Do Native and Invasive Labels Affect Consumer Willingness to Pay for Plants?

Evidence from Experimental Auctions

Chengyan Yue

Terry Hurley

Neil Andersen

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2009 AAEA & ACCI Joint Annual Meeting, Milwaukee, WI, July 26-28, 2009.

Chengyan Yue is Bachman Endowed Chair in Horticultural Marketing, assistant professor at Departments of Applied Economics and Horticultural Science, University Of Minnesota - TC; Terry Hurley is professor at Department of Applied Economics, University Of Minnesota – TC; Neil Andersen is associate professor at Department of Horticultural Science, University Of Minnesota – TC.

Abstract

The ultimate objective of commercial horticultural activities is to satisfy the needs of the final consumer. Consumer demand for novel plants drives the ornamental plant industry. Therefore, dispersal of native and invasive horticultural plants can be understood by considering the decisions/choices of consumers who decide which plants to purchase from retailers. In contrast to previous studies on invasive and native plants, this study uses an experimental auction to elicit consumers' willingness to pay (WTP) for labeled native and invasive attributes. Results from a censored random effect model show that consumers' WTP for plants decreases when the plants are labeled as invasive and increases when plants are labeled as native. The study finds that consumers discount an invasive attribute more for native than for non-native plants. Consumers' socio-demographics and attitudes—age, income, gender, concern about environment, interest in plant quality, ease of care and sensitivity to price—significantly alter consumer's WTP for native and invasive attributes. The implications of this study are notable given the consumers' increasing concern about the environment and recent debate over sustainable labeling of plants by the horticulture industry.

Keywords: native plants, invasive plants, willingness to pay, labeling, auction, marketing

Introduction

The horticultural industry has had a significant impact on the U.S. landscape since the first European colonists arrived (Mack 2003; Pauly 2007). Modern ornamental horticulture has been likened to the fashion industry, with flower color and leaf textures changing annually to match the changing fashions. Since the ultimate objective of all commercial horticultural activities is to satisfy the needs of the final consumer (Schaffner et al. 1998), consumer demand for novel plants drives the industry (Gagliardi & Brand 2007). Retailers and wholesalers are the intermediaries who, through packaging, transporting, etc., can add value to the products supplied by growers. If there is no demand from consumers for specific ornamental plants, there is no reason for retailers to stock them. Therefore, dispersal of native and invasive horticultural plants can be understood by considering the decisions/choices of consumers who decide which plants to purchase from retailers.

Some studies have shown that consumer demand for product-stewardship or environmentally-conscious products and business practices is rapidly rising. There is a segment of consumers who are concerned about the environment and they are willing to purchase and pay a premium for environmentally friendly products. These consumers are assumed to bring profits for the companies who conduct environmentally friendly practices (Russo and Fouts 1997; Laroche, Bergeron and Barbaro-Forleo 2001). However, consumers' attitudes towards environmentally friendly products may vary significantly across different industries and quality attributes (Gladwin, Kennelly, and Krause 1995). For instance, consumers' attitudes towards organic quality attributes may vary significantly across the fruit, vegetable, and ornamental plant industries. Hence, industrywise and quality attribute-wise studies need to be formulated to accurately measure the potential market for a product with specific quality attributes.

Invasive plant dispersals have been most strongly affected through trade and distribution of horticultural plants—primarily ornamentals (Anderson and Ascher 1993; Groves 1998; Mack 2003; Mack and Erneberg 2002; Randall and Marinelli 1996; Reichard and White 2001). Most nonnative U.S. plants were deliberately introduced (Reichard and Hamilton 1997; Mack and Erneberg 2002) and more than 50% of invasive plants were ornamentals (Randall and Marinelli 1996). In the past 10-20 years, the horticultural industry has been transformed in the U.S., increasing in complexity and size. Many characteristics of today's horticultural industry contribute to increasing the risks of introducing new invasive species into the environment and the likelihood that invasive introductions may naturalize (Anderson, et al. 2006a, b; Galatowitsch, et al. 1999). In general, the horticulture industry selects plants that require little maintenance, have high environmental tolerance, wide adaptability, and consistent performance (Mack 2005; Anderson 2006a). Consequently, they can be grown worldwide.

Recently, much attention has been given to industry self-regulation to prevent the distribution of invasive or potentially invasive horticultural plants (Baskin 2002). The industry developed and adopted in 2002, a set of Voluntary Codes of Conduct for Nursery Professionals ("Codes") (Baskin 2002; Gagliardi and Brand 2007). However, they have not been very effective. California wholesalers/retailers said high costs, lack of information, personnel and time kept them from complying (Burt et al. 2007). Although Florida implemented the Codes, a majority of the industry still sold invasive species (Burt et al. 2007). Self-regulation without sanctions or informal means of coercion should be expected to fail because of both the moral hazard (Cavaliere 2000; Vetter and Karantinnis 2002) and adverse selection (King and Lenox 2000) problems are not addressed.

Most previous economic studies on invasive plants focus on governmental and institutional control of the invasion of certain invasive plants (for example, Kim et al. 2007; Moffitt and Osteen 2006) and the impact of invasive plants on economy and recreation values (for example, Adam et al., 2007) rather than on studying consumers' perception and evaluation of invasive plants. Kelley et al. (2005) studied Philadelphia consumers' awareness, knowledge and expectations of invasive plants species and found that there existed distinct consumer segments. They found that less than half (41.3%) believed that laws should be passed to prevent sale of non-native exotic plants, while 27.8% believed that laws should be passed to allow sale of only native plants in their area. Peters et al. (2006) conducted a survey with horticultural industry professionals and found that a majority of respondents (62%) felt that the invasive plant issue was very important and 89% tried to direct their customers away from potentially invasive plants. Another 76% of respondents indicated that they were responsible for educating their customers about invasive ornamental plants. Instead of arguing for more regulations like Reichard (2005), we will explore an untapped consumer concern about the environment and the possibility for the industry to adopt invasive/non-invasive labels.

For native plants, Waterstrat, Dees, and Harkess (1998) surveyed the U.S. Southern Nurserymen's Association members about their perception of native plants. They found that almost half of the respondents had increased the quantity and variety of native plants and perceived an overall consumer interest in native plants. Brzuszek, Harkess, and Mulley (2007) explored landscape architects' use of regional native plant species in the southeastern United States and found that the southeastern designers use a significant amount of regional native plants in their project specifications. Landscape architects who were surveyed reported local species were better suited to difficult or unique site conditions. The aforementioned studies along with some other studies suggest that there is potential for expansion in production and marketing of native plants; the demand for native plants by landscape architects and contractors has been increasing (Morgan 1997; Potts et al. 2002). However, regular consumers' demand for and attitudes toward native plants and consumer willingness to pay (WTP) for ornamental plants with native labeling are still unknown.

Recognizing growing consumer concern about the environment, the ornamental plant industry had initiated several voluntary sustainability labeling systems. For instance, Veriflora certification standard, which was launched in 2005 by the floral industry, was intended to certify sustainable farming methods, and good social practices relating to the production and handling of fresh cut flowers. Up-to-date labeling for native attribute and invasive attribute is voluntary and conducted by individual growers, wholesalers or retailers and there is no labeling certification standard like Veriflora. Labeling incurs real costs such as fixed cost of testing, segregation or identity preservation and variable costs of monitoring for truthfulness (Huffman, et al., 2003). Therefore, one important question is: will consumer behavior change with the presence of a native or invasive label?

This study uses an experimental auction to elicit consumers' WTP for labeled native attribute and invasive attribute using a random sample of adult consumers from Twin Cities area in Minnesota. The research objectives are to determine 1) consumers' attitudes towards native ornamental and invasive ornamental plants and 2) how much more (or less) they are willing to pay for native plants and invasive plants if native and invasive attributes were labeled, which have not been explored in the literature.

A principal component factor analysis and a censored regression with a random individual effect and fixed plant effects are used in the analysis of how the WTP for plants is affected by product attributes (native versus non-native, invasive versus non-invasive, and their interaction), as well as interactions among consumers' stated attitudes toward specific product attributes (environmental concern, concern about ease to care, etc.), production attributes, and consumers' socio-demographic characteristics. Specifically, we investigate the premium for the native attribute, the discount for the invasive attribute, how invasive attribute affects consumers' WTP for both native and non-native plants and how attitudes and socio-demographic variables affect these premiums.

Materials and Methods

1. Experimental Design

The first objective of the research was to identify the effects of native and/or invasive labels on consumers' WTP for ornamental plants that are native and/or invasive. In this analysis we conducted a set of experimental auctions in which ornamental plants differed only by the presence or absence of native and/or invasive labels.

1.1 Sampling

Auctions were planned and conducted in the Twin Cities, Minnesota. To get a representative sample for the auction, we put an advertisement on local newspapers in the Twin Cities area. The following was the full advertisement "Horticultural Science and Applied Economics Department of University Minnesota are making appointment with individuals who are willing to participate in a study on consumer purchases of ornamental plants. *The study will take place on the St. Paul campus during April 19th and April 26th, 2008.* Besides making a contribution to a scientific research project, you will be given $30. **You must be at least 18 years of age, have purchased ornamental plants in the past year.** Participation will take approximately 50 minutes. There are no foreseeable risks to participation; you will not be asked to eat anything. Participation is voluntary and you can withdraw from the study at any time without penalty by notifying the project staff."

The advertisement was put on 13 local newspapers, which went to 13 cities in the Twin Cities areas, ensuring a diversified sample across urban and suburban areas. Additionally, in the advertisement we specified the requirement for the participants as "You must be at least 18 years of age, have purchased ornamental plants in the past year" to make sure the participants were representative of ornamental plant purchasers. Three time slots were available for each auction day: 10am-11am, 1pm-2pm and 3pm-4pm. The participants chose a time slot that was most convenient to their schedule. During registration and analysis, further screening was conducted to make sure that only one person per household was included in the study. Ninety people registered to participate and 80 of them showed up to participate in the auctions. We conducted the experiments in April 2008, since in late March and April consumers start growing plants in their gardens and most purchases of ornamental plants occur in the second quarter of a year (Yue and Behe, 2008). Therefore, we expected to get a representative sample of regular ornamental plants purchasers in Minnesota or the Midwestern region. Nevertheless, generalization of the results to a broader population should be made with caution.

1.2 Native and/or Invasive Ornamental Plants

In this research, we define "Native" as "Native to North America." For "Invasive plant" we used the Minnesota Nursery and Landscape Association's definition: "A plant that has spread or may spread into native ecosystems and dominate or disrupt those ecosystems" (http://www.mnla.biz/). Participants were informed about these definitions before they bid on labeled plants.

The ornamental plants we used in the auction were from four different families. To minimize the effects of appearance on consumer WTP we selected five species pairs of plants and within each pair the plants were very similar to each other in appearance since they were in the same genus and family (Table 1). Two species pairs (*Gaura, Epilobium)* were in the same family (Onagraceae). Most plants used in the experiment were perennial and some were annual/biennial.

Table 1. Plants Used in the Experimental Auction

Plant Name	Family	Pair	Plant Type	Native	Invasive
Dianthus armeria	Caryophyllaceae	1	Biennial /Annual	No	Yes
Dianthus repens	Caryophyllaceae	1	Biennial	Yes	No
Daucus carota	Apiaceae	2	Biennial	No	Yes
Daucus pusillus	Apiaceae	2	Biennial	Yes	No
Oxalis vulcanicola	Oxalidaceae	3	Perennial	No	No
Oxalis crassipes	Oxalidaceae	3	Perennial	No	Yes
Gaura coccinea	Onagraceae	4	Perennial	Yes	No
Gaura lindheimeri	Onagraceae	4	Perennial	Yes	Yes
Epilobium angustifolium	Onagraceae	5	Perennial	Yes	Yes
Epilobium angustifolium	Onagraceae	5	Perennial	Yes	No

Plants used in the experiment were available from retail or wholesale outlets to consumers. We ordered seeds from retailers and grew the plants in University of Minnesota department of Horticultural Science greenhouse. At the time of auction most plants were blossoming and grown for the sale size in regular stores. The products participants evaluated were the same products they would buy at the end of the auction.

1.3 The 2nd -Price Auction

In the last 15 years, experimental auctions have been used to elicit WTP for a wide variety of food quality attributes (see, e.g., Hobbs et al. 2005; Brown, Cranfield and Henson 2005; Alfnes and Rickertsen 2003; Lusk, Feldkamp and Schroeder 2004; Lusk et al. 2004; Melton et al. 1996; Roosen et al. 1998; Rozan, Stenger and Willinger 2004; Umberger and Feuz 2004). A 2nd -price sealed-bid auction is an auction in which the bidders submit sealed bids and the price is set equal to the 2nd-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 dominant strategy for people to bid so that if the price equals their bid, they are indifferent to whether they receive the product or not. As a consequence, people not knowing the other participants' values have an incentive to truthfully reveal their private preferences. If they bid lower than their WTP they risk forgoing a profitable purchase. If they bid higher they risk buying a product at a price that is above what they perceive the product to be worth given the available alternatives. The 2nd-price auction has gained great popularity because it is demand revealing theoretically, relatively easier to explain compared to other auctions, and its market-clearing price is endogenous.

We conducted experimental 2nd -price sealed-bid auctions rather than field studies on the consumer willingness to pay for invasive plants and native plants because most stores selling plants did not label plants about these attributes. And there was no real purchase data about the effects of invasive or native labels on sales of plants. In the questionnaire we asked participants when they bought plants in stores if they were informed the plants were native. Only 4% of participants were “always” informed, 18% were informed “most times”, 38% were “sometimes” informed, 30% were “seldom” informed, and 10% were “never” informed. Compared with the native attribute, even less people got information about plants’ invasiveness when they made purchases. Specifically, 29% of participants were “never” informed, 38% were “seldom” informed, 14% were “sometimes” informed, 11% were informed “most times”, and 8% were “always” informed.

Two modifications to the traditional second price auction were used to accomplish the objectives of the study. First, since we were auctioning ten different plants, there was potential for demand reduction if participants could win more than one plant (List and Lucking-Reilly, 2000). To avoid this issue, participants were only given the opportunity to purchase one plant. They were told that the plant they would actually get to bid on would be randomly determined after they submitted their bids for all ten plants. Second, we wanted to have paired bids for each participant with and without information on whether a particular plant was invasive or native. To accomplish this, we held two rounds of bidding for the plants. In the first round, participants were not told which plants were invasive or native. In the second round, they were told which were invasive or native. Participants were told that they would be given the opportunity to bid on the same plants in two separate rounds, but that the bids they submitted for only one of the rounds would be used to determine the winner of the second price auction. They were not told that new information would be revealed between rounds. Since new information was revealed after the first round, second round bids were used to determine the winners of the auction.

We conducted six sessions with a total of 80 participants with each session having ten to fifteen people. In each of the auctions they were simultaneously bidding on 10 alternatives.

1.4 Stages in the Experimental Auction

At the beginning of each session, the participants were asked to sign a consent document to agree with the participation. Each participant was then given a folder containing instruction booklet and bidding sheets. Each individual was assigned an ID number to maintain anonymity. The auction proceeded in 10 stages:

Stage one: Learn about the auction.

In this stage, participants received detailed instruction about how the 2^{nd} price auction works, including concrete examples illustrated by the moderator. After the examples, we emphasized that "In this auction it is always in your best interest to bid your true value for the item being auctioned."

Stage two: Knowledge test for the auction.

After participants learned the auction, a short quiz composed of true or false and multiple choice questions were given to them to ensure everyone understood how the auction worked. Answers to the questions were given and explained to participants after they finished the quiz.

Stage three: Submit bids for a practice auction.

We asked participants to engage in an induced value second price auction to gain experience. The induced value auction was identical to the actual auction participants would participate in except they were told exactly how much money they would receive, instead of a plant, from winning an auction prior to paying the second price.

Stage four: Complete the first section of the survey.

When the monitors were tabulating participant's bids for the practice auction, participants were asked to answer some survey questions. The questions were about their past experience of purchasing ornamental plants, what kind of flower color and flower type they liked, and what type of stores from which they purchased most of their ornamental plants.

Stage five: Record and review the practice auction results.

In this stage, the monitors reviewed the results from the practice auction and asked participants to calculate the practice round rewards of the winners. During this practice round, participants learned exactly how only one of the ten auctions was chosen randomly to be binding.

Stage six: Submit first round bids for the ornamental plant auction.

In this stage participants were asked to bid on 10 different real ornamental plants with basic information about the plants such as plant name, annual/biennial/ perennial, habitat, height, flower color, flower size, flowering time and zone. An example of the basic label was as follows:

Plant #1

Dianthus armeria
Biennial/Annual
Family: Caryophyllaceae
Habitat: dry fields
Height: 8-20 inches
Flower size: 1/2 inch wide
Flower color: pink
Flowering time: May to September
Zone: 6

The information on the basic labels was similar to the information consumers would receive at retail places when purchasing ornamental plants. Participants were allowed to start from any plant to avoid order effects.

Stage seven: Complete the second section of the survey.

While the monitors were tabulating participant bids for the first round, participants were asked to answer some additional survey questions. The questions include how they define native plants, what the definition of "native plants" and invasive plants would be in the experimental auction, and if they were informed about plants' native or invasive attributes when they made purchases in regular stores, etc.

Stage eight: Submit second round bids for the ornamental plant auction.

We put an additional label next to each plant and its basic label delineating the native and invasive attributes of each plant in the species pairs. An example of the additional label was shown below:

Classified by Minnesota Nursery and Landscape Association as

Non-Native
Invasive

Stage nine: Complete the third section of the survey.

When the monitors were tabulating participant bids for the second round, participants were asked answer the last part of the survey questions. The questions included socio-demographics, behavioral and attitudinal questions.

Stage ten: Record ornamental plant auction results.

In this stage the monitors sorted the bids, determined market prices, and randomly drew the binding round and binding plant for each participant, and announced the winners. Participants received their $30 participation award. If they won the practice auction, they received the induced value of the auction minus the auction price. If they won the plant auction, they paid the auction price and were given the plant they won to take home.

Four participants' bids were not included in the analysis due to one or more missing data bids, leaving 76 participants' bids, that is, 1520 observations for the two rounds of auctions with 760 observations for each round in the analysis.

2. Statistical Analysis and Model Set-up

A principal component factor analysis and a censored regression with an individual random effect and plant fixed effects are used in the analysis of how the WTP for plants is affected by product attributes (native versus non-native, invasive versus non-invasive and their interaction), as well as interactions among consumers' stated attitudes toward specific product attributes (environmental concern, price sensitivity, etc.), consumers' socio-demographic characteristics and product attributes. Specifically, we investigate the premium for the native attribute, the discount for the invasive attribute, how native and invasive attributes affect consumers' WTP for plants, and how attitude and socio-demographic variables affect these premiums.

One of the initial tasks was to identify and develop measures of consumer attitudes and preferences based on the survey questions. In addition to direct responses to questions, several consumer attitudes toward product attributes were measured as composite constructs based on the participants' degree of agreement with selected statements. Because the participants answered several questions on the same product attributes, we used principal component factor analysis to select and rank the questions included in the set of composite indicators and avoid the problem of multicolinearity (Greene 2002, p. 58).

To measure consumers' sensitivity to price (***Price***) we asked the participants if they agreed or did not agree with three statements about the trade-off between price and other product attributes using a five-point Likert scale. For instance, one statement read, "I usually buy the lowest priced products." Consumers with a larger value of the index ***Price*** tend to be more sensitive to price of products. Other composites included consumers' concern with the environment (***Environment***) and consumers' attitude toward quality of plants (***Quality***). ***Environment*** was based on the statements such as "I make a point of choosing products that do not damage the environment" and "I buy products made from recycled materials even if they are more expensive." Consumers with a larger value of the index ***Environment*** were more concerned about the environment. ***Quality*** was based statements such as “I usually buy plants that are of higher quality” and “I usually buy plants that require less care.” Consumers with a larger value of the index *Quality* are more concerned about plants’ quality and ease to care. Appearance was based on statements such as “I usually buy plants that are attractive in appearance” and “Color is important attributes when I decide to buy outdoor plants.” Principal component factor analysis indicated these composite constructs were uni-dimensional (all had alpha reliability of 0.6 or higher) (Cronbach 1951). These composite indexes were shown in the last four rows of Table 2?.

To further explore the effects of native label and invasive label on participants’ bids we set up a censored random effect model. Consider the following equation:

$$P_j^k = a_j + b^k X_j + g_j^k + m_j^k \qquad k = \textit{plain-labeled, native/invasive-labeled}, \qquad (1)$$

where P_j^k is participant ***j***’s bid for ***k***th labeled product; a_j is a linear unmeasured effect that is constant across product labels for a given individual; X_j is the vector of independent variables. It includes product attributes such as native and invasive and interaction effect between product attributes and individual’s socio-demographics and attitudes; g_j^k is a zero mean random individual effect that is to capture the correlation among each individual’s bids on multiple products; m_j^k is a zero mean random disturbance term across labels and individuals. If we take a difference across label types we get:

$$\begin{aligned} P_j^{native/invasive-labeled} - P_j^{plain-labeled} &= (b^{native/invasive-labeled} - b^{plain-labeled})X_j \\ &+ (g_j^{native/invasive-labeled} - g_j^{plain-labeled}) + (m_j^{native/invasive-labeled} - m_j^{plain-labeled}) \end{aligned} \qquad (2)$$

The unmeasured effect across labels for a given individual disappears after taking the difference. We can condense the coefficients and random terms in (2) and get:

$$P_j^{native/invasive-labeled} - P_j^{plain-labeled} = b^* X_j + g_j^* + m_j^* \qquad (3)$$

The elements of vector b^* is expected to be significantly different from zero only if a variable has a different effects on the price of ***native/invasive-labeled*** than on ***plain-labeled*** plants. Otherwise the coefficients would be close to zero; g_j^* follows a normal distribution with mean zero and standard deviation s_g; and m_j^* follows a normal distribution with mean zero and standard deviation s_m.

Since all participants placed a bid on ten plants from five pairs, equation (3) is estimated with plant fixed effects. While plants within each pair were very similar to each other in appearance but plants from different pairs were significantly different from each other in appearance, we only included the five fixed plant pair effects rather than the ten fixed individual plant effects.

The price participants bid on plants could be censored at zero since the minimum bid for any product is zero even though some participants may have disliked a product and given a negative valuation. In equation (1) for both ***plain-labeled*** and ***native/invasive-labeled*** plants, the bids could be censored at zero. Therefore, we need to take into account the censoring problem when we estimate equation (3). The dependent variable in (3) is regarded censored if the bid for the ***native/invasive-labeled*** plant is zero, the bid for the ***plain-labeled*** plant is zero, or the bids for both ***plain-labeled*** and ***native/invasive-labeled*** plants are zero. Similar to the study conducted by Huffman et al. (2003) on genetic modified food, there are four cases of censoring: a) participant ***j*** places positive bids for both *plain-labeled* and *native/invasive-labeled* plants. This is the non-censored case; b) participant ***j*** places a zero bid for the *native/invasive-labeled* (censored at zero) plant and a positive bid for the *plain-labeled* plant. In this case, the “true” difference between bid prices with the censored regression is absolutely larger than the difference between the observed bids; c) participant ***j*** places a positive bid for the *native/invasive-labeled* plant and a zero bid for the *plain-labeled* plant (censored at zero). In this case, the “true” difference between bid prices with the censored regression is greater than the difference between the observed bids; d) participant ***j*** places zero bids both plants. In this case, no information can be derived about participant’s preference for native/invasive plants. All the four aforementioned cases are correctly taken into account in the censored random effect model in (3).

Although some variables have a naturally interpretable metric, others do not, especially the ordinal variables and interaction effects (McCall, 2001). Therefore, to simplify the interpretation of the parameters associated with the interaction effects between socio-demographic and attitude variables with product attribute variables, the socio-demographic and attitude variables are standardized with a mean of zero and a standard deviation of one. The standardization is done by subtracting the respective variable’s mean and dividing by its standard deviation.

Results and Discussions

Table 2 summarizes the characteristics and attitudes of auction participants. The average age of participants was 49.93 years. Participants’ mean income level was 64.8 thousand dollars. For education level, two percent of participants finished high school or less, 5% had high school diploma, 28% had some college, 45% had got college diploma, 8% had finished some graduate school, and 12% had graduate degree. The mean educational level was a college diploma. Twenty four percent of participants were male. The average number per participant's household was 2.46. The average number of separate purchases the household made for plants or garden-related products in 2007 was around 16.

Table 2. Characteristics and Attitudes of Auction Participants

Variable	Definition	Mean	Std. Dev.
Native	1 if plant is native; 0 otherwise	0.60	0.49
Invasive	1 if plant is invasive; 0 otherwise	0.50	0.50
Age	Participant's age (years)	49.93	13.02
Income	Household's income level ($000s)	64.80	27.54
Education	Participant's Education Level	3.86	1.12
	1=Some high school or less (2%)		
	2=High school diploma (5%)		
	3=Some college (28%)		
	4=College diploma (45%)		
	5=Some graduate school (8%)		
	6=Graduate degree (12%)		
Gender	1 if male; 0 if female	0.24	0.43
Household	Number of people in participant's household	2.46	1.39
Purchase	Number of separate purchases the household made for plants or garden-related products in 2007	15.93	11.29
Price	Participant's sensitivity to price	0	1
Environment	Participant's concern about environment	0	1
Quality	Participant's concern about plant quality and ease to care	0	1
Appearance	Participant's concern about plant appearance	0	1

Previous studies had shown that 80% of ornamental plant consumers were female and 73% of plant purchasers were 40 years and older (Yue and Behe, 2008). Table 2 shows that auction participants were older (around 50 years old); most of them were female (74%); and the average number of purchases of plants and garden-related products were about 16. Therefore, we are very confident that the participants were regular plant purchasers.

Table 3. Mean Bids for Plain-labeled and Native/Invasive-labeled Plants

Product Attributes	No. of Observations	Plain-labeled Bids			Native/Invasive-labeled Bids		
		Mean Bid	Std. Dev.	No. of Zero bids	Mean Bid	Std. Dev.	No. of Zero bids
Native and Invasive	152	3.10	3.06	14	1.82	2.27	41
Native and Non-invasive	304	2.45	2.38	20	2.79	2.90	15
Non-native and Non-invasive	76	2.20	1.79	12	2.27	1.79	10
Non-native and Invasive	228	1.94	1.68	20	1.28	1.62	63

Table 3 shows participants' mean bids for plants in rounds 1 (Plain-labeled) and 2 (Native/Invasive-labeled). When supplied with information, participants bid significantly less for native and invasive plants compared with when there was no information (p-values of t-test and Wilcoxon signed-rank test <0.001). Participants bid significantly more for native and non-invasive plants after given the information (p-values of t-test and Wilcoxon signed-rank test <0.001). They bid less for non-native and invasive plants by knowing these attributes (p-values of t-test and Wilcoxon signed-rank test <0.001); participants' mean bid for non-native and non-invasive plants did not significantly change before and after they were given the attribute information (p-value of t-test = 0.5; p-value of Wilcoxon signed-rank test= 0.32). The t- and Wilcoxon signed rank tests are univariate. Test results indicate participants paid less for plants with native and invasive labels, more for plants with native and non-invasive labels, less for plants with non-native and invasive labels. But these results provide no information about the interaction effects of native and invasive attribute and why participants paid less or more for plants with different labels.

Additionally, we find that 37% of participants bid more for plants with a native noninvasive label; 64% of participants bid less for plants with a native invasive label; 57% of participants bid less for plants with non-native invasive label; and 38% of participants do not change their bid plants with a non-native non-invasive label.

Censored Regression Estimation Results

The censored model with random individual effect and fixed plant pair effects is estimated using a maximum likelihood procedure in Stata 10.0. Censored regression results by fitting equation (3) with an individual random effect and fixed plant pair effects to explain the difference in bid prices between a *native/invasive-labeled* plant and the *plain-labeled* plant are shown in Table 4.

Table 4. Censored Regression, Random Individual Effect and Fixed Plant Effects Model Explaining Difference in Bid Price for *Native/Invasive-labeled* and *Plain-labeled* Plants (N=760)

Independent Variables	Coefficients	Standard Error
Intercept	0.258	0.651
Invasive	-1.957*** [a]	0.754
Native	0.907	0.735
*Invasive*Native*	-0.767**	0.375
Interaction effects between *Native* and Socio-demographics and Attitudes		
*Native*Purchase* [b]	-0.099	0.120
*Native*Income*	-0.001	0.178
*Native*Age*	-0.459**	0.235
*Native*Education*	0.068	0.217
*Native*Gender*	-0.019	0.095
*Native*Household*	-0.076	0.145
*Native*Environment*	0.184**	0.093
*Native*Price*	0.087	0.091
*Native*Quality*	0.158*	0.096
*Native*Appearance*	0.025	0.094
Interaction effects between *Invasive* and Socio-demographics and Attitudes		
*Invasive*Purchase*	-0.152	0.124
*Invasive*Income*	-0.313*	0.191
*Invasive*Age*	0.444*	0.256
*Invasive*Education*	0.325	0.240
*Invasive*Gender*	-0.198**	0.094
*Invasive*Household*	0.065	0.152
*Invasive*Environment*	-0.229***	0.090
*Invasive*Price*	-0.171*	0.089
*Invasive*Quality*	0.390***	0.096
*Invasive*Appearance*	0.103	0.092
Fixed Plant Pair Effects		
Pair1	-0.155	0.258
Pair2	-0.166	0.256
Pair3	-0.404	0.356
Pair4	-0.020	0.211

Random Individual Effect		
$\hat{s}_g$	0.648***	0.103
Log Likelihood	-1328.44	

[a] *, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.
[b] Interaction effects between two variables, as between *Native* and *Purchase*, is represented as *Native*Purchase*. Similar definitions hold for other socio-demographic and attitude variable. The interaction effects are standardized in the estimations, which makes interpretation of the main effect coefficients' straightforward because the interaction effects have zero means and unitary standard deviations (s.d.).

We have tried a model with all the main effects of the socio-demographic and attitude variables in addition to the interaction effects, and the coefficients of the main effects were all not statistically significant at 0.05 significance level. The log likelihood of the model with all the main effects is -1322.90 compared with the log likelihood value -1328.44 of the model without the main effects. The likelihood ratio test shows the main effects of socio-demographic and attitude variables are jointly insignificant at 0.10 significant level. Additionally, these main effects were largely captured by the random individual effect. Therefore, we use the model with only the interaction effects between plant attributes and socio-demographic and attitude variables (Table 4).

The coefficient of *Invasive* is negative and statistically significant at the 0.01 significance level, which indicate that participants discount invasive attribute of plants (Table 4). On average, participants bid $1.96 less for invasive attribute. The positive coefficient of *Native* means participants are willing to pay $0.91 more for a plant if they are informed the plant is native, but the coefficient is not statistically significant. The interaction effect between *Invasive* and *Native* is negative and significant at 0.01, which means that participants discount invasive attribute for native plants more than for exotic plants. On average, participants were willing to pay $0.77 less for native invasive plant than for exotic invasive plant. The insignificant interaction effects between *Purchase* and *Native*, and *Purchase* and *Invasive* mean that number of purchases a consumer makes for plants and garden related products does not affect their WTP for native and invasive attributes of plants. Participants' income does not affect their WTP for plant native attribute significantly but it does affect their WTP for invasive attribute of plants. The negative and significant coefficient of *Invasive*Income* means participants with higher income level discount invasive attribute more than participants with lower income level. The significant and negative coefficient of *Native*Age* and the significant and positive coefficient of *Invasive*Age* mean younger participants are willing to pay a higher premium for native attribute and discount more for invasive attribute of plants than older participants. Participants' education level and number of people per household do not significantly affect their WTP for native and invasive attributes of plants. There was no significant difference in female and male participants' WTP for native plants but male participants are willing to pay less for invasive attribute than female participants. Some of participants' attitudes affect their WTP for native and invasive attributes. Participants who are more concerned about environment are willing to pay a higher premium for native plants (indicated by positive and significant coefficient of *Native*Environment*) and they discount invasive plant attribute more (indicated by negative and significant coefficient of *Invasive*Environment*) than those who care less about environment. Participants who are more sensitive to price discount more of invasive attribute of plants, which is indicated by the significant and negative coefficient of *Invasive*Price*. Participants who are concerned more about plant quality and ease of care are willing to pay a higher premium for native and invasive attributes, which is indicated by the positive and significant coefficients of *Native*Quality* and *Invasive*Quality*. Participants' concern about appearance of plants does not affect their WTP for native and invasive attributes of the plants studied, which further verifies that the plants in each pair were controlled to be similar to each other in appearance in the experimental design.

The coefficients of the four dummy variables for plant pair fixed effects are not significantly different from zero. No plant pair-specific fixed effects are observed in the results in Table 4. However, $\hat{s}_g$, which means that the correlation between the multiple bids made by the same participant, is significant at 0.01 level. Therefore, the random individual effect cannot be ignored and the model without the random individual effect cannot get correct results.

Discussion

The research presented here has important findings in several key areas. First, it was observed that that 37% of participants prefer native and non-invasive plants, 64% of participants dislike native but invasive plants and 57% of participants did not prefer non-native and invasive plants.

Second, the method allows us to estimate the price premium or price discount U.S. consumers might place in stores selling ornamental plants if native or invasive plants were labeled. In our experimental auction, participants were willing to pay 41% less for native but invasive plants, 34% less for non-native and invasive plants, and 14% more for native and non-invasive plants. For the ten plants studied in the experiment, on average, participants discount invasive attributes by $1.96, they are willing to pay $0.90 premium for native plants and they discount invasive attribute by $0.77 more for native plants than for exotic plants. The horticulture industry seems likely to agree on native labels and therefore can charge a premium. It might also oppose invasive labels, but stakeholders selling non-invasive plants in the industry may see new opportunities to supply and label non-invasive plants at a premium. Without native labels, a consumer pays a lower price for native plants than s/he would, so native labels will benefit suppliers of native plants. Without the invasive labels, a consumer pays a higher price for invasive plants than s/he otherwise would. In this case, consumers would be better off from invasive labels by being informed that the plants were invasive, which would lower their bids.

Third, we found that consumers' socio-demographics and attitudes affect their WTP for native and invasive attributes. An interesting finding is that younger consumers like native plants and dislike invasive plants more than older consumers. Consumers concerned about the environment place a positive valuation on native plants and negative value on invasive attribute. Some earlier studies found that young consumers (18 to 34 years old) are aware and concerned about environment and sustainability, and reported that "green" purchases that are beneficial to environment to be "trendy"(Adweek 2008). The fact that consumers primarily associate native and invasive attributes with the environment and the younger consumers are more concerned with environment may explain why younger consumers prefer native plants but not invasive plants more than older consumers. Another intriguing finding is that those consumers who regard plant quality or ease of care as important are willing to pay a higher premium for both native and invasive plants. Native plants with regional adaptation are often regarded as hardy and easy to grow. Invasive plants often spread around and dominate an ecosystem. From these perspectives, both native and invasive plants are "easy to care." This explains why those consumers who value "easy to care" prefer native and invasive plants. These findings have important marketing implications. Since younger consumers like native and non-invasive plants, labeling plants with these attributes can help the industry obtain a higher premium from the young consumer target market. Educating the public about the environmental benefits of native plants and non-invasive plants and labeling native and non-invasive plants can attract those consumers who belong to environmental groups and who are concerned with environmental issues. Advertisements and consumer education should be focused on native plant hardiness, ease of care and environmental benefits in order to be effective. For non-invasive plants, advertisement should emphasize environmental benefits.

Conclusions

This study has demonstrated that consumers' WTP for plants decreases when the plants are labeled as invasive and increases when plants are labeled as native. Consumers discount invasive attributes more for native than for non-native plants. Consumer socio-demographics and attitudes—age, income, gender, concern about environment, concern about plant quality and ease to care and sensitivity to price—significantly alter consumer's WTP for native and invasive attributes to different extents.

Implications of the study are notable given the consumers' increasing concern about the environment, the fact that invasive plant dispersals have been most strongly affected through trade and distribution of ornamental plants and recent debate over sustainable labeling of plants by the horticulture industry. Given that the average adult consumer in the Twin Cities area revealed a positive premium for native plants, a mandatory labeling policy of native plants seems likely to be in the best interests of both consumers and the green industry. However, since the average adult consumers revealed a significant discount for labeled invasive plants, a mandatory labeling policy for invasive plants seems unlikely to be in the best interest of the horticulture industry but maybe in the interest of consumers. From the perspective of horticulture industry, a labeling of non-invasive plants might increase consumer WTP for plants which otherwise would be plain labeled.

As mentioned earlier, the experimental auction was conducted in Twin Cities area of Minnesota. The sample of consumers is representative of Minnesota or Midwestern ornamental plant consumers rather than the whole U.S. population. Therefore, the exploration of the results to other regions should be made with caution. Future research is needed to examine the robustness of these results by replicating experiments in other U.S. areas. Other future research might also be focused on consumers' reaction to more detailed information about native plants and invasive plants.

References

Adams, D.C., D.J. Lee, S. Bucaram, and A.N. Bwenge. 2007. The Impact of Invasive Plants on the Recreational Value of Florida's Coastal, Freshwater and Upland Natural Areas. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, OR, July 29 – August 1, 2007.

Adweek. 2008. http://www.adweek.com/aw/content_display/news/agency/e3ibfc872c5b952c69b2a630ac11ccbfbbb

Anderson, N. O., S. M. Galatowitsch, et al. 2006a. "Selection strategies to reduce invasive potential in introduced plants." Euphytica 148: 203-206.

Anderson, N. O., Gomez, N. et al. 2006b. "A non-invasive crop ideotype to reduce invasive potential." Euphytica 148(1-2): 185-202.

Anderson, N.O. and P.D. Ascher. 1993. Male and female fertility of loosestrife (*Lythrum*) cultivars. Journal of the ASHS, 118(6):851-858.

Baskin Y (2002) The greening of horticulture: new codes of conduct aim to curb plant invasions. Bioscience 52:464–471.

Brzuszek, R. F., R. L. Harkess, and S. J. Mulley. 2007. Landscape Architects' Use of Native Plants in the Southeastern United States. *HortTechnology* 17(1):78-81.

Burt, J. W., A. A. Muir, et al. 2007. "Preventing horticultural introductions of invasive plants potential efficacy of voluntary initiatives." Biological Invasions 9(8): 909-923.

Cavaliere, A. 2000. "Overcompliance and Voluntary Agreements." Environmental and Resource Economics 17(2): 195-202.

Gagliardi, J.A. and M.H. Brand. 2007. Connecticut nursery and landscape industry preferences for solutions to the sale and use of invasive plants. HortTechnology 17(1): 39-45.

Galatowitsch, SM, NO Anderson & PD Ascher. 1999. Invasiveness in wetland plants in temperate North America. Wetlands 19:733-755.

Gladwin, T. N., Kennelly, J. J., and Krause, T-S. 1995. Shifting paradigms for sustainable development: Implications for management theory and research. *Academy of Management Review*, 20 (4): 874-907.

Groves, R. H. 1998. Recent incursions of weeds to Australia 1971–1995. CRC for Weed Management Systems Technical Series 3:1–7.

Huffman, W. E., J. F. Shogren, M. Rousu, and A. Tegene. 2003. Consumer Willingness to Pay for Genetically Modified Food Labels in a Market with Diverse

Information: Evidence from Experimental Auctions. Journal of Agricultural and Resource Economics 28 (3): 481-502.

List J. and D. Lucking-Reilly.2000. Demand reduction in multi-unit auctions: Evidence from a sportscard field experiment. *American Economic Review* 90 (4): 961–972.

Mack, R.N. 2003. Plant Naturalizations and Invasions in the Eastern United States: 1634-1860. Annals of the Missouri Botanical Garden, Vol. 90, No. 1 (Winter, 2003), pp. 77-90.

Mack, R.N. 2005. "Predicting the Identity of Plant Invaders: Future Contributions from Horticulture." HortScience 40(5): 1168-1174.

Moffitt L. J. and C. D. Osteen. 2006. Prioritizing Invasive Species Threats Under Uncertainty. *Agricultural and Resource Economics Review* 35/1 (April 2006) 41–51.

Kelley K. M., Stumpf J. R., Sellmer, J. C. and R. M. Bates. 2005. Invasive Plant Species: Consumer Awareness, Knowledge, and Expectations. *HortScience* 40(4):1136.

Kim C.S., D. Lee, G. Schaible, and U. Vasavada. 2007. Multiregional Invasive Species Management: Theory and an Application to Florida's Exotic Plants. Journal of Agricultural and Applied Economics 39: 111-124.

King, A. A. and M. J. Lenox 2000. "Industry Self-regulation Without Sanctions: The Chemical Industry's Responsible Care Program." Academy of Management Journal 43(4): 698-716.

Laroche, M., Bergeron, J., and Barbaro-Forleo, G. 2001. Targeting consumers who are willing to pay more for environmentally friendly products. *Journal of Consumer Marketing*, 18 (6): 503-520.

Mack, R. N. and M. Erneberg. 2002. The United States Naturalized Flora: Largely the Product of Deliberate Introductions. Annals of the Missouri Botanical Garden, Vol. 89, No. 2, (Spring, 2002), pp. 176-189.

Morgan, D. 1997. David Chiappini on Florida's native plant nursery association. Nursery management and production. <http://www.greenbeam.com/features/they112497.html>.

Pauly, P. J. 2007. Fruits and Plains: The Horticultural Transformation of America. Cambridge, Massachusetts, Harvard University Press.

Peters W. L., M. H. Meyer and N. O. Anderson. 2006. Minnesota horticultural industry survey on invasive plants. Euphytica (2006) 148: 75–86

Potts, L.E., M. Roll, and S.J. Wallner. 2002. Colorado native plant survey—Voices of the green industry. *Native Plants J.* 3(2):121–125.

Randall, J. M. and J. Marinelli, (eds.) 1996. Weeds of the global garden. Brooklyn, Brooklyn Botanic Garden.

Reichard, S. 2005. The tragedy of the commons revisited: invasive species. Frontiers in Ecology and the Environment 3:109 110.

Russo, M.V. and Fouts, P. A. 1997. A Resource-Based Perspective on Corporate Environmental Performance and Profitability. *Academy of Management Journal,* 40: 534-559.

Schaffner, David J., William R. Schroder, and Mary D. Earle. Food Marketing: An International Perspective. Boston: WCB McGraw-Hill, 1998, 509 pp.

Vetter, H. and K. Karantininis 2002. "Moral hazard, vertical integration, and the public monitoring of credence goods." European Review of Agricultural Economics 29(2): 271-279.

Waterstrat J., J. Deeds, and R. L. Harkess. 1998. Assessment of the Native Plants Market in the Southeastern United States. *HortScience* 33(4):603.

Yue C. and B. K. Behe. 2008. “Estimating U.S. Consumers’ Choice of Floral Retail Outlets.” *HortScience* 43(3): 764–769.