Segmentation of the market for labeled ornamental plants by environmental preferences: A latent class analysis

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ABSTRACT

Labeling is a product differentiation mechanism which has increased in prevalence across many markets. This study investigated the potential for a labeling program applied in ornamental plant sales, given key ongoing issues affecting ornamental plant producers: irrigation water use and plant disease. Our research investigated how to better understand the market for plants certified as disease free and/or produced using water conservation techniques through segmenting the market by consumers' environmental preferences. Latent class analysis was conducted using choice modeling survey results and respondent scores on the New Environmental Paradigm scale. The results show that when accounting for environmental preferences, consumers can be grouped into two market segments. Relative to each other, these segments are considered: price sensitive and attribute sensitive. Our research also investigated market segments' preferences for multiple certifying authorities. The results strongly suggest that consumers of either segment do not have a preference for any particular certifying authority.

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1. Introduction

Labeling as a product differentiation mechanism has increased in prevalence across many products in recent decades, particularly among credence goods. Credence goods are characterized by asymmetric information; a consumer is unable to observe differences among goods with varying attributes, but nevertheless has preferences for these attributes. When unobservable attributes are environmental in nature, such as production that utilizes less resource intensive methods, labels can better facilitate informed purchasing decisions (Galarraga Gallastegui 2002; Dulleck and Kerschbamer 2006; Baksi and Bose 2007). Given the availability of two products, one being more environmentally friendly but otherwise not differentiable at the time of sale, a label allows consumers to make tradeoffs between environmental attributes and corresponding prices. Producers can potentially recover some of the added costs of resource-conserving production methods by differentiating their goods through the use of labels.

Two key issues affecting ornamental plant producer profitability include availability of irrigation water and plant disease. Drought concerns and controlling runoff have resulted in shifts toward water conserving production practices. Capture and reuse of irrigation water has been found to potentially result in higher incidences of disease reinnoculation of plants. Capturing runoff to reduce nonpoint source pollution and mitigating plant disease are costly endeavors for producers.

Certification programs are well suited to ensuring that agricultural goods are produced in a specific manner, such as water conserving methods, or comply with specified guidelines, such as not host to diseases. These certification schemes can be made apparent to consumers through of labels applied to products at the time of sale. Thus, development of a certification program and plant labels are one way for producers of ornamental plants to offset the cost of controlling runoff and mitigating disease if they reuse water captured from their operations.

The focus of this paper is on investigating consumer preferences for two labeling certification schemes for ornamental plants:

- healthy plant certification, which guarantees a disease-free plant, and
- water conservation certification, which ensures that a plant has been grown using water conserving growing practices.

The specific objectives of this study are as follows:

- investigate if there are significant price premiums for healthy plant and water conservation labeled plants;
- investigate if plant certifying authority affects price premiums; and
- investigate heterogeneity in consumer preferences for labeled plants.

These objectives are investigated in a choice experiment conducted with purchasers of ornamental plants; the plant labels and certifying authorities are attributes in the choice experiment.

The results indicate plant purchasers will pay price premiums for healthy plant and water conservation labeled plants, but the certifying authority (government, industry or NGO) does not affect price premiums. Results also suggest that by accounting for individuals' environmental preferences, we can identify two segments in the market for ornamental plants. One segment is relatively more sensitive to price, while the second is relatively more sensitive to plant attributes.

These findings are useful for ornamental plant producers by allowing them to better market their products and recoup some of the costs of evolving production practices.

2. Application

Irrigation water is the principal means by which ornamental plant producers encourage and control plant growth, minimize losses and ensure plant hardiness (Atkinson et al. 1994). Ongoing effects of drought have increased the risk of production loss among producers, who use large quantities of water in production (Folger, Cody and Carter 2013).[1] For example, within the contiguous United States, 56% of land area faced moderate to exceptional drought in January 2015 (The National Drought Mitigation Center 2015). Conservation methods to reduce the risk associated with water availability such as irrigation water recapture and recycling are costly to implement. Therefore, if producers are to offset some of the costs of recapturing it is necessary to develop a mechanism to command price premiums. These price premiums could be obtained by a labeled certification program that guarantees production in accordance with water conservation.

Many geographic areas have been experiencing water quality degradation due to nonpoint source pollution from agriculture. In some such areas, federal and state agencies have begun to encourage producers to meet Total Maximum Daily Load (TMDL) nutrient loading targets by way of capturing irrigation and stormwater runoff. The Chesapeake Bay in particular has been subject to such TMDL targets for nitrogen and phosphorus. Many state governments have been relying on a voluntary approach to meet nutrient loading reduction goals, while the U.S. Environmental Protection Agency maintains the ability to take regulatory action in the future to ensure that nutrient targets are met (Cultice et al. 2013). In Maryland, state regulatory

[1] Throughout this paper, ornamental plant producers will be referred to as "producers".

enforcement of management practices which reduce nutrient loading in accordance with TMDLs has been enacted. Nurseries in particular have been highlighted as a key source from which the mandated 24% reduction in nitrogen loading and 12% in phosphorus loading by 2025 will be achieved in Maryland (Maryland Department of The Environment 2012). Capture and recycling of irrigation and stormwater runoff provides a solution for producers to reduce their susceptibility to water shortages, while also complying with TMDL goals.

Though there are benefits to producers associated with irrigation water recycling, this practice also compromises an operation's resilience against water-borne plant diseases. Recycling of runoff comes at the increased risk of reinnoculating plants with water-borne pathogens, which have the potential to result in significant production losses. When such water-borne diseases are present in an operation, water which is applied to infected plants and recaptured may still contain diseases. If this water is reapplied to plants in an operation, there exists a chance that the disease can reinfect original plants bearing the disease and also infect additional plants throughout an operation. A 2012 survey of Mid-Atlantic ornamental plant producers indicated that 36% of respondents experienced plant losses to disease in excess of 3% of their sales (Rees et al. 2014). In particular, *Pythium* and *Phytophthora* have been identified as two diseases affecting ornamentals, which have been found to re-infect plants when water is recycled and reapplied throughout an operation (Hong and Moorman 2005; Moorman 2010a; Moorman 2010b). Consequently, producers must take extra precautionary measures to reduce disease reinnoculation when recycling water, which result in increased operating costs.

Faced with incentives to conserve water and reduce runoff, management practices to capture and recycle may increase in adoption in coming years. Consequently, producers who undertake these practices may expect to see increased upfront and ongoing infrastructure, operating and maintenance-related costs in addition to possible disease management costs.

Should producers choose to adopt these costly strategies, an option to mitigate higher production costs is to charge higher prices for plants. However, there is no reason to expect consumers will be willing to pay higher prices unless they are able to perceive a valuable difference in the product. Assuming consumers have a positive willingness to pay for resource-conserving production practices, creation of healthy plant and water conservation labels which differentiate plants produced using certain management practices could result in price premiums. The magnitude of these price premiums would be dependent on consumer willingness to pay for them, however any premium gained could help to offset a portion or all of the increased costs associated with these production methods (Yue, Hurley and Anderson 2011). Labels increase the transparency of the otherwise non-observable environmental attributes, and thereby facilitate transfer of consumer' willingness to pay for goods which minimize their concerns about the environmental impact of plant production via the price premium. Those consumers who derive the most utility from environmental production attributes have the option to buy labeled plants which are likely to be sold at a price premium, while those who do not share the same viewpoint will still have the option of buying ornamental plants which don't bear a label at a lower price point.

3. Product Labeling and Environmental Preference Literature

Information captured by product labels varies greatly between product types. In general, labels exist to display information pertaining to product-specific attributes to potential consumers, such as price, quality, nutrition, and production characteristics (Teisl and Roe 1998). Claims and certifications presented on a label are especially useful as product differentiation mechanisms for credence goods. Inclusion of product-specific labeling information reduces the costs borne by consumers of recognizing hidden attributes while also increasing the level of trust and transparency between consumers and producers (Thøgersen 2002; Crespi and Marette 2001; Baksi and Bose 2007).

Labeling is a predominant means by which producers can readily present information pertaining to unobservable environmental attributes associated with producing or consuming a particular good (Blend and Ravenswaay 1999; Rotherham 1999; Galarraga Gallastegui 2002). Shifting consumer preferences in favor of more ecologically-conscious goods has resulted in the widespread adoption of many labeled products in numerous industries, including: "Dolphin Free" tuna, Partial Zero Emissions Vehicles, and USDA Organic food products (Teisl, Roe and Hicks 2002; Noblet, Teisl and Rubin 2006; United States Department of Agriculture National Agricultural Statistics Service 2014).

There are a number of factors that influence a consumers' propensity to purchase environmentally-related labeled goods; such as: environmental consciousness, social values, perception of and ability to identify the highlighted environmental attributes, one's utilitarian value of environmental attributes, one's perception of their ability to mitigate environmental issues, and costs and availability of the labeled product (Hemmelskamp and Brockmann 1997). Chen and Chai (2010) found that personal environmental norms contribute towards attitudes regarding consumption of green products. James et al. (2009) found that increased knowledge of agricultural systems resulted in a lower willingness to pay for organic and local applesauce. These aforementioned factors are likely to vary across geographic range, culture, and product market. As such, investigation regarding the impact of environmental preferences on consumption of labeled products is likely to be more pertinent on a case-specific basis.

The demand for labeled ornamental plants has been the subject of numerous studies which have indicated that consumers are willing to pay a price premium on products bearing such labels. Increased utility and a willingness to pay this premium for a label have been found for: powdery mildew resistant flowering dogwoods; Texas Earth-Kind™ and Superstar™ plants; “origin-certified” native plants; plants grown in biodegradable containers and those that are carbon-saving; noninvasive and native plants; privately certified eco-labeled roses and low-carbon footprint roses; and plants grown using energy-saving production practices, sold in non-plastic containers, and locally grown plants (Gardner et al. 2002; Klingeman et al. 2004; Collart, Palma and Hall 2010; Curtis and Cowee 2010; Yue et al. 2010; Michaud, Llerena and Joly 2012; Khachatryan et al. 2014). The prices that consumers are willing to pay for these goods are reflective of their private utility derived from these aforementioned products in addition to the societal benefits associated with the highlighted environmental attributes. Consumers’ values placed on societal benefits related to their product purchases are indicated by their increased utility for labeled goods and therefore a corresponding price premium.

3.1 Consumers’ Environmental Preferences

Effective marketing of environmental attributes requires and understanding of how environmental preferences influence consumer behavior. For voluntary and easily performed behaviors that lend themselves to deliberation, such as the purchase of labeled ornamental plants, the Theories of Reasoned Action and Planned Behavior are useful for predicting and explaining the influence of attitudes and beliefs (Ajzen 1991; Sorice et al. 2011). These theories suggest that a consumer’s behavioral beliefs pertaining to the environment shape their attitudes into behavioral intentions and therefore influence their final purchasing decisions (Best and Mayerl 2013).

Findings in behavioral psychology literature have suggested that higher levels of concern for the environment and more ecologically-centered worldviews influence environmentally sustainable consumption due to their effect on behavioral intentions (Kollmuss and Agyeman 2002). Behaviors which aim to limit the environmental impact of consumption have been shown to be linked to an individual's environmental concern and worldview in a number of cases, including: water conserving behavior (Gilg and Barr 2006; Willis et al. 2011; Wolters 2014); purchase of sustainable tourism alternatives (Hedlund 2011); purchase of beverages with environmentally friendly packaging and eco-friendly disposal methods (Birgelen, Semeijn and Keicher 2009); energy conservation (Wicker and Becken 2013); and eco-labeled fish purchases (Brécard et al. 2009).

Among the most commonly used indicator of environmental preferences across disciplines is the New Environmental Paradigm (NEP) scale, which measures an individual's ecological worldview; that is, their 'primitive beliefs' pertaining to their level of concern for the environment (Dunlap 2008). High NEP scores, which represent an ecologically-oriented worldview, have been found to be indicative of ecologically-conscious behavior in numerous studies (Roberts and Bacon 1997; Tarrant and Cordell 1997; Ebreo, Hershey and Vining 1999; Kotchen and Reiling 2000; Clark, Kotchen and Moore 2003). It follows that these primitive beliefs should also have some bearing, though not necessarily a direct linear relation, on consumption and purchasing patterns for various environmental goods. Khachatryan (2014) found that individuals with higher than average scores on an environmental concern scale were willing to pay a higher price premium for Chrysanthemums produced using pro-environmental production practices. However, the measure of support for the environment used in this study was based on Schultz (2001) which measures egoistic, altruistic and biospheric environmental concerns, not a general ecological worldview as with the NEP scale. While there may be measures of support for the environment more directly tied to choice behaviors, NEP was used in this study because it is a scale with established reliability and validity which has been used in other economic applications.

In this study, respondent scores on the NEP scale were used in conjunction with preferences for plant attributes in order to group individuals into segments. However, because there is no consensus regarding how many constructs of worldview that NEP measures, use of the scale in research requires identification of factors present in a specific sample. The number of dimensions identified within the scale have varied widely in literature: three dimensions have been reported by Albrecht et al. (1982) and Thapa (2001); Edgell and Nowell (1989) found evidence for both unidimensionality and three dimensions between samples; Amburgey and Thoman (2012) found five interrelated dimensions. NEP was created to be an additive, unidimensional scale with internal consistency. Dunlap (2008) reports that there may be as few as one or many as five underlying facets of the measures worldview depending on the sample used, but suggests factor analysis should be conducted on a case-specific basis because the number of factors found have varied across samples and applications. Accordingly, we employed principal component analysis here to investigate the presence of multiple dimensions in our sample.

3.2 Demand Analysis and Market Segmentation

Understanding consumer groups is important both for initial choices about what products will be identified by certification, and also for identifying efficient marketing strategies for likely consumer groups (Behe et al. 2013). Should there be multiple consumer groups identified in a market, producers and industry groups can better target their sales. Due to the fact that ornamental plants are agricultural goods and their production generates an environmental impact, it is expected that environmental beliefs are taken into account during the purchasing process. Taking these beliefs into account can better inform our investigation of heterogeneity within the market for labeled ornamental plants.

Segmenting the market for labeled plants is a crucial step in marketing products and in the creation of certification programs. Characterizing segments has long since been a valuable tool in product marketing through facilitating a firm's ability to cater to heterogeneous preferences of distinguishable consumer groups, with each segment being made up of individuals with homogenous preferences (Smith 1956; Swait 1994). Analyses of consumer segments have been previously conducted in the ornamental plant industry based on demographic and prior purchasing characteristics (Behe 2006; Dennis and Behe 2007; Behe and Dennis 2009; Behe et al. 2013). Environmental preferences can be accounted for by simultaneously explaining choice behavior and segmenting the market for ornamental plants via latent class modeling. Market segments can be readily identified using consumer choice survey data by assessing commonalities between respondents' worldviews and their choice behaviors. This framework has recently been applied in the economic literature in a number of different areas: preference heterogeneity for wilderness visitation characterized by individuals' motivations for visiting and preferences for wilderness management (Boxall and Adamowicz 2002); an assessment of fishing preferences for segments characterized by environmental attitudinal data (Morey, Thacher and Breffle 2006); motivations for preservation and heterogeneity in preferences for landscape preservation (Morey et al. 2008); and travel demand preferences as segmented by individuals' attitudes about conventional travel versus "greener" cities (Hurtubia et al. 2014). Specifically, the effect of environmental preferences as measured by the New Environmental Paradigm on market segmentation via latent class analysis for stated preference data has been used by Milon and Scrogin (2006) as well as Kotchen and Reiling (2000). Research identifying segments of ornamental plant consumers by explicitly accounting for environmental preferences has not been performed in product labeling economics literature.

4. Study Design and Administration

For this research, consumer preferences were elicited using a choice modeling framework. Choice modeling is commonly used for estimating consumer demand and implicit prices for attributes or products not available in markets at the time of research. Questions and choice scenarios included in the survey were developed with the assistance of academic horticultural experts and expert ornamental plant producers in the industry (Hartter et al. 2012).

Focus groups were used to assess the quality of the online instrument, identify effective and readily understood questions and also to aid in determining key attributes and their corresponding levels in the choice experiment. Three two-session focus groups consisting of 7-9 consumers with varying degrees of gardening experience were held in Blacksburg, Richmond and Virginia Beach, Virginia between 2011 and 2012. Following the focus groups, two online pilot studies were employed to further test the online survey instrument and ease of timely completion among respondents. Individuals completing the pilot studies included samples of 152 consumers expressing an interest in gardening and 350 consumers from an ornamental plant retailer in the Washington D.C. metro area (Hartter et al. 2012).

Based on the focus groups, key attributes of importance were selected. Those attributes chosen for choice questions included: plant species, density, color, blossoms present, whether or not a given plant blooms and the presence of labels. Subsequent pilot studies informed coefficient values for use in the choice set designs. Ornamental plant types were chosen due to their susceptibility to water-borne diseases, in particular, *Pythium* and *Phytophthora*. Sales levels were also used as a secondary measure to identify susceptible plants with the largest sales volumes. Annual bedding and perennial broadleaf evergreen plants were selected for the study due to their prevalence in the market for horticultural products. In 2009, annual bedding plant sales amounted to $2.3 billion, or 18% of all horticultural specialty sales, while broadleaf evergreen plant sales were $793 million, or 7% of all horticultural sales (United States Department of Agriculture 2010). Because focus group participants identified the presence of blossoms as an attribute that would influence their plant purchases, both blossoming bedding plants and evergreen plants were included in the survey to allow for differences between preferences for both plant types (Hartter et al. 2012).

The specific annual bedding plants chosen for inclusion in the final survey were: Petunia, Geranium, and Chrysanthemum, which together comprised 20% of total national annual bedding sales in 2009 (United States Department of Agriculture 2010). Broadleaf evergreen plants chosen for analysis were Azalea, Boxwood and Holly, which comprised 39% of total national broadleaf evergreen sales in 2009 (United States Department of Agriculture 2010).

The final online survey instrument included a choice experiment in which individuals were asked to make hypothetical plant purchase decisions based key plant characteristic and labeling attributes. The labels included for consideration by participants were water conservation labels, certifying that plants had been produced using water conservation techniques, and plant health labels, certifying that a plant is disease-free at the time of sale. In order to test if consumer utility for these labels varied by certifying authority, multiple authorities were included in the choice experiment (Hartter et al. 2012). Those included in the choice experiment were water conservation labels and plant heath labels certified by a government authority, a non-governmental organization (NGO) and an industry organization. The U.S Department of Agriculture was selected to represent the governmental certifying authority for both water conservation and plant health labels, while fictitious certifying authorities were employed for the depiction of both the NGO and industry labels. These fictitious authorities were defined as: the NGO American Nursery Association, which was applied for both label types as well as Water for Tomorrow, which was used for water conservation labeling, and Plant Society of America, which was used for plant health labeling (Hartter et al. 2012).

Labels were depicted for respondents as they would be presented at a retailer, both as affixed to a plant pot and as a tag placed in soil along with price and physical attribute information. The prices used in the choice experiment were chosen to be representative of the study area, with retail price data observed at home and garden centers and nurseries in the area at the time of survey construction (Hartter et al. 2012).

Respondents who had indicated that they were in the market for a specific plant, based on a previous purchase of the plant within the preceding 12 months for annual bedding and 24 months for broadleaf evergreen, were presented with a choice scenario pertinent to their purchasing patterns (Hartter et al. 2012).[2] For each plant that respondents were considered to be in the market for, they were instructed to choose one of two plant options (both of the same plant type) with varying physical, labeling and price attributes, or indicate that they would purchase neither. The survey instructed respondents that in each choice scenario, attributes that were not explicitly mentioned such as plant color were the same between the two plants presented.

[2] Due to the method by which we identified individuals in the market for given plants, we may have missed sampling individuals who would have joined the market given the presence of labels.

D-efficiency was used as the criterion for identifying choice profiles presented in the survey, as a full-factorial design would not have been feasible (Hartter et al. 2012). By using D-Efficiency as a design criterion, we were able to select attribute levels for each profile in a manner which minimized the errors associated with choice question designs. Using Ngene, sixteen profiles each were created for annuals, Azaleas, and shrubs: Holly and Boxwood.

The final surveys were administered to consumers with an interest in gardening via the internet by qSample. Individuals targeted included those residing in: Georgia, Maryland, Pennsylvania and Virginia. Georgia was chosen as an area for research due to the extreme drought conditions it has faced in recent years, while Maryland, Pennsylvania and Virginia were chosen because principal investigators reside in each of them (Hartter et al. 2012; Folger et al. 2013).

5. Economic Model

Latent Class Modeling is a semi-parametric expansion of Random Utility Maximization models developed by Lancaster (1966) and McFadden (1974) and is used when there are assumed to be multiple segments, *S*, of a population. Each segment is expected to have various preference structures for the attributes in question and thus, differing utility functions for a given profile (Swait 1994; Holmes and Adamowicz 2003). Using this framework, preference heterogeneity is hypothesized to be a function of preferences for plant attributes as well as latent attitudes. The latent attitudes specified to influence segment membership in this study are responses to NEP environmental worldview items. Once the number of segments present in the population has been estimated, separate logit models estimating choice behavior as a function of plant attributes can be estimated for each segment. It is important to note that preference parameters can vary across segments and that after the number of segments have been estimated, NEP response is not used as a dependent variable in the choice logit models.

The use of latent class modeling involves simultaneous identification of market segments and prediction of consumer purchase choices. Because market segments are estimated directly from the choice behavior of particular interest coupled with attitudinal data, the results obtained are posited to be more relevant in aiding product marketing decisions than traditional segmentation techniques that do not account for revealed choice behavior (Swait 1994). In this study, the particular psychographic data used in segmenting respondents were scores on the NEP scale items that measure individuals' ecological worldviews. Using these scores as well as attribute preference data, we were able to estimate segments present in the market.

Estimation of individual choices made by segmented consumers in light of the latent class model is described by Swait (1994) as follows:

1) Segment membership likelihood functions are created for each individual based on observable characteristics (in this study, we employ scores on NEP items and plant attribute preferences).
2) The above likelihood functions are used to identify which latent segment an individual belongs to.
3) Individuals form preferences pertaining to a choice scenario, based on product attributes and the personal characteristics and perceptions related to their specific latent class membership.
4) Individuals follow a decision protocol whereby their final choice decisions are made, resulting in the chosen choice behavior conditional on the segment to which they belong.

In order to specify which segment an individual belongs to, a logit model is used. This model identifies the probability of an individual belonging to a specific segment, s, given a set of attribute preference characteristics, β and respondent ecological worldview, λ. In order to best account for worldview among respondents, our study employed use of principal component analysis to estimate how many constructs of worldview were measured in our sample. This analysis informed us to use a single variable to measure responses on worldview, which was used, in addition to attribute preferences to sort individuals into segments as follows:

$$P_{ns} = \frac{\exp(\lambda_n, \beta_s)}{\sum_{s=1}^{S}(\lambda_n, \beta_s)} \qquad 1$$

The number of segments chosen for analysis is that which minimizes Akaike's Information Criterion (AIC) (Pacifico and Yoo 2012). An individual will be placed in segment s of the population when the probability of them being in that segment is greater than the probability of their membership to any other segment. That is:

$$P_{ns} \geq \max\{P_{nj}\};\ j \neq s, j = 1, \dots, S \qquad 2$$

Upon identification of latent classes among respondents, the conditional indirect utility, U, of a choice made by individual n who is a member of segment s (s = 1,…,S) of the population is expressed:

$$U_{in|s} = \beta_s X_{in} + \varepsilon_{in|s} \qquad 3$$

Where β_s is the preference parameter for segment s of the population and X_{in} is a vector of alternative characteristics while $\varepsilon_{in|s}$ refers to the random component of an individual's utility. These parameter estimates are the same for each individual within a given segment s, but vary across segments. Therefore, the probability of an individual *n* choosing alternative *i* varies for individuals in differing segments. While individuals in each segment have been sorted by their environmental worldview, once they are assigned segments, their individual worldview does not come into consideration as a dependent variable in estimating choice.

For an individual in segment *s*, a logit model is then computed and their probability of choosing *i* given membership in *s* is expressed as a function of parameter estimates, segment characteristics, product alternatives and a scale factor, μ_s, which is inversely related to the variance of $\varepsilon_{in|s}$ (Holmes and Adamowicz 2003):

$$P_{in|s}(i) = \frac{\exp(\mu_s, \beta_s X_i)}{\sum_{j \epsilon C} \exp(\mu_{s,} \beta_s X_i)} \qquad 4$$

Assuming that consumers are rational utility-maximizing individuals, the choice of alternative *i* for those in segment *s* will be made when the following condition holds:

$$U_{in|s} \geq U_{jn|s};\ \forall\, j \neq i, j \in C \qquad 5$$

The econometric model used separately for each plant to estimate the specified systematic utility for alternative *i* for an individual *n* belonging to segment *s* in a population given the bundle of attributes explored in this study has been defined as follows:

$$\begin{aligned} V_{in|s} = {} & ASC_s + \beta_{Prices}(Price_i) + \beta_{1s}(partialbloom_i) + \beta_{2s}(fullbloom_i) \\ & + \beta_{3s}(medium_i) + \beta_{4s}(full_i) + \beta_{5s}(USDAWC_i) + \beta_{6s}(ANAWC_i) \\ & + \beta_{7s}(ENGOWC_i) + \beta_{8s}(USDAPH) + \beta_{9s}(ANAPH_i) \\ & + \beta_{10s}(GOPH_i) \end{aligned} \qquad 6$$

For this study, preference parameters are considered to influence one’s utility and therefore probability of purchasing a particular plant. Differing models as shown in (6) are estimated for each segment determined to be present. Included in choice sets were an alternative specific constant, bloom levels, plant density, and the presence of a label by a number of differing certifying authorities. *ASC* is an alternative specific constant which takes a value of 1 if respondents are presented with an alternative and 0 if otherwise. *Price* is the price of the plant associated with the choice set. *Partialbloom* and *fullbloom* are dummy variables representing the level of bloom in a plant, with the base bloom level, low, omitted from modeling in order to correct for perfect collinearity. Bloom variables were not used in the modeling of broadleaf evergreen plant types and are therefore not represented in model estimates. Likewise, *medium* and *full* are dummy variables which refer to the density of a given plant, with low density omitted for collinearity issues. Dummy variables for water conservation labels included *USDAWC*, *ANAWC* and *ENGOWC*, representing a water conservation label certified by the USDA, a fictitious industry group and a non-governmental organization, respectively. Dummy variables were also used to account for plant health labels: *USDAPH*, *ANAPH* and *ENGOPH*, refer to healthy plant labels certified by the USDA, a fictitious industry group and a non-governmental organization, respectively. For both of these sets of label dummy variables, a variable designating a plant as not bearing a label has been omitted.

Segmenting individuals for latent class modeling requires identification of preference parameters in addition to identification of a latent variable hypothesized to account for preference heterogeneity. The latent variable representing environmental preferences used to aid in segmentation was determined through principal component analysis and is defined as *NEPsum*. This variable is obtained by summing respondents' individual scores on New Environmental Paradigm questions. In order to maintain directionality of the scale, even-numbered scale items have been reverse coded because they are worded in such a way that higher response scores on them indicate lower support for an ecological worldview. By reverse coding these variables, high scores on *NEPsum* correspond to higher levels of support for an environmental world view among respondents.

6. Results

6.1 Respondent Characteristics

Online surveys were administered in April 2012 to 14,175 individuals. Of those received, 745 completed surveys were deemed eligible for use in this study. Approximately half of respondents were administered the New Environmental Paradigm questions, so only those answering them completely were able to be included in the analysis. The number of observations is equal to six times the number of respondents in each category due to the fact that each respondent was given two choice sets, each consisting of two plant purchases and an option not to buy for each plant that they were determined to be in the market for.

Table 1: Response summary for annual bedding and broadleaf evergreen plants

	Chrysanthemum	Geranium	Petunia	Azalea	Boxwood	Holly
# of Respondents	649	719	712	691	496	462
% of Respondents	87%	97%	96%	93%	67%	62%
# of Observations	3,894	4,314	4,272	4,146	2,976	2,772

Table 2: Sample summary statistics compared to previous study

	This Study	Previous Study
% Female	70%	76%
Average Age	55	45
Average Income	$100,000	$69,000
Average Household Size	2.4	2.45
% Holding College Degree or Higher	63%	73%

The demographic characteristics seen in our sample have been compared to a previous study which estimated willingness to pay among consumers for biodegradable containers for ornamental plants (Yue et al. 2010). While our study sampled individuals from Georgia, Maryland, Pennsylvania and Virginia, the previous study estimates resulted from a sample of individuals from Minnesota and Texas. Both studies sampled individuals with a history of purchasing ornamental plants, however our sample was drawn via a market analysis by qSample and the previous study respondents were recruited through advertisements, www.craigslist.org and newsletters. Comparing between only two studies, statistics cannot be computed. We can see that the percentage of females in our study is 6% lower than in the previous study, the average age found in our sample was ten years older than the previous study, the average income in our sample was $31,000 higher than in the previous study, the average household size differed by 0.05 individuals and the percentage of individuals holding a college degree or higher was 10% higher in the previous study than in ours. Additional summary statistics of our sample indicate that of the respondents, 91% were white, 83% live in detached houses and the average length of reported residency was 15 years. Though the estimates obtained from each sample differ somewhat, we see in both samples that individuals in the market for ornamental plants are mostly white females of higher education and income status than the general population.

On average, respondents reported 25 years of gardening experience. When asked to rate themselves on their level of gardening expertise on a scale from 1 (novice) to 10 (expert), they rated themselves a 5.5 on average, while 6% of the sample were members of a gardening organization. Many individuals reported plant loss within 30 days of purchase; 49% of those who had purchased annual bedding plants and 54% of those who had purchased broadleaf evergreen plants reported such losses. Additionally, of those who experienced these losses shortly after purchase, 8% of annual bedding purchasers and 6% of broadleaf evergreen purchases believed that plant diseases were the cause of plant loss. For many cases, respondents were unsure of the cause of plant loss, with 35% of annual bedding purchasers and 39% of broadleaf evergreen purchasers who had experienced loss reporting as such.

Execution of the latent class analysis required specification of variables by which to classify survey respondents via principal component analysis in addition to identification of how many segments of individuals were to be selected.

6.2 Principal Component Analysis

The underlying structure of environmental preferences was assessed by conducting principal component analysis given that literature pertaining to use of the New Environmental Paradigm is inconclusive as to how many factors are embodied in the scale.

Table 3: New Environmental Paradigm items as presented to survey respondents

Item	Variable Name
We are approaching the limit of the number of people earth can support.	*Nep1*
Humans have the right to modify the natural environment to suit their needs.	*Rnep2*
When humans interfere with nature it often produces disastrous consequences.	*Nep3*
Human ingenuity will insure that we do NOT make the earth unlivable.	*Rnep4*
Humans are severely abusing the environment.	*Nep5*
The earth has plenty of natural resources if we just learn how to develop them.	*Rnep6*
Plants and animals have as much right as humans to exist.	*Nep7*
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	*Rnep8*
Despite our special abilities humans are still subject to the laws of nature.	*Nep9*
The so-called "ecological crisis" facing humankind has been greatly exaggerated.	*Rnep10*
The earth is like a spaceship with only limited room and resources.	*Nep11*
Humans were meant to rule over the rest of nature.	*Rnep12*
The balance of nature is very delicate and easily upset.	*Nep13*
Humans will eventually learn enough about how nature works to be able to control it.	*Rnep14*
If things continue on their present course, we will soon experience a major ecological catastrophe.	*Nep15*

Correlation results between scale items indicate that when excluding the main diagonal, 45.7% of items exhibit correlation coefficients greater than 0.3, but only 7.6% exceed a correlation coefficient of 0.50 (R-matrix of all correlation coefficients is found in Table C.5). This may be indicative of items that have a poor ability to be factored together. For this study, the feasibility of retaining three factors based on Kaiser's Criterion was further assessed via an analysis of Varimax rotated factor loadings, which revealed that there were heavy crossloading issues, where items loaded significantly onto more than one factor. Crossloading does not represent an issue when using the sum of NEP scores as a segmentation variable because there is only one factor onto which the items can load. In our sample, retention of three factors yielded only four items which did not exhibit crossloading issues and experimenting with dropping items which were most poorly behaved still did not result in successful factorization. In order to maintain consistency for comparisons to previous studies and to not lose preference data, it was decided to retain all scale items in the analysis. Furthermore, due to the poor ability to factor the survey results drawn in this sample, the scale is treated as a unidimensional measure of respondents' worldview. As per Dunlap (2008), the singular measure used for segmentation and coefficient estimation was calculated by summing individuals' scores on all fifteen scale items. Chronbach's Alpha for this scale is 0.87 with an overall Kaiser-Meyer-Olkin measure of sampling adequacy statistic of 0.90. These measures are consistent with excellent internal consistency and a successful sample size (Field and Miles 2010).

6.3 Segmentation Process

Using the *NEPsum* variable, segmentation for each plant data set was conducted in Stata. Stata codes for this process were created based off of those obtained in Pacifico and Yoo (2012). The selection criterion for the number of segments to use was considered to be the number of classes which minimized Bayesian and Bozdogan's Consistent AIC (CAIC) information criterion. Information criterion was estimated for ranges of 2 to 10 segments for each plant type and for each plant, 2 segments minimized both of these criterion. All latent class estimation results were obtained using two population segments.

6.4 Econometric Model Results

Separate latent class models were estimated for each plant using Stata statistical software. For each plant, the number of segments was estimated independently and used for estimating segment-specific coefficients. Segment-specific coefficients were used to test the following null hypothesis: For each individual population segment, the label parameters do not differ by certifying authority and can be collapsed into two aggregated label attributes, water conservation and disease free.

Our results indicate that by accounting for environmental preferences, we are able to identify two segments of the market for ornamental plants. Of these segments, we can characterize them relative to each other. One segment tends to be relatively more price sensitive than the other segment, while the other can be generally characterized as more attribute sensitive than the other segment. These segments are referred to as price sensitive and attribute sensitive, respectively.

Though the price sensitive segment is not more price sensitive than the attribute sensitive segment in every case, we can see that they are more price sensitive than the attribute sensitive segment in four out of six plant models. Likewise, we can say that the attribute sensitive segment generally tends to favor physical and labeling attributes more so than the price sensitive segment. This is evidenced by their consistently significant plant characteristic and plant labeling preference coefficients, which is not consistently the case across plant and labeling attributes for the price sensitive segment. Comparing these two groups together, we generally tend to see price coefficients higher in magnitude in the price sensitive group with fewer plant characteristic and labeling coefficients of significance than seen in the attribute sensitive group. Likewise, attribute sensitive consumers tend to have lower magnitude price coefficients and more plant and labeling characteristic coefficients of significance and of higher magnitude than the price sensitive segment of the market. Both segments, however, show that the presence of healthy plant labels contribute significantly towards their likelihood of purchasing a given plant.

While respondents' scores on the New Environmental Paradigm scale were used to simultaneously segment groups and explain their behavior, we do not find large differences in *NEPsum* scores across segments. However, segmenting by environmental preferences has been useful in helping us differentiate consumer groups and characterize the market for labeled goods by groups with differing preference structures for plant attributes which are likely to be readily catered to in market environments.

Neither segment is in the majority for all plants. Respondents in the market for Chrysanthemums, Petunias and Azaleas are made up in large part by price sensitive consumers and those in the market for Geraniums, Boxwood and Holly are mostly made up of attribute sensitive consumers. These results indicate that individuals may be in differing segments across plant types, which was expected due to the varying nature of the plants selected. For example, while plants such as Boxwood and Holly are selected by many due to their shape, these physical characteristics are not necessarily as important in purchasing decisions of other plants such as Chrysanthemums and Petunias which are regularly purchased before they bloom.

Table 4: Estimated latent class models for Chrysanthemums, Geraniums, Petunias, Azaleas, Boxwood and Holly.

		Annuals			Perennials		
	Attribute	Chrysanthemum	Geranium	Petunia	Azalea	Boxwood	Holly
Price Sensitive Segment	Price	-0.477***	-0.810***	-0.333**	-0.632**	-1.261***	-0.488***
		(0.082)	(0.140)	(0.147)	0.306	(0.412)	(0.087)
	ASC	3.782***	0.171	20.319	16.755	12.618***	4.932***
		(0.751)	(0.563)	(1421.855)	(493.675)	(3.937)	(0.849)
	Partial Bloom	0.378**	0.523	0.058			
		(0.191)	(0.362)	(0.231)			
	Full Bloom	0.585***	0.835**	0.183			
		(0.177)	(0.361)	(0.206)			
	Medium	0.209	0.651*	0.194	0.988*	-0.223	-0.954**
		(0.197)	(0.342)	(0.215)	(0.519)	(0.696)	(0.463)
	Full	0.518**	1.316***	0.363	1.517**	0.313	0.508*
		(0.207)	(0.375)	(0.244)	(0.721)	(0.527)	(0.277)
	USDAWC	1.026***	0.239	0.450*	0.865**	1.114	-0.991**
		(0.215)	(0.404)	(0.260)	(0.474)	(0.891)	(0.339)
	ANAWC	0.944***	0.125	0.436**	0.917***	0.836	0.048
		(0.199)	(0.353)	(0.212)	(0.308)	(0.718)	(0.298)
	ENGOWC	0.938***	0.461	0.323	0.746**	0.690	-1.798***
		(0.213)	(0.348)	(0.255)	(0.375)	(0.869)	(0.544)
	USDAPH	0.789***	0.908**	0.959***	1.485***	3.406***	-0.334
		(0.142)	(0.360)	(0.158)	(0.387)	(1.236)	(0.616)
	ANAPH	0.930***	1.067**	0.798**	1.438**	2.736***	0.814**
		(0.232)	(0.443)	(0.280)	(0.574)	(1.015)	(0.300)
	GOPH	0.973***	1.243***	0.888***	1.703***	2.737**	1.008***
		(0.180)	(0.380)	(0.188)	(0.326)	(1.109)	(0.302)
Attribute Sensitive Segment	Price	-1.257***	-0.597***	-0.954***	-0.505***	0.008	-0.133***
		(0.245)	(0.090)	(0.202)	(0.111)	(0.077)	(0.040)
	ASC	1.074	4.263***	0.850	-0.015	-2.126**	0.432
		(0.747)	(1.040)	(0.850)	(0.470)	(0.903)	(0.628)
	Partial Bloom	1.274**	0.810***	0.593*			
		(0.419)	(0.246)	(0.316)			
	Full Bloom	0.989**	0.790***	1.076***			
		(0.383)	(0.211)	(0.289)			
	Medium	1.570***	0.590**	0.381	0.907***	0.641**	1.105**
		(0.426)	(0.229)	(0.315)	(0.301)	(0.288)	(0.371)
	Full	1.993***	0.836***	1.287***	1.568***	1.318***	1.683***
		(0.435)	(0.252)	(0.311)	(0.399)	(0.294)	(0.336)
	USDAWC	1.083**	1.220***	0.018	0.545*	1.551***	1.248***
		(0.425)	(0.282)	(0.373)	(0.316)	(0.318)	(0.390)
	ANAWC	0.681*	1.080***	0.644**	0.634*	1.072***	1.047***
		(0.382)	(0.230)	(0.314)	(0.353)	(0.269)	(0.309)
	ENGOWC	0.545	1.107***	0.466	0.755**	1.071***	1.722***
		(0.405)	(0.278)	(0.320)	(0.320)	(0.317)	(0.420)
	USDAPH	1.427***	0.715***	0.599	1.380***	1.300***	1.427***
		(0.514)	(0.143)	(0.377)	(0.499)	(0.355)	(0.377)
	ANAPH	1.173**	1.316***	0.909**	1.151***	1.542***	1.228***
		(0.409)	(0.287)	(0.385)	(0.432)	(0.317)	(0.341)
	GOPH	1.575***	0.895***	0.926**	1.092**	1.500***	1.095**
		(0.416)	(0.183)	(0.390)	(0.452)	(0.339)	(0.380)

Standard errors in parentheses; *** p< 0.01, ** p<0.05, *p<0.1

Table 5: Average New Environmental Paradigm (*NEPsum)* scores for each segment, by plant

Segment	Chrysanthemum	Geranium	Petunia	Azalea	Boxwood	Holly
Price Sensitive	38.404	38.604	38.765	39.075	40.112	38.313
Attribute Sensitive	38.968	38.877	39.532	37.769	38.288	38.385

Table 6: Total number of observations and respondents by consumer segment and plant

	Chrysanthemum	Geranium	Petunia	Azalea	Boxwood	Holly
Total Observations	3894	4314	4272	4146	2976	2772
Total Respondents	649	719	712	691	496	462
Price Sensitive Respondents	460	182	571	535	187	176
Attribute Sensitive Respondents	189	537	141	156	309	286

The price coefficient is negative and significant in all models besides that for the attribute sensitive segment for consumers of Boxwood plants. The price sensitive segment exhibits price coefficients higher in magnitude than the attribute sensitive segment for Geraniums, Azalea, Boxwood and Holly plants. These findings were as expected and suggest that as prices for plants increase, consumers are less likely to decide to purchase them.

For both segments of the market, the partial bloom and full bloom attributes on annual bedding plants have positive coefficients, though they are only consistently significant for those in the attribute sensitive segment. These results suggest that respondents of the attribute sensitive segment prefer partial bloom and full bloom plants over low bloom plants, though those who are less attribute sensitive only prefer them over low bloom plants in the cases of partial and full bloom chrysanthemums and full bloom geraniums.

Results for medium and full density plants are mixed in the price sensitive segment. Positive and significant coefficients are only found for medium density Azaleas and full density Chrysanthemums, Geraniums, Azaleas and Holly. Likewise, the coefficients for full density

Petunias and Boxwoods are not significant in the price sensitive segment. Given the characterization of this segment as relatively less attribute sensitive, these results are expected. Conversely, for attribute sensitive consumers, medium and full density plants are preferred over all low density plants, as suggested by positive and significant coefficients. These results were as expected given the increased importance this segment places on physical plant attributes. Results for the bloom coefficients were similar to those found for density between segments. The price sensitive segment tends to be less responsive to full bloom and medium bloom attributes than the attribute sensitive segment, as measured by the corresponding magnitude of coefficient attributes. For the price sensitive segment, the Geranium partial bloom and Petunia partial bloom and full bloom coefficients are not significant, meaning that for these less attribute sensitive consumers, the aforementioned attributes do not come into consideration in purchases.

For price sensitive consumers, water conservation label coefficients are positive and significant for Chrysanthemums and Azaleas, regardless of certifying authority and for Azaleas bearing a water conservation label as certified by a governmental and industry certification. Additionally, consumers of this segment exhibit negative and significant coefficients for water conservation labelled Holly plants when certified by a governmental and nongovernmental source. Where present, these positive and significant water conservation attribute coefficients suggest that consumers in this segment would be more likely to purchase a plant bearing the corresponding labels. In the cases of negative and significant coefficients such as governmental certified Holly plants, we can infer that price sensitive consumers would actually be less likely to make a purchase. Conversely, in the case for attribute sensitive consumers, for all water conservation labels besides those certified by a nongovernmental organization on Chrysanthemum and Petunias, coefficients are positive and significant. In general, this suggests that the presence of a water conservation label would make an attribute sensitive consumer more likely to purchase a given plant.

Both segments in the market are sensitive to disease free certification. Barring governmental plant health labels on Petunias and Hollies, all coefficients on disease free labels are positive and significant and indicate that their presence would make consumers of both segments more likely to purchase a given plant than those without such a label. We expected consumers to be more sensitive to plant disease labeling than they were to water conservation labeling. Purchase of a potentially diseased plant could mean the loss of a plant purchased as well as the potential to infect other plants in an individual's landscaping, which would negatively impact consumers of both segment types. The presence of disease in a plant bears more of an impact on consumers' private utility than water conservation labeled production practices, which measures a public, rather than private benefit.

6.4.1 Testing for preference heterogeneity between certifying authority

For both population segments of consumers for each plant, hypothesis testing was conducted in order to test the null hypothesis that the label parameters do not differ by certifying authority and can be collapsed into two label attributes, water conservation and disease free.

Table 7: Chi-squared test for differences between water conservation label certifying authorities, p-values

Segment	Chrysanthemum	Geranium	Petunia	Azalea	Boxwood	Holly
Price Sensitive	0.794	0.540	0.588	0.579	0.821	0.003**
Attribute Sensitive	0.323	0.604	0.169	0.749	0.044**	0.048**

**p<0.05

Table 8: Chi-squared test for differences between disease free label certifying authorities, p-values

Segment	Chrysanthemum	Geranium	Petunia	Azalea	Boxwood	Holly
Price Sensitive	0.502	0.546	0.797	0.454	0.515	0.148
Attribute Sensitive	0.578	0.041**	0.510	0.550	0.520	0.471

**p<0.05

We fail to reject the null hypothesis in the case that there is no preference heterogeneity in regards to certifying authority in all cases besides both segments of Holly consumers and the attribute sensitive segment of Boxwood consumers. Additionally, we fail to reject the null hypothesis that there is no preference heterogeneity between certifying authority for all cases besides attribute sensitive Geranium consumers. Testing at the 10% level of significance, we expected that approximately 3 of these tests would be rejected due to random chance and as such, the results of this testing strongly suggest that consumers do not have heterogeneous preferences for certifying authorities of either label type. These results were expected and are consistent with Hartter et al. (2012).

7. Discussion and Conclusions

Our findings indicate that respondents show a positive and significant response to water conservation and healthy plant labels. We found that for most of the six plants studied, neither segment showed a preference for the certifying authority of either disease free or water conservation labels. In light of these findings, it is suggested that additional research pertaining to the potential for differing governmental, nongovernmental and industry groups to offer such certification schemes be conducted. The matter of how such a labeling scheme could be implemented by any certifying authority should be investigated further in order to successfully market water conservation and disease free labeled plants to consumers of both price and attribute sensitive market segments.

Our findings suggest that while one segment can be characterized by increased price sensitivity, another segment is more attribute sensitive. The attribute sensitive segments were generally more responsive to physical plant attributes, such as density and bloom levels, while the price sensitive segments showed more concern for price than density and bloom characteristics. Both segments were similarly sensitive to healthy plant labels, with slightly less sensitivity to water conservation labels among price sensitive respondents than those who were attribute sensitive.

Our results are suggestive of the possibility of selling a mix of both labeled and non-labeled plants at the retail level. An assessment of segment characteristics indicates that there is a group of attribute sensitive consumers more likely to purchase a labeled plant at a higher price, and a price sensitive group of consumers more likely to buy a non-labeled plant at a lower price. Given that retailers will not be able to distinguish between differing consumer segments, offering a mix of both product types may be advantageous for sellers. By doing so, retailers have the potential to draw in both consumer bases while also benefiting from any increased revenues which may be gained through sales of additional products during store visits from this more diverse group of customers. Lower sales prices that producers may be able to command by selling non-labeled plants are expected to be offset by those higher value labeled sales to those willing to pay a higher premium on disease free and water conservation labels.

While our estimates for the share of price versus attribute sensitive consumers in the market for each plant studied can serve as a starting point for setting the level of labeled versus non-labeled plants at retailers, it is suggested that further research be conducted on profitable product mixes across plant types, retailers and geographic areas. Furthermore, it is also suggested that future research investigate the price premiums gained for labels in a retail setting. Given that our sampling techniques may have omitted individuals who would have entered the markets for plants bearing a label, future research may also investigate how the makeup of the market for each ornamental plant studied may change upon introduction of these labeling schemes.

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Appendix A: Depiction of Labeling Information

Figure A-1: Water conservation certification labels

Label	Description
None	'None' describes a plant that is grown using typical watering practices.
	A choice labeled 'Water Smart' by the U.S. Department of Agriculture (USDA) means the ornamental plants were grown to meet U.S. Department of Agriculture requirements concerning water conservation and produced with water recycling technology. The USDA is a government agency charged with developing policy concerning farming, food and agriculture. The certification implies producers are regularly audited and monitored by the USDA to ensure requirements are met.
	A choice labeled 'Water Smart' by the American Nursery Association (ANA) means the ornamental plants were grown to meet American Nursery Association requirements concerning water conservation and produced with water recycling technology. The American Nursery Association is an industry association representing the producers of ornamental plants. The certification implies producers are regularly audited and monitored by the industry association to ensure requirements are met.
	A choice labeled 'Water Smart' by Water for Tomorrow means the ornamental plants were grown to meet Water for Tomorrow requirements concerning water conservation and produced with water recycling technology. Water for Tomorrow is an environmental non-governmental organization (NGO) which advocates for the protection of public water resources. Examples of other NGO's in the U.S. are the Sierra Club and The Forest Stewardship Council. The certification implies producers are regularly audited and monitored by Water for Tomorrow to ensure requirements are met.

Source: Hartter et al. 2012

Figure A-2: Disease-free certification labels

Label	Description
None	'None' describes a plant that has no plant health certification.
HEALTHY PLANTS® U.S. DEPARTMENT OF AGRICULTURE CERTIFIED DISEASE FREE	A choice labeled 'Healthy Plants - Certified Disease Free' by the U.S. Department of Agriculture (USDA) means the plant was grown under conditions that meet U.S. Department of Agriculture (USDA) requirements to ensure the plant is free of disease and healthy. The USDA is a government agency charged with developing policy concerning farming, food and agriculture. The certification implies plants and producers are regularly audited and monitored by the USDA to ensure requirements are met.
HEALTHY PLANTS® AMERICAN NURSERY ASSOCIATION CERTIFIED DISEASE FREE	A choice labeled 'Healthy Plants - Certified Disease Free' by the American Nursery Association (ANA) means the plant was grown under conditions that meet American Nursery Association requirements to ensure the plant is free of disease and healthy. The American Nursery Association is an industry association representing the producers of ornamental plants. The certification implies the plants producers are regularly audited and monitored by the industry association to ensure requirements are met.
HEALTHY PLANTS® PLANT SOCIETY OF AMERICA CERTIFIED DISEASE FREE	A choice labeled 'Healthy Plants - Certified Disease Free' by Plant Society of America means the plant was grown under conditions that meet Plant Society of America requirements to ensure the plant is free of disease and healthy. Plant Society of American is a gardening organization promoting gardening and healthy plants. The certification implies the plants producers are regularly audited and monitored by Plant Society of America to ensure requirements are met.

Source: Hartter et al. 2012

Appendix B: Choice Experiment Design

Table B-1: Choice experiment attributes and levels

Attribute	Level	Value	Variable Name	Description
Bloom	2	Low Bloom	Omitted	Less than 30% of the buds are in bloom
	1	Partial Bloom	*Partialbloom*	30 to 70% of the buds are in bloom
	0	Full Bloom	*Fullbloom*	80 to 100% of the buds are in bloom
Fullness	2	Light	Omitted	The plant has a light density of foliage
	1	Medium	*Medium*	The plant has a medium density of foliage
	0	Full	*Full*	The plant has a full density of foliage
Water Conservation	3	ENGO Certification	*ENGOWC*	Certified for water conservation by Water for Tomorrow, a non-governmental organization
	2	ANA Certification	*ANAWC*	Certified for water conservation by American Nursery Association, an industry organization
	1	USDA Certification	*USDAWC*	Certified for water conservation by the United States Department of Agriculture, a government agency
	0	None	*Omitted*	No water conservation certification
Plant Health	3	GO Certification	*GOPH*	Certified disease-free by Plant Society of America, a gardening non-governmental organization
	2	ANA Certification	*ANAPH*	Certified disease-free by American Nursery Organization, and industry association
	1	USDA Certification	*USDAPH*	Certified disease-free by the United States Department of Agriculture, a government agency
	0	None	*Omitted*	No disease-free certification
Price ($)		**Chrysanthemum**	**Geranium**	**Petunia**
	3	6.53	6.04	4.54
	2	5.53	4.84	3.84
	1	4.54	3.64	3.15
	0	3.54	2.44	2.45
		Azalea	**Boxwood**	**Holly**
	3	7.04	12.74	15.78
	2	5.7	10.81	12.5
	1	4.37	8.87	2.22
	0	3.03	6.94	5.94

Source: Hartter et al. 2012

Table B-2: Bedding plant choice experiment design

Choice 1	**A**	**B**	**Choice 9**	**A**	**B**
Bloom	2	0	Bloom	0	1
Fullness	0	1	Fullness	2	1
Water Conservation	3	2	Water Conservation	2	0
Plant Health	2	0	Plant Health	3	2
Price	2	1	Price	0	2
Choice 2	**A**	**B**	**Choice 10**	**A**	**B**
Bloom	0	2	Bloom	0	2
Fullness	1	2	Fullness	1	0
Water Conservation	1	2	Water Conservation	2	1
Plant Health	0	1	Plant Health	2	0
Price	3	0	Price	2	0
Choice 3	**A**	**B**	**Choice 11**	**A**	**B**
Bloom	0	1	Bloom	1	2
Fullness	2	0	Fullness	2	0
Water Conservation	1	2	Water Conservation	0	1
Plant Health	1	3	Plant Health	1	3
Price	0	3	Price	0	3
Choice 4	**A**	**B**	**Choice 12**	**A**	**B**
Bloom	1	0	Bloom	1	0
Fullness	2	0	Fullness	0	1
Water Conservation	3	2	Water Conservation	2	3
Plant Health	3	1	Plant Health	2	3
Price	1	1	Price	2	1
Choice 5	**A**	**B**	**Choice 13**	**A**	**B**
Bloom	2	2	Bloom	1	2
Fullness	2	2	Fullness	0	1
Water Conservation	0	0	Water Conservation	1	0
Plant Health	0	1	Plant Health	1	2
Price	2	3	Price	3	0
Choice 6	**A**	**B**	**Choice 14**	**A**	**B**
Bloom	2	1	Bloom	0	1
Fullness	0	2	Fullness	1	2
Water Conservation	3	1	Water Conservation	3	1
Plant Health	0	2	Plant Health	1	0
Price	0	3	Price	3	0
Choice 7	**A**	**B**	**Choice 15**	**A**	**B**
Bloom	2	0	Bloom	2	0
Fullness	1	0	Fullness	1	0
Water Conservation	1	3	Water Conservation	2	0
Plant Health	3	0	Plant Health	0	3
Price	1	2	Price	1	2
Choice 8	**A**	**B**	**Choice 16**	**A**	**B**
Bloom	1	0	Bloom	0	1
Fullness	0	2	Fullness	0	1
Water Conservation	0	3	Water Conservation	0	3
Plant Health	3	2	Plant Health	2	1
Price	1	2	Price	3	1

Source: Hartter et al. 2012

Table B-3: Azalea choice experiment design

Choice 1	A	B	Choice 9	A	B
Fullness	0	1	Fullness	0	2
Water Conservation	2	0	Water Conservation	3	0
Plant Health	0	3	Plant Health	1	2
Price	1	0	Price	2	0
Choice 2	**A**	**B**	**Choice 10**	**A**	**B**
Fullness	2	2	Fullness	1	0
Water Conservation	0	3	Water Conservation	1	0
Plant Health	3	1	Plant Health	2	1
Price	2	3	Price	1	0
Choice 3	**A**	**B**	**Choice 11**	**A**	**B**
Fullness	1	0	Fullness	1	0
Water Conservation	3	1	Water Conservation	2	3
Plant Health	3	2	Plant Health	0	2
Price	0	2	Price	1	3
Choice 4	**A**	**B**	**Choice 12**	**A**	**B**
Fullness	0	1	Fullness	1	2
Water Conservation	3	2	Water Conservation	0	2
Plant Health	3	1	Plant Health	0	3
Price	2	1	Price	3	3
Choice 5	**A**	**B**	**Choice 13**	**A**	**B**
Fullness	0	2	Fullness	2	0
Water Conservation	1	3	Water Conservation	2	1
Plant Health	3	0	Plant Health	2	0
Price	3	0	Price	0	1
Choice 6	**A**	**B**	**Choice 14**	**A**	**B**
Fullness	0	1	Fullness	0	2
Water Conservation	0	1	Water Conservation	0	1
Plant Health	2	1	Plant Health	1	3
Price	1	1	Price	3	2
Choice 7	**A**	**B**	**Choice 15**	**A**	**B**
Fullness	2	1	Fullness	2	0
Water Conservation	1	2	Water Conservation	1	3
Plant Health	0	2	Plant Health	1	0
Price	0	2	Price	0	2
Choice 8	**A**	**B**	**Choice 16**	**A**	**B**
Fullness	2	1	Fullness	1	0
Water Conservation	2	0	Water Conservation	3	2
Plant Health	1	0	Plant Health	2	3
Price	3	3	Price	2	1

Source: Hartter et al. 2012

Table B-4: Boxwood and Holly choice experiment design

Choice 1	**A**	**B**	**Choice 9**	**A**	**B**
Fullness	0	2	Fullness	1	2
Water Conservation	0	2	Water Conservation	3	2
Plant Health	3	1	Plant Health	2	0
Price	2	0	Price	3	2
Choice 2	**A**	**B**	**Choice 10**	**A**	**B**
Fullness	1	0	Fullness	0	2
Water Conservation	1	3	Water Conservation	2	1
Plant Health	2	0	Plant Health	1	3
Price	2	0	Price	3	0
Choice 3	**A**	**B**	**Choice 11**	**A**	**B**
Fullness	2	2	Fullness	0	1
Water Conservation	1	0	Water Conservation	2	3
Plant Health	0	0	Plant Health	0	1
Price	2	1	Price	1	3
Choice 4	**A**	**B**	**Choice 12**	**A**	**B**
Fullness	0	1	Fullness	1	0
Water Conservation	0	2	Water Conservation	1	3
Plant Health	1	2	Plant Health	0	3
Price	0	1	Price	0	2
Choice 5	**A**	**B**	**Choice 13**	**A**	**B**
Fullness	2	1	Fullness	1	0
Water Conservation	3	1	Water Conservation	2	1
Plant Health	2	3	Plant Health	3	2
Price	0	1	Price	0	2
Choice 6	**A**	**B**	**Choice 14**	**A**	**B**
Fullness	2	0	Fullness	0	1
Water Conservation	0	1	Water Conservation	3	0
Plant Health	3	1	Plant Health	3	2
Price	2	3	Price	1	0
Choice 7	**A**	**B**	**Choice 15**	**A**	**B**
Fullness	2	0	Fullness	2	0
Water Conservation	2	0	Water Conservation	0	2
Plant Health	1	3	Plant Health	0	2
Price	3	2	Price	1	3
Choice 8	**A**	**B**	**Choice 16**	**A**	**B**
Fullness	1	2	Fullness	0	1
Water Conservation	3	0	Water Conservation	1	3
Plant Health	1	0	Plant Health	2	1
Price	3	1	Price	1	3

Source: Hartter et al. 2012

Appendix C: Factor Analysis Results

Table C-1: R-matrix of correlation coefficients for New Environmental Paradigm scale items

New Environmental Paradigm Scale Item Correlations

	nep1	Rnep2	nep3	Rnep4	nep5	Rnep6	nep7	Rnep8	nep9	Rnep10	nep11	Rnep12	nep13	Rnep14	nep15
nep1	1.00														
Rnep2	0.13	1.00													
nep3	0.32	0.28	1.00												
Rnep4	0.26	0.31	0.21	1.00											
nep5	0.45	0.28	0.54	0.25	1.00										
Rnep6	0.31	0.24	0.17	0.35	0.22	1.00									
nep7	0.30	0.28	0.34	0.10	0.43	0.06	1.00								
Rnep8	0.31	0.39	0.34	0.42	0.41	0.34	0.22	1.00							
nep9	0.10	0.16	0.28	0.11	0.25	-0.01	0.25	0.11	1.00						
Rnep10	0.40	0.41	0.35	0.40	0.48	0.36	0.32	0.60	0.16	1.00					
nep11	0.51	0.18	0.34	0.24	0.43	0.30	0.28	0.34	0.21	0.38	1.00				
Rnep12	0.24	0.37	0.25	0.28	0.30	0.25	0.36	0.40	0.15	0.45	0.24	1.00			
nep13	0.33	0.25	0.46	0.21	0.50	0.17	0.37	0.36	0.21	0.41	0.36	0.26	1.00		
Rnep14	0.11	0.24	0.14	0.37	0.12	0.25	0.07	0.30	0.18	0.24	0.12	0.29	0.03	1.00	
nep15	0.54	0.29	0.47	0.29	0.63	0.28	0.38	0.39	0.21	0.58	0.52	0.29	0.55	0.11	1.00

Table C-2: Factor eigenvalues greater than one for varimax rotation results of New Environmental Paradigm items

Factor	Variance	Difference	Proportion	Cumulative
Factor1	3.78346	1.06842	0.2522	0.2522
Factor2	2.71504	1.03152	0.181	0.4332
Factor3	1.68352	.	0.1122	0.5455

Figure C-1: Screeplot of eigenvalues for factors one through fifteen of New Environmental Paradigm items

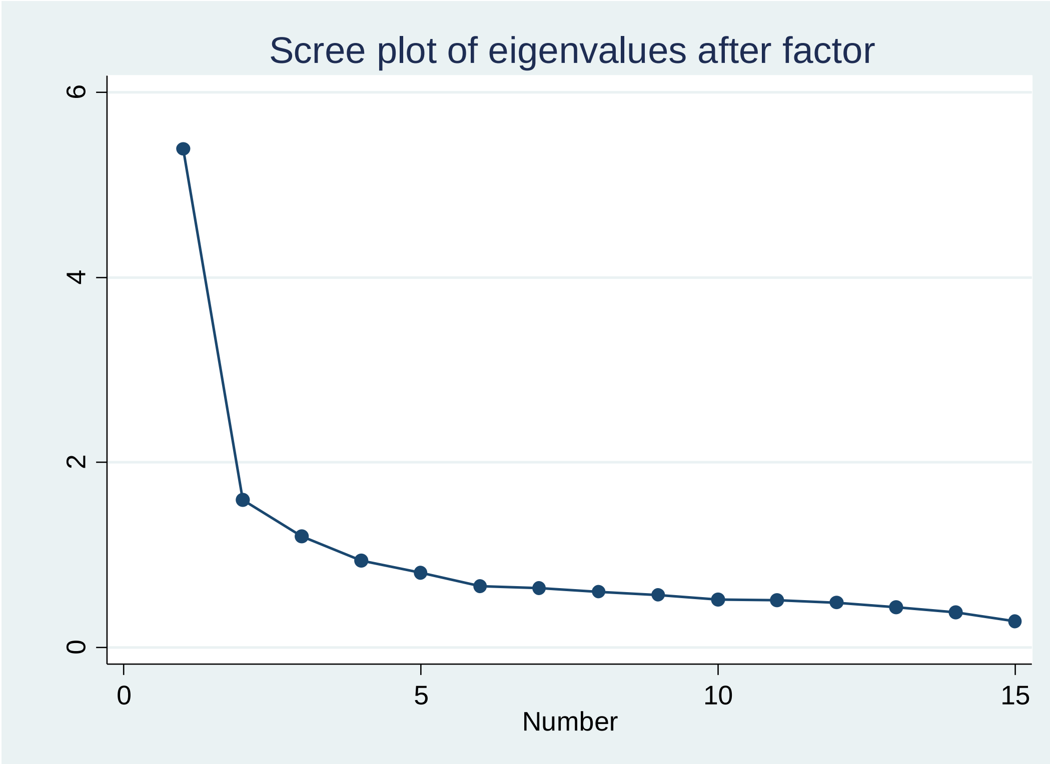

Table C-3: Varimax rotated factor loadings of New Environmental paradigm items with three retained factors

	Rotated Factor Loadings		
Variable	Factor1	Factor2	Factor3
nep1	0.7569	0.1331	-0.1192
Rnep2	0.1200	0.5757	0.3704
nep3	0.5361	0.1382	0.4348
Rnep4	0.2230	0.6800	-0.0763
nep5	0.7092	0.1521	0.3354
Rnep6	0.3654	0.5438	-0.3457
nep7	0.3934	0.0716	0.5976
Rnep8	0.4039	0.6250	0.0849
nep9	0.0895	0.0936	0.6660
Rnep10	0.5453	0.5434	0.1381
nep11	0.7107	0.1456	0.0010
Rnep12	0.1968	0.5596	0.3349
nep13	0.6346	0.0721	0.3484
Rnep14	-0.0972	0.7041	0.1170
nep15	0.8022	0.1743	0.1762

Table C-4: Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for New Environmental Paradigm scale items

Variable	KMO
nep1	0.8940
Rnep2	0.9143
nep3	0.9214
Rnep4	0.9017
nep5	0.9194
Rnep6	0.9003
nep7	0.8839
Rnep8	0.8985
nep9	0.8275
Rnep10	0.9003
nep11	0.9128
Rnep12	0.9030
nep13	0.9249
Rnep14	0.8016
nep15	0.8923
Overall	0.9002

Appendix D: Latent Class Segmentation Results

Table D-1: Bayesian and Bozdogan's consistent AIC (CAIC) for the estimation of latent classes in annual bedding plants

Chrysanthemum			Geranium			Petunia		
Segments	CAIC	BIC	Segments	CAIC	BIC	Segments	CAIC	BIC
2	2652.7	2626.7	2	2823.9	2797.9	2	2786.7	2760.7
3	2691.9	2651.9	3	2888.3	2848.3	3	2798.3	2758.3
4	2774.9	2720.9	4	2969.8	2915.8	4	2899.1	2845.1
5	2856.5	2788.5	5	3051.5	2983.5	5	2995.3	2927.3
6	2964.2	2882.2	6	3130.1	3048.1	6	3081.5	2999.5
7	3044.6	2948.6	7	3250.0	3154.0	7	3167.2	3071.2
8	3155.3	3045.3	8	3341.8	3231.8	8	3230.8	3120.8
9	3246.5	3122.5	9	3417.0	3293.0	9	3357.3	3233.3
10	3380.6	3242.6	10	3516.9	3378.9	10	3474.8	3336.8

Table D-2: Bayesian and Bozdogan's consistent AIC (CAIC) for the estimation of latent classes in broadleaf evergreen plants

Azalea			Boxwood			Holly		
Segments	CAIC	BIC	Segments	CAIC	BIC	Segments	CAIC	BIC
2	2624.1	2602.1	2	1904.8	1882.8	2	1860.3	1838.3
3	2655.8	2621.8	3	1920.9	1886.9	3	1877.0	1843.0
4	2699.9	2653.9	4	1972.2	1926.2	4	1945.9	1899.9
5	2783.4	2725.4	5	2044.6	1986.6	5	2020.1	1962.1
6	2898.6	2828.6	6	2113.8	2043.8	6	2097.6	2027.6
7	2947.8	2865.8	7	2211.9	2129.9	7	2183.6	2101.6
8	3034.4	2940.4	8	2288.9	2194.9	8	2252.9	2158.9
9	3119.2	3013.2	9	2366.9	2260.9	9	2339.4	2233.4
10	3228.4	3110.4	10	2448.3	2330.3	10	2425.6	2307.6

Appendix E: Example Stata Codes for Latent Class Model

```
 *Generate variables
gen ASC = a | b
*Reverse-code even-numbered NEP variables
gen Rnep2 = 6 - nep2
gen Rnep4 = 6 - nep4
gen Rnep6 = 6 - nep6
gen Rnep8 = 6 - nep8
gen Rnep10 = 6 - nep10
gen Rnep12 = 6 - nep12
gen Rnep14 = 6 - nep14

*Install plug-in program
ssc install gllamm

*Petunia Analysis
use "D:\Thesis\Data, Do Files, Results\Data\Petunia.dta"
drop if nep1 == .

*Determine the # of classes (Both hole and lclogit code journal
 forvalues c= 2/10 {

quietly lclogit choice price ASC partialbloom fb medium full usdawc anawc engowc usdaph
anaph goph, group(gid) id(pid) nclass(`c') membership(nepsum) seed(5)
    matrix b=e(b)
    matrix ic = nullmat(ic) \ `e(nclasses)', `e(ll)', `=colsof(b)', `e(aic)', `e(caic)', `e(bic)'

}
matrix colnames ic = "Classes" "LLF" "Nparam" "AIC" "CAIC" "BIC"
matlist ic, name(columns)


*estimate the latent class model with 2 classes
lclogit choice price ASC partialbloom fb medium full usdawc anawc engowc usdaph anaph
goph, group(gid) id(pid) nclass(2) membership(nepsum) seed(5)

*get the prior and posterior class membership probabilities
lclogitpr prior, up
lclogitpr post, cp

*get the conditional and unconditional choice probabilities
lclogitpr cpr, pr

*attributes coefficient means and covariances
matrix list e(PB)
```

```
*get class-specifc inferences
lclogitml, iterate(10)


*Assign respondents to a class
gen class=1
replace class=2 if post2>post1

*Conduct label collapsing tests
test _b[choice1: usdawc] = _b[choice1: anawc] = _b[choice1: engowc]
test _b[choice1: usdaph] = _b[choice1: anaph] = _b[choice1: goph]
test _b[choice2: usdawc] = _b[choice2: anawc] = _b[choice2: engowc]
test _b[choice2: usdaph] = _b[choice2: anaph] = _b[choice2: goph]
```

<repeat similar script for remaining plants>

Appendix F: New Environmental Paradigm Responses

Table F-1: Average respondent scores on New Environmental Paradigm items, by segment and plant

		Chrysanthemum	Geranium	Petunia	Azalea	Boxwood	Holly
Price Sensitive Segment	NEPsum	38.404	38.604	38.765	39.075	40.112	38.313
	Nep1	2.693	2.769	2.760	2.779	2.840	2.807
	Rnep2*	2.778	2.709	2.734	2.789	2.963	2.659
	Nep3	2.224	2.258	2.292	2.305	2.364	2.295
	Rnep4*	3.089	3.011	3.065	3.146	3.171	3.131
	Nep5	2.111	2.203	2.170	2.232	2.246	2.210
	Rnep6*	3.667	3.632	3.655	3.669	3.733	3.670
	Nep7	1.991	2.176	1.991	2.026	2.160	2.028
	Rnep8*	2.630	2.451	2.609	2.619	2.711	2.534
	Nep9	1.741	1.709	1.753	1.727	1.781	1.750
	Rnep10*	2.704	2.654	2.737	2.787	2.840	2.670
	Nep11	2.398	2.445	2.471	2.458	2.594	2.386
	Rnep12*	2.700	2.945	2.765	2.763	2.840	2.608
	Nep13	2.189	2.302	2.226	2.269	2.337	2.222
	Rnep14*	2.865	2.670	2.765	2.826	2.754	2.705
	Nep15	2.622	2.670	2.639	2.680	2.781	2.636
Attribute Sensitive Segment	NEPsum	38.968	38.877	39.532	37.769	38.288	38.385
	Nep1	2.899	2.775	2.858	2.654	2.767	2.678
	Rnep2*	2.661	2.739	2.865	2.635	2.641	2.752
	Nep3	2.228	2.251	2.142	2.077	2.233	2.266
	Rnep4*	3.048	3.140	3.277	2.853	3.087	3.059
	Nep5	2.265	2.173	2.277	2.115	2.139	2.157
	Rnep6*	3.741	3.676	3.801	3.667	3.680	3.622
	Nep7	2.106	1.976	2.170	2.038	1.932	2.010
	Rnep8*	2.492	2.650	2.546	2.519	2.560	2.577
	Nep9	1.683	1.754	1.745	1.718	1.673	1.671
	Rnep10*	2.720	2.771	2.716	2.551	2.748	2.654
	Nep11	2.460	2.467	2.461	2.397	2.427	2.406
	Rnep12*	2.979	2.717	2.901	2.897	2.803	2.811
	Nep13	2.296	2.229	2.270	2.218	2.162	2.196
	Rnep14*	2.730	2.899	2.709	2.859	2.858	2.892
	Nep15	2.661	2.659	2.794	2.571	2.579	2.633

*Denotes items have been reverse coded to keep directionality of scale consistent. Higher scores indicate levels of environmentalism.
A full description of each item can be found in Table 2.

Appendix G: Respondent Summary Statistics

Table G-1: Summary statistics of socio-demographic characteristics (n = 745)

Demographic variables		Percentage			Percentage
Gender	Male	28.9%	Income	<$20k	2.8%
	Female	69.9%		$20k to $40k	10.1%
				$40k to $60k	17.2%
Race	Asian	2.8%		$60k to $80k	16.1%
	Black	0.4%		$80k to $100k	16.4%
	White	90.9%		$100k to $120k	12.2%
	Other	5.9%		$120k to $140k	6.8%
				$140k to $160k	6.6%
Education	Some high school or less	0.4%		$160k to $180k	3.4%
	High school graduate	8.6%		$180k to $200k	3.1%
	Some technical school	3.6%		$200k to $300k	3.4%
	Some college	24.4%		>$300k	2.0%
	College graduate	30.2%			
	Master's degree	24.7%	Age	Mean	55.19
	Doctorate degree	4.8%		Standard Deviation	13.56
	Professional degree	3.2%			
			Household Size	Mean	2.41
Housing Type	Detached house	82.8%		Standard Deviation	1.25
	Attached house	13.0%			
	Apartment	3.6%	Years in Residence	Mean	14.82
	Other	0.5%		Standard Deviation	11.91