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Consumer Preference for Bio-based Batteries

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*Selected Paper prepared for presentation at the 2018 Agricultural & Applied Economics Association
Annual Meeting, Washington, D.C., August 5-August*

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INTRODUCTION

- The potential environmental and health repercussions of battery use and disposal is staggering. In 2014, 6.7 billion household batteries were consumed in the U.S., a number that was projected to increase with the growing consumer electronics industry.
- Discarded batteries containing heavy metals are easily disposed of into landfills. The large and dispersed volume of discarded batteries can be harmful to the environment and health because of the chemicals they leach into the earth.
- Rechargeable batteries have been promoted as less waste-generating than non-rechargeable batteries. However, they are as easily disposed of as household waste (but not as often) and contribute to environmental and health damage. Government programs to collect and recycle rechargeable batteries are often not strictly enforced.
- Bio-based batteries made of agricultural bi-products are a sustainable alternative. These batters are biodegradable and safer to dispose. Bio-based batteries are novel in the market, yet can potentially be consumed by every household.

OBJECTIVES

- To test whether consumers internalize the positive benefits of bio-based batteries and to assess the marketability of innovative bio-batteries, understanding consumers' preference and willingness-to-pay (WTP) is essential.
- We investigate the characteristics of U.S. consumers and their attitudes regarding environmental-friendly practices and product attributes, and how these are linked to WTP for bio-based batteries. We further assess whether consumers would view bio-based batteries and rechargeable batteries as substitutes. We also analyze how exposure to information about bio-based batteries prior to the survey affects WTP.
- This information can provide insights for stakeholders to better understand revenue streams and assess the market to formulate effective management and marketing strategies to promote the purchases of bio-based batteries.

DATA

- We obtain a U.S. nationwide survey of 1,522 randomly-selected potential consumers in the fall of 2016. Below we report demographic characteristics of the respondents and compare to Census results.

	Census (%)	All sample (Col %) (N)		Sample by region (Col %)			
				Northeast	Midwest	South	West
Number of sample (Row %)			1,493	19.29	21.70	32.28	26.32
Gender							
Male	49.20	53.99	806	60.07	52.78	51.87	53.44
Female	50.80	46.01	687	39.93	47.22	48.13	46.56
Education							
Below bachelors' degree	70.00	47.49	709	40.28	49.07	51.24	46.82
Bachelors' degree or higher	30.00	52.51	784	59.72	50.93	48.76	53.18
Children							
No children in the household	60.00	70.93	1,059	71.18	65.74	69.71	76.34
Children under age 18 in household	40.00	29.07	434	28.82	34.26	30.29	23.66
Marriage							
Single (never married)	32.00	63.09	942	63.19	60.49	63.07	64.89
Married, separated, divorced or widowed	68.00	36.91	551	36.81	39.51	36.93	35.11
Employment							
Students, unemployed or retired	36.90	39.79	594	33.68	41.67	40.25	42.24
Employed	63.10	60.21	899	66.32	58.33	59.75	57.76
Race							
Non-White/Caucasian	22.90	22.57	337	19.79	10.49	24.69	32.06
White/Caucasian	77.10	77.43	1,156	80.21	89.51	75.31	67.94
Average household income (US\$1,000)	53.88	N.A	58.51	63.04	57.92	55.96	59.21
Average age	43.50	N.A	36.07	35.17	36.98	36.08	35.95

METHODOLOGY

- We employ a double bounded dichotomous-choice contingent valuation method (DC-CVM) using maximum likelihood estimation.
- The sample was split into two groups, with one receiving an information treatment about the product. We obtain responses given an initial bid, and then from a follow-up bid.
- The data obtained consists of mainly five parts. We measure consumers:
 - Exposure to information about bio-batteries randomizing an information treatment
 - Preferences toward product attributes related to batteries' functional and environmental features such as price, brand, durability, packaging design, green production processes, and rechargeability
 - Attitudes toward environmentally-friendly practices and whether they are socially motivated to convince others to purchase eco-products
 - Self-evaluation of knowledge about the bio-based batteries, and
 - Demographic characteristics

ML REGRESSION RESULTS

	Coefficient	Standard error	Probability	Marginal effect	Standard error	T-value
Bid	-1.148***	0.036	0.000			
Constant	8.882***	0.394	0.000			
Information Treatment	0.331***	0.102	0.001	0.288***	0.089	3.243
Price importance	-1.399***	0.137	0.000	-1.219***	0.117	-10.393
Durability importance	0.269*	0.140	0.056	0.234*	0.122	1.913
Brand importance	0.164	0.126	0.195	0.142	0.110	1.296
Rechargeability importance	-0.529***	0.137	0.000	-0.461***	0.119	-3.872
Importance of green production practice	1.137***	0.150	0.000	0.990***	0.129	7.661
Importance of packaging design	-0.180	0.229	0.433	-0.157	0.199	-0.785
Level of motivation to convince others to buy eco-products	0.391***	0.126	0.002	0.341***	0.110	3.108
Recycle products	0.350***	0.120	0.004	0.305***	0.105	2.918
Self-evaluation of own knowledge	0.153	0.104	0.142	0.133	0.091	1.467
Frequency	0.158	0.133	0.234	0.138	0.116	1.190
Primary shopper	0.080	0.146	0.584	0.069	0.127	0.547
Shop online	-0.212	0.168	0.208	-0.185	0.147	-1.258
Female	0.288***	0.108	0.008	0.251***	0.094	2.670
Age	-0.144	0.109	0.187	-0.125	0.095	-1.319
Income	0.101	0.107	0.346	0.088	0.093	0.942
Children in the household	-0.012	0.118	0.921	-0.010	0.102	-0.100
Employment status	0.126	0.108	0.241	0.110	0.094	1.173
White	0.052	0.125	0.680	0.045	0.109	0.413
Reside in Northeast	0.359**	0.160	0.025	0.313**	0.139	2.247
Reside in South	0.124	0.140	0.375	0.108	0.122	0.887
Reside in West	0.317**	0.149	0.033	0.276**	0.129	2.134

Change in estimated probability of choosing bio-based batteries given bids

CONCLUSIONS

- Our results support consumers on average were willing to pay US\$7.91 for bio-based batteries, presenting a premium of 41 cents (5.5%) based on the initial bid of \$7.50.
- The marginal effects imply that the respondents who consider green production and recycling practices important are willing to pay an average estimated premium of 99 cents and 31 cents, respectively.
- Those who consider price factor important are willing to pay \$1.22 less on average.
- Overall, we find that consumer preferences and WTP for bio-based batteries are tied to the following (value in parentheses indicates a respective estimated average premium):
 - Price
 - Exposure to information treatment about environmental benefits of product (29 cents)
 - Product attributes (23 cents for durability feature)
 - Concern about green production and recycling (99 cents and 31 cents, respectively)
 - Demographic characteristics such as gender, income, and geographic region (25 cents for female, 31 cents and 28 cents for the respondents from the Northeast and West, respectively)
- We also find that consumer preferences for bio-based or rechargeable batteries differ based on preference for a particular product attribute:
 - Respondents who consider rechargeability features of batteries important are willing to pay an estimated amount of 46 cents less on average.
 - Those who highly value the rechargeability function demonstrate preference that corresponds to a propensity for environmentally-friendly products.
 - Despite the common feature of environmental friendliness, consumers who value rechargeability exhibit significantly less WTP for non-rechargeable bio-based batteries.

IMPLICATIONS

Our findings offer stakeholders evidence-based insights:

- Consumers can become more aware of the issues with conventional batteries and are willing to pay more for bio-based batteries made of agricultural bi-products.
- An incentive exists for manufactures to develop and produce bio-based batteries that efficiently utilize abundant yet environmentally sustainable resources.
- Policy strategies that are nation- and region-wide applicable are necessary to reach various consumer groups to reinforce the demand for innovative bio-based products.
- Corporations, governments, and consumers can help provide essential pathways for protecting our environment and health by promoting the use of household batteries that are safe and sustainable.