventional foods, is variable.

Environmental Impacts and Food Security:

- Private companies are not capable of screening new biotech materials for every possible pathogen or environmental stress. Unnoticed and unsafe mutations could strike after the occurrence of extreme stress, such as plant disease outbreaks, droughts, floods, and heat waves.
- New biotech crops may cross-pollinate with other plants and are likely to cause super weeds.
- Some herbicides used on biotech crops diffuse into the air and leach into streams and waterways in some areas. These herbicides are toxic to amphibians (e.g., frogs, salamanders) and earthworms, which impacts bird populations.
- Biotech crops are doing little to help international food security or relieve hunger in poor countries. The major biotech crops, corn and soybeans, are mainly used for animal feed, biofuels, and processed human food in developed countries.

Appendix B: Company Perspective on Low Bruising and Low Acrylamid Potential Using Biotechnology

General Statement:

- Potatoes have well-known vulnerability to bruising during harvest and while in storage. In addition, a fresh potato turns brown upon cutting when exposed to the air. Recently, it has been discovered that frying or broiling potatoes at high temperatures forms acrylamide.
- This tendency for bruising causes a large amount of potato wastage and costs potato growers and processors millions of dollars annually. Sodium bisulfite is sometimes used to preserve freshness.
- In 2002, acrylamide, a chemical compound, was discovered in foods containing certain natural sugars when cooked at high temperatures (above roughly 250°F), such as French fries, hash browns and potato chips. They are also formed in the baking of bread (crust) and cookies and roasting of coffee beans.
- Acrylamide is formed from naturally occurring sugars and asparagine (a building block of a protein) in food. It is a toxin and possible carcinogen in humans.
- The Simplot Company has developed improved versions of three popular potato varieties that have significantly reduced bruising and acrylamide forming potential than conventional potato varieties. These new potato varieties are slower to oxidize after peeling or cutting. Hence, these new potato varieties provide major advantages to potato producers, processors and consumers.
- The new varieties were made possible using InnateâĎć technology, which is a new biotech process for moving genes swiftly and precisely from wild and domesticated potatoes into popular varieties.

Nutrition and Health:

- Food and cigarette smoke are the two main sources of human exposure to acrylamide. In the American diet, processed potato products (potato chips and cooked French fries) are the leading source of acrylamide. Long-term, low-level intake of acrylamide by lab animals has been shown to create serious health problems. One study found that consuming conventional potato chips regularly for a month caused some health changes in humans.
- Under Proposition 65, California requires certain restaurants, including Applebee's, Chili's, McDonald's, Burger King, Wendy's, and KFC, to post a warning stating that "cooked potatoes that have been browned, such as French fries, hash browns and baked potatoes, contain acrylamide, a chemical known to the State of California to cause cancer."
- Simplot's latest Innate™ potato varieties reduce acrylamide formation by approximately 90% in processed potato products cooked at high temperatures. This reduction places them below the minimum amounts of California's Proposition 65, and removes acrylamide level health concerns.
- Biotech methods were also used to develop golden rice, which enhanced vitamin A content. Other opportunities exist for enhancing consumer attributes such as antioxidants and vitamins in food.
- Biotech foods, relative to conventional foods, have similar low allergy potential.

Environmental Impacts and Food Security:

- Innate^{TM} biotech modifies a plant's genes without incorporating foreign genes or antibiotic resistance. There are no adverse impacts on the environment or new food allergens.
- Commercial potatoes are grown from pieces of whole potato and not seed. Many commercial potatoes are either sterile or not sexually compatible with wild potatoes so there is very low risk of the Innate^{TM} potato varieties crossing with other potato varieties or other plants.
- Innate^{TM} potatoes have undergone extensive field testing and consumer taste testing by Simplot, and have been thoroughly evaluated by the USDA and FDA.
- Approval is being sought for Innate^{TM} potato exports to Canada, Mexico, South Korea and Japan.