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A Nonhypothetical Ranking and Auction Mechanism for Novel Products

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Preferences for pomegranates, including some novel pomegranate varieties, were evaluated using an experimental auction and nonhypothetical preference ranking mechanism. Additional information on the taste and health benefits of the products was provided to mimic the information-gathering process on novel products. Product familiarity, product information, and reference prices were key factors in explaining willingness to pay for the included novel products. Results from the auction and nonhypothetical preference ranking procedures were divergent. Furthermore, interactions were detected between information treatments and product characteristics.

Key Words: experimental auction, novel product, preference ranking, willingness to pay

JEL Classification: C91

Experimental economic methods are useful for eliciting consumer willingness to pay (WTP) and have been used for a wide range of products. Experiments are often designed to be incentive-compatible (Lusk, Fields, and Prevatt, 2008); that is, they are designed to induce consumers to reveal their true preferences to researchers. Particularly for novel products, experimental economics provides a useful way to gather information on market potential (Alfnes, 2007) or develop information on attributes for which consumers may be willing to pay a premium (Abidoye et al., 2011).

Elicited values using stated preference methods may not be consistent with actual decision-making if consumers do not face real economic decisions (List and Gallet, 2001) and incentive compatibility has traditionally been lacking in hypothetical choice experiments (Murphy et al., 2005). Furthermore, the informational efficiency of choice experiments can be increased by using incentive compatible ranking procedures: although a single choice provides information on just the one option that is most preferred, rankings provide preference information for the full set of possible choices (Chang, Lusk, and Norwood, 2009; Lusk, Fields, and Prevatt, 2008).

This article proposes a value elicitation mechanism that, to the authors' knowledge, has not been previously implemented in a form that combines incentive-compatible and nonhypothetical experimental auctions and explicit choice rankings; this allows for a unique

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opportunity to compare an individual's responses in ranking and auction procedures, in particular for products that subjects had not previously had the opportunity to purchase. This mechanism was applied to elicit consumer preferences and WTP for various pomegranate products. The use of auction and ranking procedures contributes an additional tool to determine preferences for new products before they are brought to market. Although novel products are sometimes defined as products that are not readily available in the marketplace, the term novel products is also used in this study to describe products that a consumer has never purchased before.

A number of issues related to paired bids (multiple bids by the same individual paired before and after information treatments) and novel products have been raised in the literature (e.g., Alfnes, 2009; Kanter, Messer, and Kaiser, 2009). Also, the novelty of the products indicates the need for providing reference prices to bidders as a result of a lack of an outside benchmark price for the value of the goods. Subjects who are provided with "reference prices" were shown to raise estimates of WTP by Drichoutis, Lazaridis, and Nayga (2008). Although this finding may not hold absolutely, it does raise questions on whether prior information on market prices will affect value elicitation procedures. Bernard and He (2010) also found price effects on experimental auction bids and suggest that these should be taken into account in experimental auction design.

Jaeger and Harker (2005) used experimental methods applied to horticultural innovation and suggest their application for new product development. Pomegranates are considered a type of functional food resulting from its high concentration of antioxidants (Lansky and Newman, 2007). Functional foods often contain antioxidants and other phytochemical compounds that have short- and long-term health benefits. Pomegranate health benefits range from reduction of atherosclerosis indicators and blood pressure in humans (Aviram et al., 2004) to improvement in prostate cancer indicators (Pantuck et al., 2006) in addition to the many health effects on diabetes, cancer, and other diseases as shown in animal studies (e.g., Huang et al., 2005; Shiner, Fuhrman, and Aviram, 2007). This article analyzes both the novelty and health properties of pomegranate products.

Methodology

Consider an individual i of n total individuals engaged in an experimental auction mechanism in which bids are submitted on J products with S information treatments applied between rounds of bidding. Assuming that no reservation price is imposed and that bidders' private values are independent,[1] the equilibrium bid function for bidder i who has valuation V_i has the form $B_{ij} = \beta(V_{ij}) = V_{ij}$ where $\beta(V_i)$ is the vector of equilibrium bid functions (Paarsch and Hong, 2006).

The expected utility to an individual based on rankings can be understood using the random utility framework applied to rankings by McFadden (1974). Thus, an individual i's utility U_{ij} (unobserved to the researcher) from product j can be given by the deterministic (V_{ij}) and a random (ε_{ij}) component as given by $U_{ij} = V_{ij} + \varepsilon_{ij}$. Furthermore, consider a ranking mechanism for the same individual i who must also submit rankings on $L = (J + 1)$ product options with S information treatments applied between rounds of ranking where the $J + 1$ product options are the same J products from the bidding with an additional opt-out option for no product. If individual i is asked to rank L product options that differ in terms of a vector of attributes x_l, the systematic portion of utility derived from product l is $V_{il} = \beta_i x_l$ where β_i is a vector of marginal utilities. In the ranking decision process, individual i ranks a choice set C of L products with each product l ranked higher than k for $k = 1, 2, \ldots, l - 1$ if $U_{il} > U_{ik}$.

The probability that any product will be chosen as the item to be purchased based on the ranking procedure is modeled following Lusk, Fields, and Prevatt (2008); the chance of any

[1] Bidders' private values are independent and thus follow the independent private values (IPV) paradigm where each individual knows his own private value for the good, but the valuations of other individuals are independent and not known to other individuals.

product l with ranking r being randomly selected as binding is given by:

$$(1) \qquad \frac{L+1-r_l}{\sum_{l=1}^{L} 1} * 100\%.$$

This function provides the weighted probabilities of a product being selected. Higher-ranked products are more likely to be selected and lower ranked products are less likely to be selected. There is a 100% chance that one product will be selected. If product l is selected, then participants pay price P_1 based on the binding price in the auction procedures. Thus, each participant's expected utility (EU_i) for ranking L products is:

$$(2) \qquad EU_i = \sum_{l=1}^{L} \left(\frac{L+1-r_l}{\sum_{l=1}^{L} 1} \right) U_{il}$$

Each individual has an expected utility that is equal to the sum of the probability that a product is received multiplied by the individual utility that would be received from purchasing that product. To maximize expected utility, an individual should rank the products such that product $l = 1$ is ranked highest, product $l = 2$ is ranked next highest, and so on. As Lusk, Fields, and Prevatt (2008) detail, this implies that the individual cannot improve his or her expected utility by assigning a higher numerical rank (implying it is less preferred) to a more preferred product; thus, the mechanism is itself incentive-compatible using the expected utility framework.

Experimental Procedures and Data

Subject participants (n = 203) were recruited using newspaper and online advertisements from the Bryan-College Station area of Texas to participate in a study on fruit purchase decision-making. Participants were assigned to study sessions based on schedule availability and according to their age and gender to reflect demographics of U.S. grocery shoppers (Carpenter and Moore, 2006). A total of 198 participants submitted usable auction bids and 188 submitted usable preference rankings. Participant bids were considered unusable if demographic survey data, bids, or rankings were incomplete. Table 1 shows summary statistics of participants.

Procedures

Subjects participated in auctions for seven fruit products: California Wonderful pomegranate (predominant variety in the market), Texas pomegranate one (variety Texas Red), Texas pomegranate two (variety Salavatski), ready-to-eat (RTE) California pomegranate arils, RTE Texas pomegranate arils, mixed pomegranate juice, and pineapple as a control fruit. None of the Texas products are currently available in retail markets. Subjects were compensated $35 less any purchases they made in exchange for participation in a 1.5-hour-long session. Before their arrival at the study site, participants were not aware that pomegranates would be a part of the study; this was done to ensure that responses reflected preferences before the experiment. Five of the eight study sessions (n = 135) received information of the current average retail prices of $3.50 for each of the products included in the study. Figure 1 shows the procedures that each participant followed as a part of the experimental auction. A combination of an 11th-price sealed-bid modified-Vickrey auction and a nonhypothetical ranking procedure was used to elicit consumer preferences. The detailed nature of these procedures was extensively described to subjects. The instructions clearly stated that cash would be paid for any good purchased and that there would be 10 buyers from the auctions and 10 buyers from the rankings for each session. In an 11th-price auction, the 11th highest price is the market price, and the 10 highest bidders pay the market price for the product. The 11th price is near the median price for the auction for sessions of 20–30 subjects and thus should elicit WTP in a way similar to the Vickrey second-price auction (Vickrey, 1961) while engaging a wider range of bidders. Binding prices were not posted in the fruit product rounds to avoid bid affiliation and confounding effects with the additional information treatments. This also prevented subjects from knowing the market prices for each product before the ranking procedure.

The likelihood of a product being selected as the item purchased from the rankings was proportional to the subjects' ranking of that

Table 1. Demographic and Other Characteristics of Participants (n = 198)

Variable	Category	Mean	Standard Deviation	Percent
Age (years)		42.84	17.51	
Education	High school diploma or less			11.4
	4-year college degree or less			60.7
	Graduate courses or more			27.9
Household size (number of individuals)		2.24	1.15	
Gender	Female			68.7
	Male			31.3
Marital status	Married			54.2
	Not married			45.8
Household income ($/year)		53,693	36,973	
Primary shopper	Yes			88.0
	No			12.0
Weekly household spending on food ($)		109.13	75.49	
Weekly household spending on fruits and vegetables ($)		25.13	17.72	
Fresh fruits and vegetables on hand (lbs.)		6.37	4.65	
Previous purchase of pomegranate fruit	Yes			24.6
	No			75.4
Have a serious health issue	Yes			28.5
	No			71.5
Tobacco use (% of days per year smoked)		20.79	57.77	
Exercise (% of days per year exercised)		43.52	38.97	

item; thus, there was an incentive to truthfully rank the most preferred product the highest and so on until the least preferred product was ranked lowest. This procedure was described to subjects to emphasize that the first ranked product was most likely to be chosen with the likelihood of a product being chosen decreasing.

Subjects participated in practice rounds, using soft drinks and snacks, to familiarize them with the bidding and ranking procedures. There was a brief quiz on the auction and ranking procedures, and subjects were provided with the correct answers. The market prices were only posted during the practice rounds to ensure understanding of the mechanism. In addition, subjects also completed survey questions (divided in two parts to reduce fatigue) to provide demographic, income, and additional data on fruit-buying behavior.

Subjects participated in a series of auction and ranking treatment rounds for all the fruit products. The first round was the baseline round with no information provided about the products to establish a starting point for WTP and preferences. Subsequently subjects were provided with an information treatment and then asked to resubmit bids and rankings. The order of the information treatments was randomized for each session. The information treatments were: 1) tasting: subjects tasted small (approximately 2 oz.) samples of each product and the method for removing the husk of a whole pomegranate fruit was described; 2) health and nutrition information: subjects were provided with health and nutrition information for each type of fruit

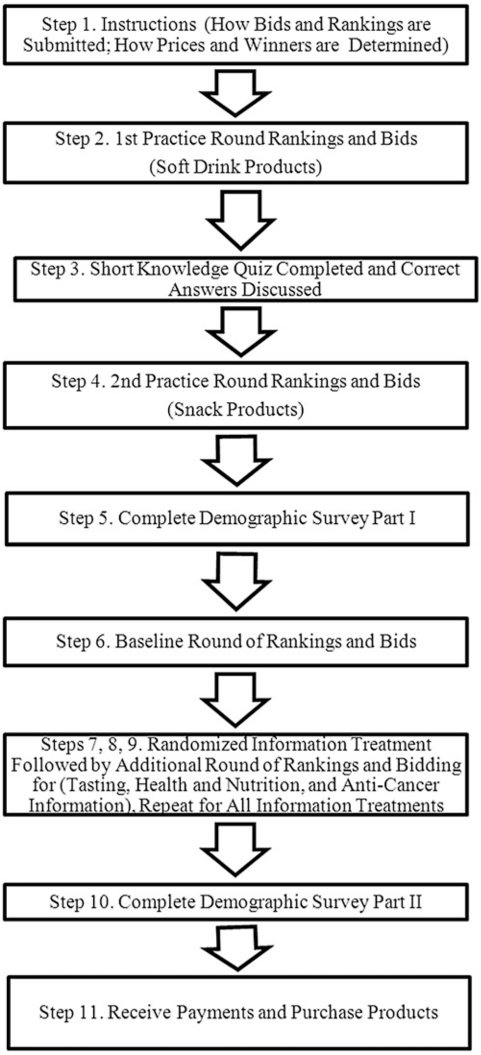

Figure 1. Experimental Procedures Used in Conducting Experimental Auctions and Nonhypothetical Preference Rankings for Novel Fruit Products

product; and 3) anticancer information: subjects were provided with information on the potential anticancer properties of pomegranate products. The anticancer information was applicable to all pomegranate products. Although subjects' tasting of the products was voluntary, no participants refused to taste the samples that were provided.

After conducting all four bidding and ranking rounds, one binding round was randomly selected and matched with a product that had previously been randomly selected and placed in a sealed envelope. This process ensured adequate supplies of all products (Bernard and Bernard, 2009). Following the 11^{th} price auction mechanism, the market price was the 11^{th} highest price, and the 10 highest bidders purchased a single randomly selected product at the market price. Of those who did not make a purchase based on the auction mechanism, 10 additional participants purchased products at the market price based on their preference rankings for the product with the highest probability as described in equation (1). It was not possible for participants to purchase more than one fruit product.

In determining what sort of ranking procedure to apply, Olsen, Donaldson, and Shackley (2005) addressed the issue of explicit vs. implicit rankings data in terms of preferences for public goods (vs. the private goods in this experiment). In this case, the implied rankings are the ordered bids, and the explicit rankings are the actual preference rankings submitted by subjects. The implicit rankings were generated by ordering the bids (given in dollars) such that the product with the highest bid was assigned a rank of one, the second highest bid was assigned a rank of two, and so forth. Bids with the same values (ties) were considered to have the same level of utility and hence participants were indifferent between equal bid products. In these cases, the tied products were assigned the same ranking and were analyzed using the exact marginal likelihood for indifference in alternatives in the rank-ordered logit model (StataCorp, 2009).

In the explicit ranking portion of the procedure, subjects were given the option of "no product" to allow for matching of bids of \$0.00 with the ranking; the "no product" option was indicated by subjects if they preferred to have none of the products over the option of having any one of the products remaining in the choice set. For the ordered bids, the option of "no product" was assigned the appropriate ranking based on the ordered bids (OB) as $OB\ Rank_{No\ Product} = \max(OB\ Rank\ for\ Product\ with\ Bid > \$0.00) + 1$. Any products that had bids of \$0.00 were assigned ordered ranks based on $OB\ Rank_{Product\ with\ Bid\ =\ \$0.00} = OB\ Rank_{No\ Product} + 1$. Thus, the assigned ranking based on the ordered bids for the no product option was assigned one numeric rank higher than the number of products that were given bid values greater than \$0.00 and any products with bids of \$0.00 were assigned a numeric rank one higher than the no product option. For example, suppose a participant submits six bids with positive values and one bid of \$0.00. The six positive product bids would be sorted from highest to lowest and the products ranked accordingly first through sixth, the no product option would be ranked seventh, and the final product corresponding to a bid of \$0.00 would be ranked eighth.

Experimental Auction Model

The WTP for products based on experimental auction bids is modeled as a function of product characteristics, sociodemographic characteristics, behavioral characteristics, reference price, and the information treatments received, given as: *WTP = f(product characteristics, socioeconomic factors, behavioral factors, information treatments)*. The product factors included are: variety (California Wonderful, Texas Red, and Texas Salavatski), the product form (whole fruit, RTE arils, or juice), and the type of fruit (pomegranate or pineapple). Variable names and descriptions are provided in Table 2.

A random parameters model was specified to address individual heterogeneity; this model is also called a mixed model or a random coefficients model.[2] "Random parameters" refers to allowing the model to account for unobserved heterogeneity in the data by allowing the parameters to vary following a specified distribution. A normal distribution for the random parameters is used, and subject bids can be modeled as:

$$(3) \qquad y_{isj} = x_{isj}\mathrm{b} + \alpha + u_i + \eta_i x_{isj} + \varepsilon_{isj}$$

where **b** is a set of coefficients for the regressors that are constant for all bids, α is the intercept for all bidders, u_i allows for variation in the individual intercept, $\eta_i x_{isj}$ allows for variation in the values of the regressors for each individual, and ε_{isj} is the error term. This model allows for changes across individuals for any specified regressors through the $\eta_i x_{isj}$ term. The errors introduced by the terms that are correlated with each individual are independently distributed of the overall error term ε_{isj}.

Implied differences in WTP across information treatments for each individual are defined for any individual i following Lusk, Feldkamp, and Schroeder (2004) as:

$$(4) \qquad DeltaWTP_{isj} = WTP_{isj} - WTP_{i(Base)j}$$

where $s \neq Base$. For example, the implied difference in WTP by an individual with identification number four for product one between a baseline round bid of \$2.00 and a tasting information round of \$3.00 would be calculated as $DeltaWTP_{4(Taste)\mathbf{1}} = \$3.00 - \$2.00 = +\$1.00$. The equation for the implied difference in WTP can also be written as: $DeltaWTP_{isj} = (C_s - C_{Base}) + [\beta_s(X) - \beta_{Base}(X)]$ where C is a constant and X is a vector of product characteristics, demographic and behavioral features, and information treatments. The constant can be respecified as a single constant value:

$$(5) \qquad DeltaWTP_{isj} = C + (\beta_s - \beta_{Base})(X).$$

Thus, any parameters estimated based on implied differences for products are actually the changes in the parameters from information treatments to the baseline. The implied differences in WTP are not censored at a value of \$0.00, because participants had the flexibility to vary their bids positively or negatively from the baseline round. For example, it was expected that there would be a range from positive to negative value for the changes in WTP following the tasting information depending on whether subjects liked or disliked the taste of pomegranates.

The implied differences across rounds could include zero bids by an individual for both the baseline round and the information treatment (Rousu et al., 2007). These must be removed from the analysis of the implied differences because the presence of bid censoring is not

[2] A random effects Tobit model was also estimated for the auction bids; the results suggested there were random effects in the panel data and hence a random parameters model was specified to allow for heterogeneity in the parameters. These results of the random effects Tobit model are available from the authors on request.

Table 2. Demographic and Behavioral Variables Included in the Experimental Auction Model

Variable	Description
DAGE2	Value of 1 if 30 to 49 years of age, 0 otherwise
DAGE3	Value of 1 if more than 50 years of age, 0 otherwise
DEDU2	Value of 1 if for education x: high school degree < $x \leq$ 4-year college degree, 0 otherwise
DEDU3	Value of 1 if education of more than a 4-year college degree, 0 otherwise
HOUSE	Household size (number of individuals)
FEMALE	Value of 1 if female, 0 otherwise
DMAR	Value of 1 if married, 0 otherwise
DINC2	Value of 1 if for household income x: \$50,000 < x < \$99,999, 0 otherwise
DINC3	Value of 1 if household income greater than \$100,000, 0 otherwise
SPENDFV	Weekly household spending on fruits and vegetables
FPOH	Paired sum of pounds of fresh fruit and pounds of fresh vegetables on hand
POMFRUITP	Value of 1 if individual previously purchased a pomegranate fruit, 0 otherwise
ILLNESS	Value of 1 if subject had a health issue he or she considered serious, 0 otherwise
TOBACCO	Percentage of days per year that the individual used tobacco products
EXERCISE	Percentage of days per year that the individual exercised for 20 minutes or more
PRICE	Value of 1 if individual given a reference price, 0 otherwise

defined when an individual bids zero in the baseline and subsequent rounds. Although the implied difference is zero, which would otherwise indicate no change in WTP, in the case of repeated zero bids, these bids do not provide any information on the direction or magnitude of any change in WTP. Therefore, for this study, implied bid differences based on two zero bids were excluded for the estimation of the implied bid differences models.

Preference Ranking Model

The use of a rank-ordered mixed logit model accounts for the ordinal nature of the data as well as avoiding the independence of irrelevant alternatives (IIA) assumption of the standard logit model. In such a model, if the stochastic terms are used to represent deviations from the mean tastes, then the errors can be allowed to be correlated across product alternatives. Using the random utility model $U_{il} = V_{il} + \varepsilon_{il}$, each ε_{il} is assumed to be an independently and identically distributed (IID) extreme value. We specify L products here to avoid confusion with the product options presented in the models for the auction bids. Let l correspond to each of the product options to be ranked, with $L - 1$ choice decisions to be made. The model can now be specified as:

$$U_{isl} = \beta_i x_{isl} + \varepsilon_{isl} \tag{6}$$

where $V_{isl} = \beta_i x_{isl}$. To allow correlation across multiple products, the random utility function can be modified with further specification of β_i. Recall that β_i is the unobserved vector of coefficients for each individual that is randomly distributed with a conditional probability density function given by $f(\beta_i|\theta^*)$ where θ^* represents the true parameters of the distribution (Calfee, Winston, and Stempski, 2001); θ^* can also be understood as the vector of parameters of the density function (Wong, Wong, and Sze, 2008). The stochastic source of error ε_{isl} remains uncorrelated with β_i and x_{isl} and is distributed IID extreme value as before. The β coefficient vector more specifically takes on a form of $\beta = \mathrm{b} + \eta_i$ where b is the population mean and η_i are individual deviations from the average tastes for the population (Calfee, Winston, and Stempski, 2001). Utility can then be specified as:

$$U_{isl} = \mathrm{b}x_{isl} + \eta_i x_{isl} + \varepsilon_{isl} \tag{7}$$

where the stochastic portion of utility is now correlated across alternatives through the attributes in the model. Thus, the model no longer imposes IIA. The conditional probability that individual i will choose alternative k is

$$(8) \quad F_{il}(\beta_i) = \frac{e^{(\beta_i x_{isj})}}{\sum_{l=1}^{L} e^{(\beta_i x_{isl})}}.$$

The conditional probability of assigning a given full ranking of all possible alternatives of l^1, l^2, l^3, ..., l^{L-1} such that, for example, alternative l^1 is ranked first, l^2 is ranked second, and so on for a given set of information, s can be calculated as the product of the conditional probability for all choice decisions:

$$(9) \quad \text{Prob}_{is}\left(l^1, l^2, l^3, \ldots, l^{L-1}\theta^*\right) = \prod_{(L-1)}^{(l=1)} \frac{e^{(\beta_i x_{isl})}}{\Sigma_{l=k}^{L} e^{(\beta_i x_{isl})}};$$

This is the probability of the series of binary choice decisions that are "exploded" from the full rankings to take advantage of all possible information (Srinivasan, Bhat, and Holguin-Veras, 2006). As a final step, integrating the conditional probability over all possible values of β_i, where the parameters θ* define the distribution of β_i, gives the unconditional probability that a given alternative l (of alternatives l_1 to l_{L-1}) will be selected by a subject, given by

$$(10) \quad \text{Prob}_{is}(l_1, l_2, l_3, \ldots, l_{L-1}|\theta^*) = \int \prod_{l=1}^{L-1} \frac{e^{(\beta_i x_{isl})}}{\sum_{k=1}^{L} e^{(\beta_i sk)}} \times f(\beta_i|\theta^*) d\beta_i.$$

Thus, with an objective of estimating θ*, which are the parameters defining the distribution of coefficients β_i, the log-likelihood function to be maximized is

$$(11) \quad LL(\theta) = \sum_{i=1}^{n} \ln \int \prod_{l=1}^{L-1} \frac{e^{(\beta_i x_{isl})}}{\sum_{k=1}^{L} e^{(\beta_i sk)}} f(\beta_i|\theta^*) d\beta_i.$$

The integral to be maximized has no closed-form solution; therefore, it is not possible to maximize the log-likelihood function in its true form; estimation is most often done using simulation techniques (Greene, 2003). The "exploded" ranking procedure has been described by others using a mixed rank-ordered logit model, including Rabe-Hesketh and Skrondal (2005) and Srinivasan, Bhat, and Holguin-Veras (2006). Here, maximum simulated likelihood estimation in STATA/IC 11.0© (StataCorp, 2009) based on the procedure in Hole (2007) using 100 Halton draws was used to estimate the mixed rank-ordered logit models.

Results and Discussion

In analyzing the demographics of the population sample, 88% of participants reported themselves to be the primary shopper for their household, and all other participants reported that they carried out at least a portion of the household shopping responsibilities. Most participants were unfamiliar with pomegranate fruits with only 24.5% of subjects reporting previous purchase of a pomegranate fruit. Thus, pomegranates could be considered a novel product for the majority of participants.

In the sessions that were not given reference prices, there were fewer participants who reported bids higher than the average retail price of the products in local stores ($3.50 per fruit product at the time of the study). A rational consumer would not be expected to submit a bid for a product that exceeded the sum of the retail price of the good, any associated transaction costs, and any additional utility received from obtaining additional information on a novel product immediately. The results suggest that those subjects who received reference price information were influenced by that value as a result of the lack of familiarity with pomegranates.

The study allowed for additional comparisons to determine if results are similar across the bidding and ranking rounds by reviewing the bids and rankings submitted by each participant. For this study, preference reversals are defined as a reversal in the order of preferences within a single round. (Changes from one round to another are not considered reversals because they may instead be the result of updating of preferences based on the information treatments.) A comparison of preference reversals is provided in Table 3. All subjects ranked the products and submitted bids on those products at the same time and had the opportunity to check that all their implied ordered bid rankings and their actual preference rankings were the same. Although there has been extensive review in the literature of similarities and differences among discrete choice rankings and bids submitted in experimental auctions, the presence of many preference reversals included in Table 3 suggests that at least in this case, the

Table 3. Count of Individuals per Round with at Least One Preference Reversal (n = 198)

	Baseline	Tasting Information	Health and Nutrition Information	Anticancer Information	Full Information
Individuals with at least one reversal	142[a]	141	132	133	137

[a] Preference reversals are defined here as instances when an individual ranked the goods in an order for the preference ranking portion of the experiment, which differed from the ranking implied by his or her ordered bids.

two methods of preference elicitation do not provide identical results. Each individual submitted rankings for eight product options in each round; this means that there were 40,320 ways to rank the products; the complexity of the ranking procedure may have played a role in the high number of individuals with at least one preference reversal for each round.

Full Bid Model

The experimental auction bids were pooled; thus, the data set contained 28 bids (seven products × four rounds) submitted by each individual. The random parameter model allows testing for the presence of individual heterogeneity in the data. The standard deviations of the random parameters are interpreted as the dispersion effects for that parameter (Rickard et al., 2011). Thus, although an individual's preferences may give a different intercept than another individual in the study, the product characteristics and information treatments can influence subsequent bids differently as well.

The novelty of the fruit products investigated in this study led to the hypothesis that a number of subjects would be at least partially unengaged in the auction process. That is, these "partially unengaged bidders," despite being recruited for a fruit purchase decision-making study, were disinterested in the bidding for at least one of the fruit products. These subjects were identified as those who submitted bids of $0.00 for a particular product for all four information rounds. Completely unengaged bidders would be those who submitted bids of $0.00 for all products in all rounds.

Table 4 presents the results for the model including all bidders and the results for the model excluding unengaged bidders (unengaged for any product). Estimates based on the entire population of bidders may be more reflective of the general population, because it was unlikely that all bidders purchase all included products in a real-world setting on a regular basis. Therefore, the model including all subjects was more representative of the general population of shoppers. However, the population of potential buyers of all these fruit products was also of economic interest, and that could be reflected in the model of bidders who were engaged for all the products.

Results for both models including "all bidders" and "excluding unengaged bidders" were similar. Both models show an increase in WTP for the Texas varieties, RTE and juice products, the control pineapple, and all information treatments. For both models, household size had a statistically significant and negative effect on the bids, whereas a previous purchase of pomegranate fruit had a positive effect on WTP. The household size effect suggests that there may be some tradeoff between the quantity and quality of food desired as household size increases. The significance of previous purchases suggests that experience with novel goods such as pomegranates is a key for determining WTP, even more so than the demographic factors that are predictors for more familiar goods. The model with all bidders showed a higher WTP associated with females, high income, and highly educated participants. Recall that the average retail price of all products included in the experiments was $3.50. The magnitude of the increase in WTP for all bidders is $0.04 for Texas Red and $0.03 for Texas Salavatski over the baseline California Wonderful variety. Ready-to-eat products increase WTP by $0.27, whereas juice forms increase it by $0.56 and the control fruit pineapple increases it $0.94 over a whole California Wonderful fruit. All information treatments had a positive and statistically significant effect on

Table 4. Random Parameter Model Results for Willingness to Pay for Fruit Products Using Experimental Auction Bids

	All Bidders		Excluding Bidders Who Are Unengaged for Any Product[bc]	
	Parameter[a]	Standard Error	Parameter	Standard Error
Constant	0.112	0.188	0.253	0.197
Standard deviation	0.346***	0.040	0.313***	0.048
Variety				
1: Texas Red	0.041*	0.024	0.053**	0.026
Standard deviation	0.225***	0.026	0.184***	0.030
2: Texas Salavatski	0.031*	0.019	0.054***	0.017
Standard deviation	0.171***	0.020	0.081**	0.032
Product form				
Ready-to-eat (RTE)	0.272***	0.037	0.308***	0.042
Standard deviation	0.487***	0.028	0.482***	0.032
Juice	0.557***	0.062	0.555***	0.072
Standard deviation	0.837***	0.045	0.848***	0.052
Pineapple	0.942***	0.065	0.930***	0.072
Standard deviation	0.875***	0.047	0.855***	0.053
Price information	0.543***	0.088	0.644***	0.097
Standard deviation	0.720***	0.062	0.683***	0.071
Additional information				
Tasting	0.124***	0.031	0.158***	0.039
Standard deviation	0.386***	0.026	0.436***	0.031
Health and nutrition	0.097***	0.029	0.128***	0.036
Standard deviation	0.348***	0.024	0.398***	0.030
Anticancer	0.103***	0.028	0.136***	0.035
Standard deviation	0.333***	0.024	0.383***	0.029
Demographics/behaviors				
DAGE2	0.038	0.123	–0.015	0.126
DAGE3	–0.040	0.117	–0.056	0.119
DEDU2	0.200	0.133	0.140	0.140
DEDU3	0.164*	0.098	0.138	0.104
HOUSE	–0.083**	0.042	–0.067	0.045
FEMALE	0.180*	0.094	0.173*	0.098
DMAR	–0.057	0.114	–0.054	0.122
DINC2	0.059	0.103	–0.057	0.111
DINC3	0.300*	0.161	0.287	0.177
SPENDFV	0.002	0.003	0.000	0.003
FPOH	0.015	0.010	0.016	0.011
POMFRUITP	0.552***	0.102	0.436***	0.104
ILLNESS	0.068	0.096	0.092	0.102
TOBACCO	–0.053	0.139	–0.127	0.149
EXERCISE	0.173	0.142	0.373	0.158
Log-likelihood	–4484.152		–3548.334	
LR test[d]	6,643.19***		4,706.63***	
No. of observations	5544		4312	

[a] Single (*), double (**), and triple (***) asterisks are used to denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
[b] Unengaged bidders are those who submitted bids of $0.00 for all rounds for the specified fruit product.
[c] "Any products" refers to bidders who were unengaged for any of the seven fruit products.
[d] Likelihood ratio test of mixed linear model vs. linear regression.

WTP compared with the baseline round. The flavor and other physical attributes of the products had a positive influence in WTP, as evidenced by a price premium of \$0.12 following the tasting treatment. Health and nutritional information and anticancer information treatments increased WTP by \$0.09 and \$0.10, respectively.

The heterogeneity in the data for the random parameters at the individual level is reported as the standard deviations of each random parameter. The statistical significance of the standard deviations of all random parameters suggests heterogeneity in individual effects on WTP of the Texas varieties, product forms, and information treatments. The need for a random parameters model was tested using a likelihood ratio test; the null hypothesis of a nested constant parameter model was rejected in favor of the random parameter model for both sets of bidders.

Across all rounds, the percentage of unengaged bidders for a product ranged from 5% for the control product (pineapples) to 18% for the two Texas pomegranate whole fruits with 17% unengaged bidders for the whole California pomegranates and 14% for both the Texas and California RTE pomegranate products. This is supportive of a hypothesis of greater familiarity and preference for pineapple vs. the whole pomegranate fruits, but it suggests only slight differences for the California vs. Texas varieties. In comparing these products, the number of bidders who were unengaged for any one of the seven fruit products ("Any Product") was counted at n = 44.

Although some of the pomegranate products were familiar to some of the study participants, the majority of the products were unfamiliar to most participants, and some products were not available in the outside retail marketplace (i.e., Texas varieties of pomegranates) and would thus be considered truly novel products. This information can be useful to marketers of novel products who want to estimate the maximum amount that currently engaged buyers would be willing to pay. Such information can also predict the factors that influence the decisions of consumers who are not current purchasers of a product but who could be influenced to purchase a novel product once they have obtained more information on the product. Consequently, the differences in the models for unengaged vs. fully engaged bidders suggest that there is value in both subsamples depending on the question that is to be addressed by researchers or marketers. Consideration of both of these estimates is especially important when dealing with an unfamiliar product.

Implied Bid Differences Model

One important question to be answered regarding the information treatments is whether there was a difference in the bids that subjects submitted for each product following each information treatment. Although the full bids for the products for each treatment are useful, it is also instructive to compare differences across information treatments within each individual's bids.[3] The "implied bid difference" was calculated using equation (4). The intention of this approach is to focus the comparison on the changes in participants' bids across information treatments. Results of the Random Parameter model using the implied bid differences excluding unengaged bidders are presented in Table 5.

The analysis based on the implied differences in bids is of particular value when a researcher wishes to investigate the magnitude of those differences. Consider an individual bidding for several products in multiple rounds. If those products have similar outside substitutes and are similarly valued, then these relative differences will cancel out. This is true for the within-subject differences in bids for each product because the relevant outside substitutes are assumed to remain constant for each product across multiple rounds. On the other hand, this is not the case for calculating differences in overall bids for each product because the outside alternatives for a product for one

[3] The paired bid differences across treatments were compared using two-tailed nonparametric Wilcoxon signed-rank tests on the differences in bids for each product from the baseline round to the specified information round based on the conservative assumption that the values for individual WTP are often nonparametrically distributed. There were significant differences for the full information set for six of the seven products ($p < 0.01$); the California RTE arils were the only exception.

Table 5. Random Parameter Model Results for Experimental Auction Data, Implied Differences in Willingness to Pay for Fruit Products

	Parameter[a]	Standard Error
Variety		
1: Texas Red	0.108***	0.035
Standard deviation	0.320***	0.033
2: Texas Salavatski	0.070**	0.029
Standard deviation	0.289***	0.026
Product form		
Ready-to-eat (RTE)	–0.108**	0.042
Standard deviation	0.499***	0.033
Juice	–0.326***	0.061
Standard deviation	0.757***	0.047
Pineapple	–0.185***	0.051
Standard deviation	0.616***	0.040
Price information	0.220***	0.069
Standard deviation	0.688***	0.048
Additional information		
Tasting	0.221**	0.108
Standard deviation	0.160***	0.021
Health and nutrition	0.208*	0.108
Standard deviation	0.088***	0.030
Anticancer	0.218**	0.108
Standard deviation	0.118***	0.024
Demographics/behaviors		
DAGE2	0.051	0.070
DAGE3	–0.135*	0.066
DEDU2	0.023	0.076
DEDU3	0.054	0.055
HOUSE	0.008	0.026
FEMALE	–0.005	0.053
DMAR	0.123	0.067
DINC2	–0.090	0.058
DINC3	0.176*	0.098
SPENDFV	–0.001	0.001
FPOH	0.006	0.006
POMFRUITP	–0.159***	0.060
ILLNESS	–0.186***	0.055
TOBACCO	0.157*	0.091
EXERCISE	–0.375***	0.088
Log-likelihood	–2,787.938	
LR test[b]	2,458.660	
No. of oobservations	3,516	

[a] Single (*), double (**), and triple (***) asterisks are used to denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
[b] Likelihood ratio test of mixed linear model vs. linear regression.

individual are not necessarily the same as those for any other individual. Alfnes (2009) previously discussed this issue in relation to a full-bidding or endowed approach. However, this can be extended to the value elicitation procedures for novel products. In the case of a novel product, individuals lack familiarity with the characteristics of the product. There are likely to be even greater differences among individuals in regard to which products are considered relevant outside substitutes. These substitutes will differ in product characteristics and are likely to differ in price as well; both of these types of information can then influence the bids that are submitted by an individual. Therefore, the differences in WTP should provide additional useful comparisons because the difference in value across two consumers is not necessarily the same as the difference in value within a single consumer.

The bids were also aggregated following all of the information treatments for each product. This aggregation, in which only the bids for which subjects had received all three information treatments and thus the "full information set" (of the tasting, health and nutrition, and anticancer information) that was imposed during the experiment, was termed the "full information" round and remained distinguishable by product. Of the possibilities to increase, decrease, or have no change in WTP for a product, with the "full information set," 22.4% of bids decreased, 37.4% increased, and 40.2% showed no change. Thus, for the majority of participants, the full information treatment had some effect, whether positive or negative, on WTP.

The results indicate that overall 15.4% of the bids submitted were unengaged, ranging from 5.0% for the health and nutrition information treatment of pineapple up to 23.1% for the anticancer information for the Texas Red pomegranate fruit. Thus, there were more unengaged bidders depending on the familiarity of the product, and this should therefore be addressed in future analysis of bid differences for novel products. There were 192 bidders who were engaged for at least one product.

However, because the dependent variable is the difference in bids from the baseline round to the respective information treatment round, the parameter estimates are also the differences in the parameters for the information treatment round and the baseline round. For example, the Texas Red coefficient in Table 5 indicates that the estimated difference in the effect of the Texas Red variety from the baseline to the information treatments is an increase of $0.11 in value. The interpretation follows similarly for all other variables in the model; thus, the model would indicate a $0.16 increase in WTP for an individual who used tobacco products everyday but only a $0.08 increase in WTP for an individual who uses tobacco on average every other day. This was not unexpected given the potential health benefits of pomegranates that were described as part of the experimental procedures.

The model for the implied differences indicates the product and/or demographic factors are economically relevant when information is provided (i.e., advertisement, product promotional materials, etc.) with the aim of increasing WTP for a novel product. That is, the implied bid differences are an improved measure (over the full bids) of the change in individual WTP caused by the information treatments. For the implied differences models, all product characteristics were significant ($p < 0.05$). However, the sign of the effects for the product form characteristics (RTE, juice, and pineapple) was negative, indicating that the information treatments reduced the additional benefit of these characteristics relative to the whole pomegranate fruits. For any of the product form characteristics, the change in WTP attributed to that characteristic decreased from the baseline round to the information treatment rounds. The positive values on the two Texas variety variables indicate that the effect of those product varieties on WTP increased from the baseline to the information treatment rounds.

The price reference information had a significant and positive effect on WTP with the implied differences model. This suggests that price reference information had an effect on the initial baseline round and the bids for subsequent treatment rounds determine how additional information will affect those bids. This is a critical point for any additional auction research in which the availability of reference price information is asymmetric among participants. The results of the implied differences model reveal that it is not sufficient to compare only the differences in the means for the products and information treatments; use of paired differences in bids before and after each information treatment on the novel product may be necessary, especially as it relates to the design of specific marketing and advertising messages.

Mixed Rank-ordered Logit Models for Preferences

Each participant submitted a ranking of seven fruit products plus a "no product" option. Pineapple (control fruit) was the most preferred product and the no product option was the least preferred for the full information set. The Texas Salavatski RTE arils were the second most preferred and the California Wonderful pomegranate fruit was the next-to-least preferred for the full information set.

A rank-ordered mixed logit model allows for the determination of whether differences in each variable depend on each individual with estimated standard deviations and standard errors for the standard deviations. Stated differently, the standard deviations of the β parameters accommodate the presence of preference heterogeneity in the sample (Hensher and Greene, 2003). The results of the estimations for the preference rankings as well as the ordered bids are given in Table 6 with both data sets

Table 6. Mixed Rank-ordered Logit Models for Preference Rankings and Ordered Bids, Estimated Coefficients, and Standard Deviations of Coefficients (N = 188)

	Preference Rankings			Ordered Bids		
	Parameter[ab]	Standard Error	exp(b)	Parameter	Standard Error	exp(b)
Variety						
1: Texas Red	0.071	0.014	1.074	–0.508*	0.271	0.602
Standard deviation	0.037	0.099		0.831***	0.245	
2: Texas Salavatski	0.195**	0.088	1.215	–0.146	0.189	0.864
Standard deviation	0.060	0.090		0.454***	0.170	
Product form						
Ready-to-eat (RTE)	0.959***	0.132	2.609	0.970***	0.262	2.638
Standard deviation	1.500***	0.112		1.878***	0.219	
Juice	1.536***	0.216	4.646	4.144***	0.478	63.055
Standard deviation	3.320***	0.235		6.738***	0.684	
Pineapple	4.286***	0.403	72.675	7.701***	0.809	2210.557
Standard deviation	4.062***	0.266		8.618***	0.930	
No Product	–0.527*	0.304	0.590	–3.007***	0.526	0.049
Standard deviation	5.795***	0.516		7.429***	0.958	
Information treatment (Trt.) interactions						
Info Trt. × variety 1: Texas Red	0.583***	0.165	1.791	0.656*	0.366	1.927
Standard deviation	0.061	0.115		0.268	0.295	
Info Trt. × variety 2: Texas Sal.	0.262**	0.129	1.300	0.275	0.268	1.317
Standard deviation	0.215*	0.118		0.287	0.223	
Info Trt. × RTE	–0.353**	0.146	0.703	–0.497	0.371	0.608
Standard deviation	0.004	0.148		1.432***	0.415	
Info Trt. × juice	–2.080***	0.241	0.125	–1.300***	0.495	0.273
Standard deviation	0.837***	0.213		2.192***	0.342	
Info Trt. × pineapple	–0.746***	0.264	0.474	0.487	0.573	1.627
Standard deviation	0.510**	0.223		2.982***	0.512	
Info Trt. × no product	–2.353***	0.305	0.095	–0.001	0.480	0.999
Standard deviation	0.690*	0.415		0.634*	0.360	
Log-likelihood	–3,090.089			–1,072.361		

[a] Single (*), double (**), and triple (***) asterisks are used to denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
[b] The model for the full information is based on observations in the first and last rounds of rankings.

modeled using a mixed, rank-ordered logit model. As a logit model, the parameters for the mixed rank-ordered logit model can be interpreted in terms of the log odds ratio. For example, in the Texas Salavatski type, a coefficient of 0.195 implies that there is a 0.195 change in the log of the odds. The exponential of the parameters shows the change in the odds of being ranked as the most preferred option. If the variety was a Salavatski, the odds of being ranked first are 1.22 times greater holding all other variables constant. However, if the standard deviation of the parameter is significant, then the effects do not apply uniformly across all participants.

For both models, the order of the product forms was generally robust to the way in which preferences were elicited, although the magnitude of the estimated parameters varied from the preference rankings to the ordered bids. The preference rankings indicated that there was a preference for the Texas Salavatski variety for the overall model, but there was a tendency for a diminished preference for the Texas Red variety based on the ordered bids. The negative sign of the no product coefficient indicates that respondents preferred any of the fruit products included in the study rather than no product at all.

These models were also estimated to include individual level interaction effects of the full information set with each product characteristic. Individuals would not be expected to have the same reaction to each characteristic as a result of differences in each individual's preferences. The presence of individual-level interaction terms varied depending on whether explicit or implicit rankings were considered. Product rankings indicated an interaction of the two Texas varieties with the full information set, but the auction bidding (implicit) did not indicate this interaction. The preference ranking model generally predicts more individual variation in preferences and greater effects from the interaction of the product characteristics and having the full information set. Although only the Texas Salavatski variety was important alone, both Texas pomegranate varieties were important when the interaction of those varieties and the full set of information was considered. These results are in contrast to the same model estimated for the ordered bids for estimated product characteristics and interaction effects.

Comparing the two methods of preference elicitation suggests some key issues. First, in both models, product form is an important determinant of preferences, and heterogeneity across individuals was present for all product forms. In this case, accounting for individual preference heterogeneity was a necessary component of model selection for both the auction and rankings. Second, the magnitude of the increase in WTP associated with each product characteristic in the full bid and implied difference bid models suggested that respondents had the following preference (from highest to lowest): the control fruit pineapple, juice form, RTE product forms, and Texas Red and Salavatski varieties. The order of preference for the product forms was maintained in both elicitation methods. Third, the preference rankings indicate the presence of interactions between information treatments and all the varieties and product forms included ($p < 0.05$); in contrast, only one product form (juice) had an information treatment interaction for the ordered bids model. Therefore, when participants provided preference rankings, they considered the information treatment in relation to the product characteristics, but when rankings were based on ordered bids for the same products, participants did not consider the information relative to the product characteristics and the information treatment interaction with the product form was often not observed. Still, the presence of at least one interaction between information treatments and product forms in both models implies that researchers who provide information on products must be aware of the potential for that information to have different impacts on each product for both auction and ranking procedures.

Conclusions

For any product that is not currently available on the market, there is a challenge in determining potential WTP for products, especially for products whose value is derived from consumption. The application of this combined ranking and bidding preference elicitation mechanism provides a useful means of collecting information on preferences for these types of novel products and the effects of information treatments. In analyzing the experimental results, several bidders were found to be either unengaged as individuals or not fully engaged for a particular product with results indicating that unengaged bids should be accounted for in modeling WTP. Furthermore, these results indicate that unengaged bidders may be especially common in eliciting WTP for novel goods, and researchers should be aware of this possibility and plan to use an elicitation mechanism allowing them to determine if bidders are unengaged. Second, although comparisons using full bids across individuals are useful in predicting relative WTP for products, they do not account for differences in product substitutes; comparing the implied bid differences allows outside substitutes for a product and individual to cancel out. In developing estimates relative to novel products, the use of implied bid differences may be particularly important in making relative comparisons of novel products. The results from these models suggest that the change in WTP for the two Texas varieties increased but the change in WTP for RTE, juice, and pineapple decreased; this was true across the information treatments. The rankings models suggest the presence of individual preference heterogeneity for the product form characteristics as well as for the interaction of some product characteristics with the additional information treatments. These results varied depending on which information treatments were considered.

Very few of the demographic variables influenced the valuations for the novel products. Prior experience with pomegranate products had a larger effect on an individual's valuation of the products. This result indicates the importance of gauging prior experience with a novel product. The auction and ranking procedures yielded results that were similar for some product characteristics and divergent for others. In many cases, the demographic characteristics were not as important predictors of WTP as the product characteristics; additional research on which types of product characteristics (i.e. experience attributes, credence attributes, etc.) are the most important could provide results that are meaningful in regard to the marketing of new products. Although there were interaction effects between information treatments and product characteristics in both models, these were more pronounced in the preference rankings models suggesting that consumers may consider an information treatment relative to the product characteristics more strongly when asked to provide preference rankings than when asked to provide an actual WTP through submitting a bid. The differences in results lead to the question of which results are more reflective of the purchases that consumers will actually make in the future; this is the economic result of interest. In further research, a paired experiment that involved this procedure in comparison with actual sales at a retail establishment could be used to establish external validity. Results suggest that experimental economics techniques may offer interesting opportunities to evaluate new products before they are introduced to a large marketplace. The results also suggest that outside substitutes as well as characteristics of the products themselves affect the results of the preference elicitation procedures.

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