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Consumer Preference for Sustainable Attributes in Plants: Evidence from Experimental Auctions

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ABSTRACT

Experimental auctions were employed to investigate U.S. and Canadian consumers' willingness to pay for sustainable attributes in plants. The results show consumers are willing to pay a price premium for energy and water savings in plant production of $0.15 and $0.12, respectively. Consumers are only willing to pay $0.08 more for sustainably labeled product. Latent class segmentation analysis identifies three distinct consumer segments: *Import-Liking*, *Mainstream*, and *Eco-local*. *Mainstream Consumers* were the largest segment and willing to pay only modest premiums for eco-friendly attributes. *Eco-local* consumers comprised 14% of consumers and they were willing to pay the highest amount for the improved production methods and container types, while having the highest willing to pay for local and domestic products. [EconLit citations: D44, M31]. © 2015 Wiley Periodicals, Inc.

1. INTRODUCTION

Consumer demand for sustainable products and business practices is rapidly rising. Supercenters such as Wal-Mart recognize the value to consumers that "being green" not only provides value to consumers but positively impacts profits (Noon, 2007). The presence of eco-consumers has also been profitable to companies that appeal to them with a record of environmentally friendly or sustainable production practices (Russo & Fouts, 1997). Most research has found that many consumers are willing to pay a price premium for green products and certain segments share attitudes that are favorable to the environment (Laroche, Bergeron, & Barbaro-Forleo, 2001; Straugh & Roberts, 1999; Yue et al., 2010).

However, consumers' attitudes toward sustainably produced products may vary significantly across different industries and quality attributes (Gladwin, Kennelly, & Krause, 1995).

For instance, consumers' attitudes toward organic quality attributes may vary significantly across fruit, vegetable, and ornamental plants. Hence, product specific studies should be conducted to accurately measure the potential market for a product with specific quality attributes.

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There is also an increasing expectation on the part of consumers that products have environmental and social sustainability credentials that can be verified or certified. A recent study by Tonsor and Shupp (2009) suggests that the average U.S. consumer is not willing to pay a premium for beef, tomatoes, or apple products simply labeled as "sustainably produced." To our knowledge, there is no study that has investigated U.S. and Canadian consumer preference for sustainably grown plants.

While relatively few studies focus on consumer preferences for sustainable attributes in the plants, many studies of consumer preferences for eco-labeled products exist. Similar to sustainable-labels, eco-labels provide consumers with information on environmental attributes associated with the production and use of a product. The burgeoning literature on eco-labels suggests that disagreement remains over whether eco-labels increase consumer willingness to pay (WTP) for a particular product. Some find that consumers are willing to pay a premium for eco-labeled products (Blend & van Ravenswaay (1999) for eco-labeled apples; Ethier, Poe, Schulze, and Clark (2000) for "green" electricity; Nimon & Begihn (1999) for organic cotton), while others find that eco-labels only affect how consumers rank certain products and do not cause consumers to pay more for them (Nimon & Begihn (1999) for environmentally friendly dyes; Teisl, Roe, and Levy (1999) for eco-marketing and seals of approval on electricity).

Unlike the organic label, a sustainable-label is more like an eco-label, as it does not have a strict definition and includes many dimensions, such as water-saving, energy-saving, carbon footprint, product origin, container type, and chemical use, is open to consumer perceptions and inferences, with different consumers caring more about one attribute than another. For example, among sustainable attributes, consumers react positively to fair trade certification, but negatively to carbon footprint claims on fresh apples and tomatoes (Onozaka & Mcfadden, 2011). Regarding sustainably labeled plants, this literature indicates that whether or not consumers are willing to pay more remains unknown and depends on many factors, including product characteristics, the specific attributes the sustainable-label refers to, and consumer characteristics. Before investing heavily in "sustainably produced" labeling schemes for plants, consumer perceptions and their WTP for such products and the degree to which the perceptions and price premiums can be altered by information about sustainable production practices need to be better understood.

In the past few years, the floriculture industry has seen a rise in biodegradable, compostable, or bioresin containers often called "green" products (Lubick, 2007). These "green" containers have emerged to take advantage of the green marketing and environmental awareness related to high fuel prices (Kale et al., 2007). Some studies have identified consumer segments with regard to their attitudes and behaviors related to recycling and preferences for plastic and plastic-alternative biodegradable containers (Hall et al., 2010; Yue et al., 2010). Specifically, as the move to more eco-friendly products continues, the value chain must examine not only product-specific components, such as potting containers, but also the impact on consumers of production practices used to produce the product. Different from previous studies, this study seeks to look more holistically at plant production, to identify consumers' WTP for varying sustainable production practices compared to conventionally grown plants.

Product origin is another focus of this study because product origin creates a cognitive cue for the consumer and can act as an indicator of product quality or performance (Carpio & Mazza, 2008). Studies have shown the country of origin construct is based on product quality evaluations which are dependent upon the technical complexity of the product (Insch & McBride, 1998) as well as consumer's age, education level, and degree of familiarity with the product (Insch & McBride, 2004).

Some studies have examined country/place of origin on consumer evaluation of food products such as Italian olive oil (Van der Lans, Ittersum, De Cicco, & Loseby, 2001), certified U.S. beef rib eye steaks, chicken breasts, and pork chops (Loureiro & Umberger, 2005), and onions (Ehmke, Lusk, & Tyner, 2008). Other studies have investigated consumer evaluation of locally grown food products, such as potatoes (Loureiro & Hine, 2002), tomatoes (Yue & Tong, 2008), and strawberries (Darby, Batte, Ernst, & Roe, 2008). However, no research has been conducted to investigate consumer preference for and evaluation of product origin of plants.

To date, no studies have systematically investigated the market for different production systems for plants from different origins, both ornamental and edible or intended for food production. This study would fill that void and offer key insights into the impact of sustainable production practices on WTP for different plant types.

In this paper, we used a second-price sealed-bid auction using real products to elicit consumer WTP for various types of plants. Experimental auctions have been widely used by researchers to investigate stakeholders' preferences for product attributes (Gracia, De Magistris, & Nayga, 2012). Nonhypothetical auctions have advantages over hypothetical surveys in that the nonhypothetical auction is incentive compatible and is conducted in a nonhypothetical context that involves the exchange of real money and goods, whereas the hypothetical surveys can lead to hypothetical bias because no actual payment is required (Fox, Shogren, Hayes, & Kliebenstein, 1998; List & Shogren, 1998). With real economic incentives, the participants face a trade-off between money and goods, and, as in real-world markets, it is in consumers' own interest to act so that they maximize their own utility. Nonhypothetical auctions also put subjects in an active market environment where they can incorporate market feedback.

Previous studies have also shown that consumer preferences for product attributes are not the same. For example, there is considerable variation in consumers' attitudes about the environment (Gladwin et al., 1995; Purser, Par, & Montuori, 1995). Since not all consumers are alike in their attitudes, preferences, and behaviors, market segments can be identified. Market segmentation of consumers can give producers, wholesalers, and retailers a clearer perception of the marketplace, enabling them to more efficiently allocate their scarce resources and enabling them to be more profitable. Therefore, it's important to identify segments of consumers who are different with respect to their preferences for products with various attributes.

The market may be segmented in several ways. Some studies use commonsense or prior knowledge to segment the market and others use data-driven segmentation methods (Kemperman & Timmermans, 2006). This study uses latent class segmentation analysis to group consumers with respect to their preference for product attributes and their sociodemographic backgrounds, past experiences, purchases, and attitudes. This means that the heterogeneity existing among consumers is modeled using a set of latent segments (Swait, 1994) that are estimated simultaneously, along with each segment's size. The advantage of latent class segmentation over traditional segmentation approaches is the classification of individuals into segments based upon membership probabilities estimated directly from the model. The segments are also based on observed behavior so the results are intuitive and easy to communicate to marketers and policymakers (Scarpa, Willis, & Acutt, 2005). Additionally, the latent class segmentation analysis based on endogenous segmentation is relatively simple to estimate via maximum likelihood estimation (Scarpa et al., 2005; Swait, 1994).

Our overall goal of the study was to better understand the influence of various production practices on consumer WTP for various types of plant attributes. Specifically, we aim to investigate consumer WTP for different plant types grown using different production methods, from different origins and in different types of containers. We hypothesize that distinct market segments exist in terms of consumer preferences and their WTP for plants with different environment-related attributes. The results from this study are not only important for the Green Industry but also provide important implications and insights about the market potential of products labeled with different types of environment-related claims and product origin.

2. MATERIALS AND METHODS

In the last 15 years, experimental auctions have been used to elicit WTP for a wide variety of food quality attributes (Lusk et al., 2004a, Lusk, Feldkamp, & Schroeder, 2004b; Yue et al., 2010). A (real) second-price sealed-bid auction is an auction in which the bidders submit sealed product bids and the price is set equal to the second-highest bid; the winners are those who have bid more than the price. Vickrey (1961) showed that, in such an auction in which the price equals the first-rejected bid and each consumer is allowed to buy only one unit, it is a weakly

TABLE 1. Plant Attributes and the Attribute Levels Tested in This Study

Attributes	Level 1	Level 2	Level 3	Level 4
Plant type	Tomato plant	Basil	Chrysanthemum	–
Production method	Conventional	Sustainable	Water saving	Energy saving
Container type	Plastic	Compostable	Plantable	Recyclable
Product origin	Domestic	Local	Imported	–

dominant strategy for people to bid so that if the price equals their bid and they are indifferent to whether they receive the product or not.

2.1. Product

The products we used were tomato plants, basil, and yellow flowering chrysanthemums in four-inch containers. The actual plants in the containers were identical to each other in appearance, while the container attributes, plant production method, and product origin changed among the alternatives. The attributes and the associated attribute levels tested in this study are shown in Table 1. The attributes include plant production method, container type, and product origin. Other attributes that could be considered as important to the consumer's purchase decision (such as container size and plant size) were held constant. There were four types of containers: plastic, compostable (able to break down during composting), plantable (able to be planted in the ground along with the plant), and recyclable containers. We chose these four types of containers because they are currently available in the market. The plastic container was also included in our study since it is widely used by many producers and consumers and can thereby serve as control for the biodegradable containers. It is important to note that only the terms such as *plastic*, *compostable* and *plantable*, *and recyclable* were used when labeling the products. No other explanatory information was provided so as to not bias initial consumer reactions.

The second attribute studied was production method, which was included given its increasing importance both at the producer and consumer ends of the marketing channel. This increased importance can be easily seen by the increasing amount of not only academic research, but also increased media coverage and marketing strategies of businesses attempting to capitalize on claims of sustainable production methods (Pearson & Bailey, 2009; Philip, 2008). In order to determine consumer preference for and the value of production method, we compared several different labels, namely "conventional," "sustainable," "water-saving," and "energy-saving." The third attribute was product origin, which was included in this study given the increasing emphasis on "locally grown" and the increasing concern about product country of origin (Loureiro, 2003; Umberger, 2003). Product origin levels included: "domestic (but not local)," "local," and "imported."

Since it was not practical to ask each participant to evaluate all possible combinations of the attributes, a fractional factorial design was developed to minimize alternative number and maximize profile variation. The design was developed based on four principles: (1) level balance (levels of an attribute occurred with equal frequency), (2) orthogonality (the occurrences of any two levels of different attributes were uncorrelated), (3) minimal overlap (cases where attribute levels did not vary within a scenario were minimized), and (4) utility balance (the probabilities of choosing alternatives within a scenario were kept as similar as possible) (Louviere, Hensher, & Swait, 2000). The fractional factorial design generated by software SPSS yielded 16 alternatives to be used in the experimental auction. We did not manually eliminate any alternatives after the computer generated the research design. For a further discussion of factorial design, see Louviere et al. (2000).

2.2. Experimental Procedure

The experimental auctions were conducted in Twin Cities, Minnesota and College Station, Texas, and Vineland Station, Ontario, Canada during April and May 2011. We chose to conduct the experimental auctions during this time because April and May are the months when people buy most of their outdoor plants (Yue & Behe, 2008). The participants were recruited through multiple channels including advertisements in local newspapers, CraigsList.org, and community newsletters in order to make the recruitment pool as broadly representative of the local area and state/province population as possible. To ensure that participants were regular buyers of plants, we specified in the advertisement that "you have to have purchased plants in the past year and you are at least 18 years old." To avoid self-selection bias, the recruitment advertisement indicated that participants would be asked about their market decisions on plant purchases, but nothing was said about details of the plant attributes.

We conducted nine sessions with a total of 159 participants (there were three sessions in Minnesota, Texas, and Canada, respectively). In each of the auctions, there was simultaneous bidding on 16 alternatives. At the beginning of each session, participants were given a consent document and a questionnaire. To familiarize participants with the auction procedure, we ran one round of practice auction in which participants bid on candy bars. Next, the 16 alternatives were put on a large table and beside each alternative there was a label indicating the container type, production method, and product origin. The label for each product was a piece of laminated paper and was placed at a prominent position in front of each plant. Participants walked around the table and placed their bids on their bidding forms as they studied each alternative. Participants were not allowed to communicate with each other during the bidding process. To reduce any systematic ordering effects, the participants could start at any of the 16 alternatives on the table.

After the real auction, the maximum and second price for each product was calculated with the participant having the maximum bid being declared the winner, but having only to pay the second highest price. In some instances a participant won multiple items, however, they were limited to the purchase of only one item which was randomly chosen by a draw. Participants were made aware that they could only purchase a single item during the training process. Participants were given $30 to compensate for their time. At the end of the experiment, if a participant won an alternative, he/she would get the alternative he won and get $30 minus the price for the alternative; if a participant did not win, he/she received the entire $30. One hundred and forty-nine of the 159 participants provided enough information for this analysis.

2.3. Econometric Model

Latent class segmentation analyses have been widely used in many fields including natural sciences (McLachlan & Peel, 2000) and some social sciences such as marketing and retailing (Bhatnagar & Ghose, 2004; Kemperman & Timmermans, 2006) and it has received more attention in recent years in the area of applied economics (Hu, Hünnemeyer, Veeman, Adamowicz, & Srivastava,2004; Scarpa et al., 2005; Scarpa & Thiene, 2005). Latent class segmentation analysis does not rely on the traditional modeling assumptions such as normal distribution and homogeneity, which are often violated in practice. Therefore, it is less subject to biases associated with data that does not conform to these assumptions. Additionally, the relationship between the latent classes and external variables (covariates) can be assessed simultaneously with the identification of the segments, which eliminates the need for the usual second stage of analysis to relate the segmentation results to demographic and other variables.

In the traditional approaches of incorporating heterogeneity into demand analysis, a prior knowledge of the elements of heterogeneity is required. The sources of heterogeneity may include sociodemographics, but other characteristics of individuals such as attitudes, perceptions, and past experiences may also generate heterogeneity in preferences. While the prior knowledge may provide some understanding of sources of heterogeneity, it is desirable to incorporate preference heterogeneity in the estimation of economic choice or purchasing parameters. Latent class segmentation analysis is a promising avenue for tackling these problems (Boxall & Adamowicz, 2002).

Our paper applies this latent segmentation approach to the experimental auction data of a set of plants with various production methods, product origin, and plant containers. The foundation of this application is a model which incorporates motivations toward plant selections. The behavioral components come from an experimental auction in which three major environment- and origin-related plant attributes were varied. Similar to Swait (1994), this model allows market segments to be related to characteristics of individual consumers such as socioeconomic backgrounds, purchases, experiences, and attitudes, but also elements of observed bidding behavior. To examine the argument that consumers' bidding behavior might vary across different types of plants (edible plants, food-producing plants, and ornamental plants), we estimate a model with random parameters to compare how heterogeneous consumer's bids would be on these plants.

Suppose there are N consumers with G latent homogeneous classes and the latent variable $c_i = g$ if consumer i ($i = 1, \ldots, N$) belongs to class g ($g = 1, \ldots, G$). The probability of latent class membership can be explained through covariates X_{1i} using multinomial logistic regression:

$$\pi_{ig} = P(c_i = g|\boldsymbol{X}_{1i}) = \frac{e^{\gamma_{0g}+\boldsymbol{\gamma}_{1g}\boldsymbol{X}_{1i}}}{\sum_{m=1}^{G} e^{\gamma_{0m}+\boldsymbol{\gamma}_{1m}\boldsymbol{X}_{1i}}}, \tag{1}$$

where $\boldsymbol{X}_{1i}$ is a row vector of consumer i's sociodemographics, attitudes, or past experiences; $\gamma_{0G} = 0$ and $\boldsymbol{\gamma}_{1G} = \boldsymbol{0}$, that is, class G is the reference class.

Consumer i's WTP for product j($j = 1, \ldots, J$) is estimated using the following heterogeneous linear mixed regression:

$$Bid_{ij}\,|_{c_i} = g = \boldsymbol{X}_{2ij}\boldsymbol{\beta}_g + \boldsymbol{Z}_{ij}\boldsymbol{\eta}_{1i} + \varepsilon_{ij}, \tag{2}$$

where Bid_{ij} is consumer i's bid for the product j in the experimental auction, $\boldsymbol{X}_{2ij}$ is a row vector of product j's attributes consumer i bids on; $\boldsymbol{\beta}_g$ is a column vector of coefficients associated with products' attributes for latent class g; $\boldsymbol{Z}_{ij}$ is a row vector of product j's attributes that has random coefficients; $\boldsymbol{\eta}_{1i}$ is the column vector of the random coefficients; ε_{ij} is the residual error term which follows standard normal distribution with mean zero and variance σ_ε^2; $\boldsymbol{\eta}_{1i}$ follow multivariate normal distribution with mean vector zero and variance–covariance matrix $\boldsymbol{\Sigma}$.

The log-likelihood function is

$$ll = \sum_{i=1}^{N} \ln\left(\sum_{g=1}^{G} P(c_i = g|\boldsymbol{X}_{1i})\phi_{ig}(\boldsymbol{Bid}_i|c_i = g;\, \boldsymbol{X}_{2i}, \boldsymbol{Z}_i)\right), \tag{3}$$

where $\boldsymbol{X}_{2i}$, $\boldsymbol{Z}_i$, and $\boldsymbol{Bid}_i$ are matrices of J row vectors of $\boldsymbol{X}_{2ij}$, $\boldsymbol{Z}_{ij}$, and Bid_{ij}, respectively; ϕ_{ig} is the pdf of multivariate normal distribution with mean $\boldsymbol{X}_{2i}\boldsymbol{\beta}_g$ and variance–covariance matrix $\boldsymbol{Z}_i\boldsymbol{\Sigma}\boldsymbol{Z}'_i + \sigma_\varepsilon^2 I_J$; I_J is a $J\ X\ J$ identify matrix (Proust & Jacqmin-Gadda, 2005; Verbeke & Lesaffre, 1996).

The log-likelihood specified in (3) is estimated in the first stage. After the model is estimated, we applied the empirical Bayes approach (Carlin & Louis, 1996) to calculate the posterior individual probabilities for each latent segment:

$$\hat{\pi}_{ig} = P(c_i = g|\boldsymbol{X}_i, \boldsymbol{Z}_i, \boldsymbol{Bid}_i, \hat{\boldsymbol{\theta}}) = \frac{P(c_i = g|\boldsymbol{X}_{1i}, \hat{\boldsymbol{\theta}})\phi_{ig}(\boldsymbol{Bid}_i|c_i = g, \boldsymbol{X}_{2i}, \boldsymbol{Z}_i, \hat{\boldsymbol{\theta}})}{\sum_{m=1}^{G}(P(c_i = m|\boldsymbol{X}_{1i}, \hat{\boldsymbol{\theta}})\phi_{im}(\boldsymbol{Bid}_i|c_i = m, \boldsymbol{X}_{2i}, \boldsymbol{Z}_i, \hat{\boldsymbol{\theta}}))}, \tag{4}$$

where $\hat{\boldsymbol{\theta}}$ is the vector of the estimated parameters specified in (1) and (2). The individual consumer is then grouped into the class with the highest posterior probability. The estimation was conducted using software R 2.13.2 (Boston, MA, USA).

TABLE 2. Summary Statistics of Participant Sociodemographic Background and Attitude Variables ($n = 2380$)

Variable	Description of the Variable	Mean	Std. Dev.
Age	Participants' age	50.953	13.864
Gender	Participants' gender; 1 if a participant is female, 0 otherwise	0.725	0.448
Edulow	Participants' education level; 1 if a participant education level is some college or lower; 0 otherwise	0.369	0.484
Edumedium	Participants' education level; 1 if a participant education level is college degree or master's degree; 0 otherwise	0.430	0.497
Eduhigh	Participants' education level; 1 if a participant education level is higher than master's degree; 0 otherwise	0.201	0.402
Income	Participants' income level (1000 dollars)	65.570	43.981
Children	Number of children in participants' household	1.369	0.774
Householdsize	Participants' household size	2.121	0.915
Caucasian	1 if a participant is Caucasian, 0 otherwise	0.826	0.381
Country	1 if a participant is from Canada; 0 if a participant is from the United States	0.329	0.471
Metro	1 if a participant lives in a metropolitan area, 0 otherwise	0.732	0.445
Buyherb	1 if a participant has purchased herbs in the past 6 months; 0 otherwise	0.523	0.501
Organicbudget	Percentage of a participant's weekly food budget spent on organic produce (fresh fruits, vegetables, and herbs); 1 = 0%, 2 = 1%–4.99%, 3 = 5%–9.99%, 4 = 10%–14.99%, 5 = 15%–19.99%, 6 = 20% or more	2.906	1.517
Plantwater	Participants' effort of conserving water with outdoor plants; 0 = no effort, 1 = some effort, 2 = a lot of effort	1.188	0.682
Localenvir	If participants consider "environmentally friendly" as an important characteristics of local products; 1 = very unimportant, 5 = very important	3.631	1.086
Localtaste	1 if participants think local products taste better; 0 otherwise	0.497	0.502
Localcarbon	1 if participants think local products are of low carbon footprint; 0 otherwise	0.470	0.501
Localnutri	1 if participants think local products are more nutritious; 0 otherwise	0.383	0.488
Localfertil	1 if participants think local products only use natural fertilizer; 0 otherwise	0.134	0.342
Localgm	1 if participants think local products is not genetically modified; 0 otherwise	0.195	0.397

3. RESULTS

Table 2 shows the sociodemographic background and attitude information of experimental auction participants. The average age of participants was approximately 51 years old. Seventy-three percent of participants were female. Thirty-seven percent of participants had some college or less; 43% of participants had a college degree or master's degree; and 20% of participants had an education level that was higher than a master's degree. The average income level was about $66,000. The average household size of participants was two to three people per household and there was approximately one child per household. Eighty-three percent of participants were Caucasian. Seventy-three percent of participants were from a metropolitan area and about 33% participants were from Canada with 67% participants from the United States. Compared to the population in the studied regions, our participants tend to be older, with higher income and higher education level, which is consistent with earlier studies that gardening plants purchasers tend to be older, wealthier, and more educated (Yue & Behe, 2008).

Fifty-two percent of the participants had purchased herbs in the past 6 months. Approximately 5%–10% of participants' weekly food budget was spent on organic produce. On average, most participants made some effort to conserve water with outdoor plants and most considered "environmentally friendly" as a slightly important characteristics for local products.

TABLE 3. Statistics for Determining the Optimal Number of Market Segments

Number of Segments	Number of Parameters (p)	Log-Likelihood at Convergence (ll)	AIC[a]	AIC3[b]	BIC[c]
1	18	−2805.35	5646.70	5664.70	5750.65
2	50	−2602.50	5305.00	5355.00	5593.74
3	82	−2492.88	5149.76	5231.76	5623.30
4	114	−2490.88	5209.76	5323.76	5868.09

[a]Akaike information criterion (AIC) is calculated as $-2(ll-p)$.
[b]Bozdogan Akaike information criterion (AIC3) is calculated as $-2ll+3p$.
[c]Bayesian information criterion (BIC) is calculated as $-2ll+p^{*}ln(n)$, n is the sample size which is 2380 (149 participants*16 alternatives = 2384 and there are four observations with missing values; so the sample size ends up with 2380).

TABLE 4. Estimated Parameter Values on Variables for the Latent Class Model ($n = 2380$)

			Three-Segment Model					
	One-Segment Model		Segment 1 *Import-Liking Consumers* (8%)		Segment 2 *Mainstream Consumers* (78%)		Segment 3 *Eco-local Consumers* (14%)	
Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Sustainable	0.087**	2.370	0.165	1.522	0.061*	1.745	0.183**	2.247
Energy saving	0.146***	3.989	−0.064	−0.589	0.111***	3.187	0.460***	5.620
Watersaving	0.121***	3.326	0.049	0.452	0.110***	3.187	0.224***	2.730
Compostable	0.139***	3.806	0.074	0.683	0.104***	2.985	0.371***	4.535
Plantable	0.158***	4.326	0.384***	3.530	0.086**	2.470	0.427***	5.034
Recyclable	0.070*	1.925	0.472***	4.238	0.015	0.447	0.142*	1.728
Local	0.496***	15.703	−0.908***	−9.619	0.374***	12.151	1.990***	26.209
Domestic	0.351***	9.610	−1.127***	−10.181	0.257***	7.344	1.727***	19.642
Tomato	0.107**	2.223	−0.115	−0.686	0.096*	1.760	0.298**	2.270
Mum	0.848***	7.386	1.425***	3.546	0.818***	6.328	0.686**	2.252
Intercept	1.216***	12.837	3.462***	11.288	1.196***	12.101	0.030	0.128

*,**,*** Significance at the 0.10, 0.05, and 0.01 levels, respectively.

Nearly 50% of participants thought local products taste better. Around 47% of participants regarded local products as a low carbon footprint. Thirty-eight percent of the participants thought local products are more nutritious. Thirteen percent of the participants thought local products only use natural fertilizers and about 19% participants thought local products are not genetically modified.

Following Swait (1994) and Hu et al. (2004) three criteria were used to assist in determining the number of segments. These criteria were the minimum Akaike information criterion (AIC), and minimum modified Akaike information criterion (AIC3), and the minimum Bayesian information criterion (BIC). Their calculation is shown in the footnote of Table 3. We estimated one to four segment models. From Table 3 we can see the log likelihood values at convergence (column 3) reveal improvement in the model fit as segments are increased from one to three. This finding supports the fact that there is heterogeneity in consumer WTP for the product attributes. AIC and AIC3 decrease from the one-segment to the three-segment model but they start to increase from the three-segment to the four-segment model. The BIC reaches the minimum for the two-segment model. But the increase in BIC from the two-segment to the three-segment model (29) is much smaller than the decrease in AIC and AIC3 from the two-segment to the three-segment model (155 and 123, respectively). Therefore, we chose the three-segment model as having the best solution to estimate the experimental auction data.

The estimated parameters for the three-segment model are presented in Table 4. Additionally, the one-segment model is also estimated for comparison and the results are shown in the second column of Table 4. The one-segment model shows that compared to conventionally grown plants, participants were willing to pay \$0.09 more for plants labeled with "sustainable," \$0.15 more for energy-saving plants, and \$0.12 more for water-saving plants; compared to plants grown in conventional plastic containers, participants were willing to pay \$0.14 more for plants grown compostable containers, \$0.16 more for plants grown in plantable containers and \$0.07 more for plants grown in recyclable containers; compared to imported plants, participants were willing to pay \$0.50 more for locally grown plants and \$0.35 more for domestically grown plants.

The three-segment model gives results that are quite different from the one-segment model and reveals the fact that consumers are heterogeneous in their preferences for plants with different attributes. The first segment consists of 8% of participants. The production method did not influence their WTP for the plants, but their WTP was influenced by the types of containers the plants were grown in. They were willing to pay \$0.38 more for plants grown in plantable containers and they were willing to pay the highest premium (\$0.47) for plants grown in recyclable containers compared to the other two segments of consumers. Interestingly, we found consumers in this segment discounted plants grown locally and domestically and compared to imported plants such that local plants were discounted by \$0.91 and domestic plants by \$1.13. Compared to the other two segments, their WTP for chrysanthemums was the highest, approximately \$1.43. Given the fact that segment one consumers like imported plants more, we named the first segment as "*Import-liking Consumers*."

Segment two consists of 78% of participants and we named this segment as "*Mainstream Consumers*." We found that the *Mainstream Consumers'* WTP was influenced by production method, container types and product origin but compared to the conventional plants, the premiums they were willing to pay for these attributes were not very high. For example, compared to conventional plants, they were willing to pay about \$0.06 more for "sustainable" plants \$0.11 more for water-saving or energy-saving plants; they were willing to pay \$0.10 more for plants grown in compostable containers and \$0.09 more for plants grown in plantable containers; they liked local and domestic plants better compared to imported ones and they were willing to pay \$0.37 more for local plants and \$0.26 more for domestic plants.

Segment three consists of 14% of consumers and compared to *Mainstream Consumers* and *Import-liking Consumers*, they were willing to pay the highest amount for the improved production method and container type and they were also willing to pay the most for local and domestic products. Therefore, we named this segment of consumers as "*Eco-local Consumers*." Compared to conventional plants, *Eco-local Consumers* were willing to pay \$0.18 more for plants grown in a "sustainable" method, \$0.46 more for plants grown with energy-saving methods, and \$0.22 more for plants grown with water-saving methods. Compared to plants in conventional plastic containers, they were willing to pay \$0.37 more for plants in compostable containers, \$0.43 for plants in plantable containers, and \$0.14 more for plants in recyclable containers. They liked local plants and domestic plants and were willing to pay \$1.99 more for locally grown plants and \$1.73 more for domestically grown plants compared to their imported counterparts.

In addition to these fixed effects, we also estimated the random coefficients for the three plant types to investigate how heterogeneous consumer's bids would be on the three different types of plants: edible plants such as basil, ornamental plants such as chrysanthemums, and vegetable producing plants such as tomato plants. We found $\sigma^2_{\text{tomato}} = 2.28$, $\sigma^2_{\text{mum}} = 0.71$, and $\sigma^2_{\text{basil}} = 0.92$, which indicates participants' bid were most heterogeneous on tomato plants and least heterogeneous on chrysanthemums. The coefficients of the fixed effects on *Mum* and *Tomato* of the three segments confirm these results. For instance, *Import-liking Consumers*' discounted tomato plants by \$0.12 compared to basils but *Eco-local Consumers* were willing to pay about \$0.30 more for tomato plants compared to basils, while the premiums for mums are all positive and significant.

The characteristics of consumers in these three segments and how the characteristics determine the probabilities that an individual is likely to be in one segment versus another were estimated at the same time when the latent segments were determined. The results of the parameter values are shown in Table 5. The third segment, the *Eco-local Consumers*, was used as the reference group for the estimation. Compared to *Eco-local Consumers*, *Import-liking*

TABLE 5. Parameter Values on the Segment Membership Variables for the Three-Segment Model ($n = 2380$)

	Segment 1 *Import-Liking Consumers* (8%)		Segment 2 *Mainstream Consumers* (78%)		Segment 3 *Eco-local Consumers* (14%)
Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.
Age	−0.901*	−1.738	−0.973**	−2.158	0
Age-squared	0.005	1.158	0.008**	2.024	0
Gender	−1.265	−0.737	−2.091*	−1.954	0
Edumedium	−3.668*	−1.795	0.484	0.548	0
Eduhigh	1.243	0.613	1.403	1.030	0
Income	−0.045**	−2.452	−0.025**	−2.341	0
Children	−0.612	−0.662	−0.555	−0.827	0
Householdsize	0.812	1.031	0.455	1.007	0
Caucasian	6.735**	2.420	2.877**	1.971	0
Country	−13.595	−0.066	0.244	0.292	0
Metro	1.507	0.820	−0.346	−0.373	0
Buyherb	−2.080	−1.520	−1.933**	−1.974	0
Organicbudget	0.152	0.329	−0.363	−1.373	0
Plantwater	−3.544***	−2.599	−0.677	−1.056	0
Localenvir	−1.253*	−1.695	−0.466	−1.351	0
Localtaste	0.223	0.147	−1.271	−1.510	0
Localcarbon	−2.419	−1.342	−0.493	−0.716	0
Localnutri	−3.923**	−1.992	−0.038	−0.047	0
Localfertil	1.317	0.622	1.094s	0.786	0
Localgm	3.401	1.295	−1.479	−1.327	0
Intercept	38.305**	2.396	38.877***	2.755	0

*, **, *** Significance at the 0.10, 0.05, and 0.01 levels, respectively.

Consumers were more likely to be younger, were less likely to have a medium education level, tended to have lower income, and consisted of higher proportion of Caucasians. They spent relatively less effort in conserving water with outdoor plants, and they were less likely to think local products as environmentally friendly or more nutritious. *Mainstream Consumers* had both *Age* and *Age-squared* as significant indicating age affected the probability of being in this segment in a quadratic manner. The probability of being *Mainstream Consumers* decreases as participants got older when they were younger than 61[1]years old. But the probability increases as participants get older when they were older than 61 years old. When participants were 61 years they were least likely to be *Mainstream Consumers* and from another perspective, they were most likely to be *Eco-label Consumers*. Compared to *Eco-local Consumers*, *Mainstream Consumers* consisted of more male consumers and Caucasians, and had relatively lower income. *Mainstream Consumers* purchased significantly fewer herbs in the past 6 months compared to *Eco-local Consumers*. Canadian consumers do not differ significantly from U.S. consumers in terms of their likelihood of being in one segment versus the other.

4. DISCUSSION AND CONCLUSIONS

The aim of this paper was to understand consumers' WTP for more sustainable attributes of plants, notably production practice, potting container, and origin. Given the move by many consumers to environmentally products, recognizing the impact of alternative attributes is

[1]When we take the derivative of the probability of being *Mainstream Consumers* with respect to age, we get $-0.973 + 0.016*\text{age}$. The probability gets the minimum value when the derivative equals zero. That is, when age = 61, the probability gets the minimum value.

essential. This paper significantly contributes by examining sustainable production practices, i.e., energy- and water-saving, that are becoming increasingly important given the strain on our natural resources. Further, we control for the effects of food producing, ornamental, and edible ornamental by including the different types of plants in to the auction.

Utilizing a second-price sealed-bid auction we find that, overall, consumers are indeed willing to pay a price premium for certain attributes. Notably, energy and water saving garner a \$0.15 and \$0.12 premium compared to conventional production, respectively. Further, consumers are only willing to pay \$0.08 more for the more heavily used "sustainable" labeled product. We find that consumers do not treat sustainable attributes in plants equally and they care more about one sustainable attribute than another; in the case of plants, consumers care energy-saving and water-saving attributes the most and they are less willing pay a high premium for products broadly labeled as "sustainably produced" without the specific information about what "sustainable" means. This finding has important implication for the plant industry about what strategy to use in marketing the sustainably grown plants. Detailed sustainable labels such as "water-saving," "energy-saving" instead of the broad and open term "sustainably produced" should be used in order to glean premiums for their products. For container types, we found consumers' WTP differs across various potting containers. The compostable and plantable containers generate \$0.14 and \$0.16 premiums over plastic, respectively, while recyclable plastic only generates a \$0.07 premium. These results indicate that increasing the eco-friendliness of product containers can indeed result in premiums; however, these premiums are dependent on the specific types of containers. Our findings suggest the compostable and plantable containers have the better market potential than recyclable containers. This might be because it is often challenging to recycle or reuse agricultural plastics because of contamination problems or UV degradation. In the case of plant production, recycling facilities are often unwilling to accept plastics with soil or rooting media residue. Additionally, some professional plant growers have concerns about reusing plastic containers for fear that plant disease outbreaks will increase, and worry that existing sanitation practices may not be enough to render them sanitary for production (Yue et al., 2010). For product origin, our findings show that on average, consumers prefer locally grown plants the most, followed by domestically grown plants, and they do not like imported plants. These results show that product origin does matter for plants, just like for food products. Previous research show that consumers prefer locally grown food products because they think locally grown food products possess superior eating characteristics (freshness, taste, safe to eat, etc.), low carbon footprint and consumers want to support local economy (Darby et al., 2008; Yue & Tong, 2009). Because consumers do not eat plants directly (except for basil plants), the eating characteristics are unlikely to be the major drive for the higher WTP for local plants, instead, other reasons such as consumers perception that local plants are fresher and more likely to last, with low carbon footprint, and their willingness to support local economy are more likely to be the main drive. However, further studies need to be conducted to confirm if these are the reasons why the average public like locally grown plants.

As noted throughout the literature, consumers are heterogeneous in what drives their decision to purchase so the overall results may not tell the whole story. Using latent class segmentation, we find that the market is heterogeneous. We find three distinct market segments, two of which comprise nearly one quarter of the market and their differences can be used to directly market to consumers with varying concerns. For instance, the *Import-liking Consumers*' do not give premiums or discounts for any of the plant production practices; however, they do respond positively to potting containers with plantable and recyclable characteristics, resulting in a \$0.38 and \$0.47 premium, respectively. Of note, the compostable container does not differ in valuation compared to plastic. However, the major finding within this segment is that they discount local and domestic plants compared to imported plants. A locally labeled plant is discounted \$0.91, whereas a domestically labeled plant is discounted \$1.13. Through the latent class segmentation, we found a large and extremely interesting group that will not respond to messages promoting local, whether credence messages are used or not. From a retailing perspective this segment does provide an opportunity namely via potting containers instead of emphasizing on product origin.

In contrast, the *Eco-local Consumers* are willing to pay premiums for all the eco-friendly attributes, especially for energy-saving practices ($0.46) and plantable containers ($0.43). They are also very willing to spend more on locally and domestically produced plants with premiums of $2 and $1.73, respectively. This segment will react positively to both local and likely many sustainable attributes; this segment should be the main target market for these firms that have adopted sustainable practices. Among these practices, energy-saving, plantable containers, and locally/domestically produced should be emphasized and promoted to this segment of consumers.

The final segment represents the *Mainstream Consumers*, given it is the largest segment at 78% market share. As with the *Eco-local Consumers* they are willing to pay premiums for the production practices; however, their premiums are considerably smaller ranging from $0.06 for sustainable labeling to $0.11 for energy-saving. We also see limited premiums for potting containers, notably for plantable, but larger premiums for closer-to-home origins. Thus, the bulk of the market is willing to pay a modest premium for plants grown using eco-friendly practices. For these firms that are targeting this segment of consumers, more detailed cost-benefit analysis is needed to examine if the moderate premiums generated from the sustainable attributes can cover the costs of adopting these sustainable practices.

Our results provide some interesting insights and tend to answer a central question as to how consumers value various production practices in plants. Future research should look to examine the motivations of consumers in their preference and valuation of these production practices. A second further research may also look to expand these findings to examine the production cost effects of introducing these new production practices. Even though some consumers do have premiums for new production practices, the economic viability of introducing these practices is still unknown. A third future research area could be investigating how consumers view the sustainability of the growing methods they will have to use to raise the plants.

There are some limitations of our methods and analysis, so the results should be interpreted with suitable caution. The auction subjects were recruited from three areas in the United States and Canada and the sample size was relatively small compared with hypothetical surveys, so our results may not be representative of other regions of the two countries. While these limitations suggest our results should be interpreted with some caution, they also point to directions for future research that could provide additional information for the adoption of sustainable practices by the plant industry.

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