A Non-Hypothetical and Incentive Compatible Method for Estimating Consumer Willingness-to-Pay for a Novel Functional Food: The Case of Pomegranates

Callie P. McAdams [1]
Marco A. Palma [1]
Ariun Ishdorj [1]
Charles R. Hall [2]

[1] Department of Agricultural Economics, Texas A&M University, 2124 TAMU, College Station, TX 77843
[2] Department of Horticultural Sciences, Texas A&M University

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C.P. McAdams[1], M.A. Palma[1], A. Ishdorj[1], C.R. Hall[2]
[1]Dept. of Agricultural Economics, [2]Dept. of Horticultural Sciences, Texas A&M University

Introduction

- Functional foods: Health benefits beyond basic nutrition of energy, vitamins, and minerals
- Functional food industry: $27 billion in the United States in 2007[1]
- Pomegranate: Functional food with many antioxidants
- Pomegranate fruit: Novel/ unfamiliar product that reduces risk of:
  - Cardiovascular disease
  - Neurodegenerative diseases
  - Certain cancers
- Value elicitation for novel products:
  - Difficult with market data
  - Experimental techniques may be preferred
- Nonhypothetical techniques:
  Better estimates of willingness-to-pay (WTP) and preferences than hypothetical techniques.
- Previous studies have nonhypothetical auctions for novel products[2] or nonhypothetical rankings,[3] but rarely both.
- Nonhypothetical rankings better at predicting retail sales than hypothetical choices and nonhypothetical choices. [4]

Objective

- Develop a new nonhypothetical, incentive compatible technique combining 1) experimental auctions and 2) preference ranking techniques to provide more information on consumer preferences.

Methodology

- 203 subjects (split into 8 sessions) representative shoppers recruited according to Texas and grocery shopper demographics
- Two parts of procedures:
  (1) An 11th-price sealed-bid auction for the 7 products
  (2) A nonhypothetical ranking procedure for 8 product options: the 7 products pictured plus the option of "no product"
- 20 buyers per session: 10 from auction, 10 from rankings
- 4 Rounds of Information: A) Baseline
  B) Tasting Information
  C) Health and Nutrition Information
  D) Anti-Cancer Information
- Bid-Censoring: 18.4% of bids left censored at $0.00

Econometric Models

- WTP= f(socioeconomic factors, behavioral factors, information treatments, product characteristics)

- Full Bids: Random Effects Tobit Model
$$y_{isj}^* = x_i'\beta + \alpha + u_i + \varepsilon_{isj}$$

- Full Bids: Mixed Linear Model
$$y_{isj} = x_{isj}b + \alpha + u_i + \eta_i x_{isj} + \varepsilon_{isj}$$

- Rankings: Mixed Rank-Ordered Logit Model
$$\text{Prob}_{is}(l_1, l_2, l_3, \ldots, l_{L-1}|\theta^*) = \int \prod_{l=1}^{L-1} \frac{e^{(\beta_i x_{isl})}}{\sum_{k=l}^{L} e^{(\beta_i sk)}} f(\beta_i|\theta^*) d\beta_i.$$

Methodology (cont.)

Pomegranate and Other Fruit Products

California Wonderful Pom. / Texas Red Pom. / Texas Salavatski Pom. / Mixed Pom. Juice / Pineapple (as a control)

Ready-To-Eat California Pom. Arils / Ready-To-Eat Texas Pom. Arils
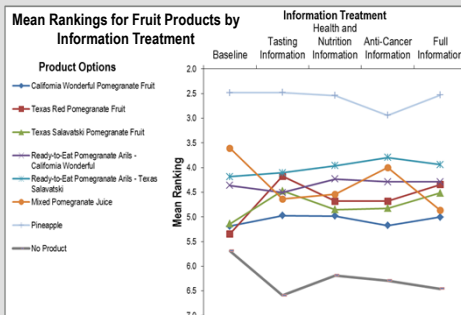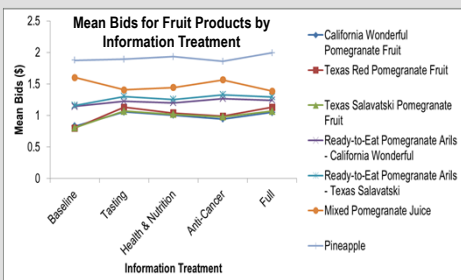
Results

Demographics

Mean Age: 42.8 years (Std. Dev: 17.5)	Mean Household Size: 2.2 people (Std Dev: 1.2)
Household Income: $56,693.47/ year (36,972.57)	Household Food Spending: $109.13/ week (75.49)

Gender: Male 31.3%, Female 68.7%

Previously Purchased Pomegranate: Yes 24.6%, No 75.4%

Mean Bids for Fruit Products by Information Treatment

Mean Rankings for Fruit Products by Information Treatment

Auction Results Summary

- ↑ Information = ↑ WTP for Pomegranate Products
- Ready-To-Eat, Juice, and Pineapple preferred over whole fruits
- WTP for Texas varieties ↔ WTP for California Variety

Results (cont.)

Table 1. Random Effects Tobit Model Estimates: WTP for Pomegranate Products

	Model A: Random Effects Tobit Model- Parameter Estimates		Model A: Random Effects Tobit Model- Marginal Effects Estimates	
	Parameter	Standard Error	$\partial y/\partial x$	Standard Error
Constant	0.149 (a)	0.137	----------	----------
Variety				
1: Texas Red	0.043	0.037	0.025	0.022
2: Texas Salavatski	0.035	0.028	0.021	0.016
Product Form				
Ready-To-Eat (RTE)	0.330***	0.028	0.195***	0.017
Juice	0.681***	0.036	0.401***	0.025
Pineapple	1.116***	0.036	0.657***	0.029
Price Information	0.709***	0.162	0.397***	0.087
Additional Information				
Tasting	0.149***	0.029	0.087***	0.017
Health and Nutrition	0.110***	0.029	0.064***	0.017
Anti-Cancer	0.117***	0.029	0.068***	0.017
$\sigma(u)$ (b)	1.099***	0.059		
$\sigma(e)$ (c)	0.735***	0.008		
ρ	0.691***	0.023		
Log-Likelihood	-5974.537			
Likelihood ratio test (d)	5066.64***			

(a) Single (*), double (**), and triple (***) asterisks are used to denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
(b) Standard deviation of individual-specific error.
(c) Standard deviation of overall error.
(d) Likelihood ratio test that σ(u) = 0.

Table 2. Mixed Linear Model Estimates for WTP for Pomegranate Products

	Model B: Product Characteristics, Price Information, Additional Information		Model C: Product Characteristics, Price Information, Demographics	
	Parameter	Standard Error	Parameter	Standard Error
Constant	0.433*** (a)	0.105	0.079	0.255
Variety				
1: Texas Red	0.041	0.030	0.041	0.030
2: Texas Salavatski	0.031	0.023	0.031	0.023
Product Form				
Ready-To-Eat (RTE)	0.272***	0.023	0.272***	0.023
Juice	0.557***	0.030	0.557***	0.030
Pineapple	0.942***	0.030	0.942***	0.030
Price Information	0.635***	0.125	0.603***	0.119
Additional Information				
Tasting	0.124***	0.025	———	
Health and Nutrition	0.097***	0.025	———	
Anti-Cancer	0.103***	0.025	———	
Demographics/Behaviors				
EDUCATION: COLLEGE	———		0.351*	0.181
HOUSEHOLD SIZE	———		-0.117**	0.055
POM FRUIT PURCHASE	———		0.517***	0.130
$\hat{\sigma}_u^2$ (b)	0.809***	0.042	0.748***	0.039
Log-likelihood	-5829.101		-5828.554	
LR Test: (c)	4481.60***		3957.35***	

(a) Single (*), double (**), and triple (***) asterisks are used to denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
(b) Estimated standard deviation for the random effects specified at the individual level.
(c) Likelihood Ratio Test of Mixed Linear Model versus Linear Regression.

Results (cont.)

Table 3. Mixed Rank-Ordered Logit Model Estimates for Pomegranate Preferences

	Preference Rankings, Fully Ranked (1-8)				Ordered Bids, Fully Ranked (1-8)			
	No Interactions(b)		Full Information Interactions(c)		No Interactions(b)		Full Information Interactions(c)	
	Parameter(a)	Standard Error	Parameter	Standard Error	Parameter	Standard Error	Parameter	Standard Error
Variety								
1: Texas Red	0.369***	(0.058)	0.071	(0.114)	-0.136	(0.123)	-0.508*	(0.271)
Std. Deviation	0.062	(0.068)	0.037	(0.099)	0.156	(0.148)	0.831***	(0.245)
2: Texas Salavatski	0.286***	(0.046)	0.195**	(0.088)	-0.024	(0.096)	-0.146	(0.189)
Std. Deviation	0.059	(0.131)	0.060	(0.090)	0.096	(0.130)	0.454**	(0.170)
Product Form								
Ready-To-Eat (RTE)	0.704***	(0.096)	0.959***	(0.132)	0.963***	(0.147)	0.970***	(0.262)
Std. Deviation	1.748***	(0.088)	1.500***	(0.112)	2.239***	(0.155)	1.878***	(0.219)
Juice	0.542***	(0.160)	1.536***	(0.216)	2.771***	(0.194)	4.144***	(0.478)
Std. Deviation	2.900***	(0.201)	3.320***	(0.236)	3.486***	(0.202)	6.738**	(0.684)
Pineapple	2.921***	(0.195)	2.286***	(0.403)	3.758***	(0.266)	7.701***	(0.809)
Std. Deviation	4.459***	(0.206)	4.062***	(0.266)	6.061***	(0.354)	8.618***	(0.930)
No Product	-1.739***	(0.209)	-0.527*	(0.304)	-1.129***	(0.206)	-3.007***	(0.526)
Std. Deviation	5.250***	(0.320)	5.795***	(0.516)	4.867***	(0.330)	7.429***	(0.958)
Information Treatment Interactions								
Info Trt x Variety 1: Texas Red	———		0.583***	(0.165)	———		0.656*	(0.366)
Std. Deviation	———		0.061	(0.115)	———		0.268	(0.295)
Info Trt x Variety 2: Texas Sal.	———		0.262**	(0.129)	———		0.275	(0.268)
Std. Deviation	———		0.215*	(0.118)	———		0.287	(0.223)
Info Trt x Ready-To-Eat (RTE)	———		-0.353**	(0.146)	———		-0.497	(0.371)
Std. Deviation	———		0.004	(0.148)	———		1.432***	(0.415)
Info Trt x Juice	———		-2.080***	(0.241)	———		-1.300***	(0.495)
Std. Deviation	———		0.837***	(0.213)	———		2.192***	(0.342)
Info Trt x Pineapple	———		-0.774***	(0.264)	———		0.487	(0.373)
Std. Deviation	———		0.510**	(0.223)	———		2.982***	(0.512)
Info Trt x No Product	———		-2.353***	(0.305)	———		-0.001	(0.480)
Std. Deviation	———		0.690*	(0.415)	———		0.634*	(0.360)
Log Likelihood	-5845.995		-3090.089		-1957.470		-1072.361	

(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 baseline information treatments is based on the observations for all four rounds of rankings.
(c) The model for the full information is based on only observations in the first and last rounds of rankings.

Preference Ranking Results Summary

- Interaction Effect:
  Product familiarity with product characteristics
- Ready-To-Eat, Juice products preferred over whole fruits; "No Product" option less preferred
- Texas Varieties 1 & 2 preferred in explicit rankings but no preference for Texas varieties in implied rankings

Conclusions

- Innovative nonhypothetical, incentive compatible combined auction and ranking procedure used
- Divergent results for nonhypothetical experimental auction and preference ranking procedure
- Individual-specific effects for the fruit product forms
- Interaction between information treatments and product characteristics ⟹ Difficult to extrapolate experimental results to other products
- Product familiarity and reference price influenced auction bids more than demographics

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