A Conjoint/Logit Analysis of Nursery Stock Purchases

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Product attributes that determine nursery-stock sales from wholesalers to retail garden centers and landscapers were studied. Conjoint analysis was used to obtain data on buyer preferences. The data were analyzed using ordinary least squares and logit procedures to determine the attributes that are preferred by buyers. It was determined that good- to excellent-quality stock, offerings with a full line of additional plants, taller plants, and cash discounts are desirable attributes. Quality is the dominant attribute affecting preferences. Packaging the preferred attributes together significantly increases the probability of a plant being purchased by buyers.

Ornamental horticulture and floriculture are two of the fastest-growing sectors of agricultural-based operations in the United States. Growth in these sectors has occurred in the production, retail sales, and related service areas. It was estimated that during 1987, 11% ($6.6 billion) of grower receipts from all crops in the United States were derived from the sale of nursery and greenhouse crops (U.S. Department of Agriculture 1989). Since 1982, producer receipts for these products, which include cut flowers, potted flowering plants, foliage plants, and bedding plants, have increased, on average, by 9.2% annually; in 1988, wholesale receipts for greenhouse and nursery crops totaled $6.9 billion (U.S. Department of Agriculture 1989, 1988).

Growth in nursery and greenhouse sales has stimulated the expansion of existing operations and the entry of new firms. By effectively marketing their products and expanding the demand for landscape plants, wholesale producers can increase the probability of their success. Improved marketing information is needed to assist these firms in making informed marketing decisions. Moreover, if economic growth slackens in the Northeast, a decline in sales will increase competition in the region and, at the wholesale level, put pressure on established businesses, new entrants, and firms which have expanded (Gineo and Omamo). Market-based analysis can help these wholesale firms maintain or increase their marketing edge and market share. The lack of marketing information has also been identified by the American Association of Nurserymen as a research priority when this group has addressed legislative committees.

An acceptable proposition from marketing theory is that if wholesalers can provide the products that intermediaries and consumers desire, their marketings can be enhanced. Thus, from the wholesalers' point of view, it is important to identify the factors that determine sales between these growers and their two primary customers, retailers and landscapers. However, the demand for most products is a complex decision-making process in which purchases depend on the number and types of services and attributes that are obtained when a product is purchased (Lancaster). This is particularly true for nursery-stock purchases where several product attributes and services, such as plant health, flower color, credit terms, and price, probably play a role in a purchase decision.

If the relative importance of alternative product attributes could be identified, wholesalers would benefit and so would the industry. For instance, growers could improve their marketing performance by providing marketable products; retailers, landscapers, and consumers would obtain the products they desire; firms could be advised on production and marketing techniques; and an industry-recognized need for research would be fulfilled.

The objective of this study is to determine those product attributes that are important to landscapers and retailers when purchasing nursery stock from wholesale firms. More specifically, the study analyzes the purchase decision of Connecticut landscapers and retail garden centers when purchasing rhododendrons, a popular woody ornamental plant.

The procedures used to accomplish the study objective are conjoint analysis and regression anal-

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ysis. Conjoint analysis is used to obtain the data, and regression techniques are used to analyze the data. In the next section, the experimental design and survey associated with conjoint analysis are presented. The subsequent sections discuss the regression models used in determining the factors important to buyers, report and discuss the results, and summarize the paper.

Experimental Design and Survey

One method frequently employed in marketing and business research that allows the relative importance of product attributes to be measured is conjoint analysis. Conjoint analysis is a relatively new technique concerned with the joint effect of two or more independent variables on the ordering of a dependent variable which emphasizes the transformation of subjective responses into estimated parameters (Green and Rao; Green and Wind; Green and Srinivasan). Basically, the procedure consists of: (1) selecting a model to describe consumer preferences; (2) determining the data collection method; (3) constructing the experimental design which, in part, consists of selecting a group of relevant attributes and values for each of the attributes considered; (4) determining the stimulus to be presented; (5) assigning a measurement scale to the dependent variable; and (6) surveying buyers and analyzing the data collected in the survey (Green and Srinivasan).

The selected attributes should be those that are relevant in determining buyer preferences. However, the number of attributes and values associated with each attribute should be minimized because as they increase, so does the complexity of the experimental design and problem size. Increases in problem size and design complexity lead to less reliable survey results and estimations. Alternatively, if too few attributes are selected for evaluation, important attributes may be overlooked and the results could provide misleading information. Thus, there is a trade-off between problem complexity and relevancy when selecting the number of attributes to be studied and assigning values.

In determining the important product attributes affecting the purchase of rhododendrons, the following eight attributes were considered: delivery days from time of placing order, flower color, origin or region of the country from which the plant is purchased, price, range of products offered by the seller, quality, size of plant, and terms of payment. The selection of these attributes was based on consultations with plant scientists, buyers, and sellers. Four of these characteristics—flower color, price, quality, and size—are assigned three values or levels, while two levels are designated for the four remaining attributes. A profile of these attributes and levels is provided in Table 1. One consideration not incorporated into the attribute selection procedure was reliability in buying. The question of reliability arises because there is a probability that the buyer may receive a product unlike the one anticipated. Since inclusion of this risk consideration would have substantially compounded the experiment, it was not introduced.

The method used to collect data on buyer preferences is referred to as a full-profile approach (Green and Srinivasan). In this approach, a buyer is asked to rank stimuli which describe rhododendrons based on a full set of the selected attributes. With four attributes at three levels and four attributes at two levels, there are 1,296 ($3^4 \times 2^4$) possible combinations of attributes and levels to consider. Since it would be extremely difficult and time-consuming for an individual to rank 1,296 different combinations, Green has suggested using fractional factorial experiment designs to reduce the number of combinations. A specific procedure developed by Addelman allows the number of combinations to be reduced to a minimum and still allow for the desired analysis.

The design used in this study is referred to as a main-effect plan for asymmetrical factorial experiments. The term main-effect plan refers to the fact that, under this design, only the main effect of each attribute is analyzed and interaction effects between the attributes are not considered. The design is asymmetrical because factors are considered at different levels rather than at the same level. In the case of a main-effect experiment, each attribute will be orthogonal to the others, implying that the factors are assumed to be uncorrelated.[1] To maintain orthogonality, each level of a factor must appear in the experimental array in frequencies that are proportional to the frequencies of the other factors (Green). Addelman describes how asymmetrical arrays are derived to obtain the minimum number of combinations in the experiment. Basically, the procedure involves collapsing symmetrical arrays into asymmetrical ones according to specified rules. Using Addelman's procedure, the $3^4 \times 2^4$ experiment reduces to eighteen combinations or trials.

To simplify the ranking task for individual re-

[1] Concerns regarding the internal validity of orthogonal main-effect experiments, as used in this study, have been raised in the literature. However, Green, Helsen, and Shandler found that additional research is necessary to determine if the concerns represent serious problems for researchers.

Table 1. Rhododendron Attributes and Associated Values

Attribute	Levels	Description
Delivery time	2	2–3 days with option to pick up at yard, or 10–14 days
Flower color	3	Red, white, or yellow[a]
Origin	2	Northeast or West Coast
Price	3	\$11.95, \$14.95, or \$17.95
Product range offered by seller	2	Limited or varied[b]
Quality	3	Excellent, good, or low[c]
Size	3	2 gallon, 15″–18″; 3 gallon, 15″–18″; or 3 gallon, 18″–24″
Terms of payment	2	COD or 30 days credit

[a] Red and white flowers are typical colors and yellow is an unusual color used to represent a hypothetical plant.
[b] Limited means that the firm offers 3–4 additional cultivars; varied implies that the firm offers several additional cultivars.
[c] Quality is described in terms of color, root systems, branching system, and evidence of pathogens. Examples of the descriptions are provided in the appendix.

spondents and increase the reliability of the results, each respondent was asked to rank a subset consisting of nine trials rather than a single set of eighteen trials. Thus, in obtaining the data, a survey was conducted in which buyers were presented nine cards, each describing a different rhododendron in terms of the eight attributes previously identified. A sample of the cards an individual may have been presented appears in the appendix. Each buyer surveyed was asked to rank the nine cards in the order in which they would purchase the product, given the information on product attributes and assigned values. The rank given to each card by the individual buyers provides the basis for the dependent variable in the regression analysis, while the attribute levels specified on the card provide corresponding data for the independent variables.

A random sample of retailers and landscapers was taken from a listing of Connecticut firms in these businesses. The sample consisted of twenty-four firms, of which 54% were landscapers and 46% were retailers. This distribution of firms was proportional to the number of businesses in the respective categories on the list of Connecticut operators. In total, there were 216 observations for analysis, 9 for each of the twenty-four firms.

Personal interviews were conducted with the principal buyer(s) of nursery stock in the firm to obtain product rankings. Besides the rankings, the survey also gathered information on purchases made by these firms and business profiles. The landscapers and retailers surveyed bought an average of 1,125 rhododendrons per year from wholesalers or rewholesalers. In addition, some operations supplemented these purchases by growing their own stock. The firms in the sample had been in business for an average of twenty-eight years. Seventy-five percent of these businesses were located in a suburban area.

Participants were also asked to describe their typical purchases in terms of the product attributes identified in Table 1. For the most part, the attribute levels specified in Table 1 are similar to those characteristics usually purchased by the respondents, which are reported in Table 2. The average purchase can be described as a 2-gallon, 18″–24″ Connecticut-grown rhododendron costing \$14.90 and having good to excellent quality. Thirty-six percent of the respondents purchased plants with a pink flower color, but a total of 58% purchased white- or red-flowering plants. Plants with yellow flowers were not purchased by buyers because yellow-flowering rhododendrons are not hardy plants in Connecticut. In the survey, it was emphasized that a yellow-flowering plant would be hardy and was being used to represent a hypothetical plant unique to the area. Finally, purchase transactions were made 123 days prior to delivery. The specified levels in the study were 2–3 days with an option for yard pickup or 10–14 days, which differ substantially from a typical purchase.

Model Development

One common method of ascertaining the relative importance of product characteristics to buyers is to have them assign a rating to each attribute. Usu-

Table 2. Attributes of Typical Rhododendron Purchases by Survey Respondents

Attribute	Characteristic	Percent Having This Characteristic
Quality	Excellent	76
Size	2 gallon, 18″–21″	55, 55
Price	\$14.90	*
Region from where purchased	Connecticut	85
Number of other plants purchased from main source	12	*
Flower color	Pink	36
Delivery time after order was placed	123 days	*
Credit/payment terms	30 days	81

*Indicates mean value for this attribute.

ally this rating is on a bounded scale (e.g., 0–100) and reflects the relative importance of the attribute. Using the rhododendron attributes listed in Table 1, this procedure was utilized in the buyer survey. The results are reported in Table 3.

The data in Table 3 suggest that quality is an important attribute and that the availability of credit is not important in buyer preferences. Based on the proximity of the average ratings for the other attributes, it is difficult to distinguish which of these has a greater impact on purchase decisions. For instance, price has a rating of 69 and the region where the plant was grown (origin) has a rating of 68. With this evidence, it is not reasonable to state that a buyer prefers the price attribute over the origin factor. Similar comparisons could be made for flower color, delivery time, or the variety of plants available. Moreover, this procedure does not provide information on the statistical significance of these characteristics.

The data obtained by using the conjoint-analysis sampling procedure enable one to make inferences on consumer value systems based upon behavior rather than self-reports (Johnson). Further, the use of conjoint techniques allows for regression analysis, which provides evidence on the statistical significance of the attributes. Two regression techniques, ordinary least squares and logit, are used to estimate two models that specify the relationship between buyer preferences and product attributes. The models are based on the following general relationship:

$$RANK = f(DELIV, FC, ORIG, PRICE, RANGE, QUAL, SIZE, TERMS),$$

where *RANK* is the rank given to the product by the survey respondent; *DELIV* represents the number of days the plant is received after ordering; *FC* is the flower color of the plant (red, white, or yellow); *ORIG* is the area from where the plant would be purchased (Northeast or West Coast); *PRICE* is the price of the plant ($11.95, $14.95, or $17.95); *RANGE* is the range of other plants available from the source (limited or varied); *QUAL* is the quality of the plant (excellent, good, or low); *SIZE* is the size of the plant in gallon size and height (2 gallon, 15″–18″; 3 gallon, 15″–18″; or 3 gallon, 18″–24″); and *TERMS* represents the payment terms offered by the seller (cash on delivery or 30 days credit). *DELIV*, *FC*, *ORIG*, *RANGE*, *QUAL*, *SIZE*, and *TERMS* are specified as discrete dummy variables in the models. The variable *PRICE* is considered to be a continuous variable. Wholesale catalogs were studied to develop the price variable, and the specified range ($11.95–$17.95) is realistic for any of the plants described in the survey. By specifying this variable as a continuous one, information on the price-rank elasticity can be obtained. However, this elasticity will be relevant only within the price range considered.

Table 3. Relative Importance of Rhododendron Attributes as Specified by Survey Respondents

Attributes	Average Rating (Rating scale = 0–100, 100 being highest)
Quality	94
Size (height, gallon)	72
Price	69
Region where plant was grown	68
Variety of plants available from source	68
Flower color	65
Delivery time after order was placed	61
Credit/payment terms	45

Expected relationships between *RANK* and the independent variables can be hypothesized. Based on apriori knowledge and the scaling procedure discussed above, it is reasonable to assume that quality may have a substantial positive impact on *RANK*. The expected sign on the coefficients for *DELIV* and *PRICE* should be negative, indicating that as the value of these variables increases, the rank or desirability of the product will decrease. It is further hypothesized that: yellow, a rare color; plants originating from the Northeast region; firms offering a wide range of plant material; good to excellent quality; larger size plants (18″–24″ or 3 gallon); and credit are all desirable product attributes. Thus, the estimated coefficients for these variables should be statistically significant at conventional levels.

The first model used in testing these hypotheses is referred to as Model I and is described as:

$$RANK_i = a_0 + a_1\,DELIV_i + a_2\,FCCU_i + a_3\,ORIG_i + a_4\,PRICE_i + a_5\,RANGE_i + a_6\,SIZEH_i + a_7\,SIZEG_i + a_8\,QUALEG_i + U_i,$$

where a_j are the parameters to be estimated;

U_i, error term;

$RANK_i$, rank given to product by survey respondent. In the ordinary least squares regression, *RANK* takes on values between 1 and 9; in the logit regression, *RANK* is 0 if the product was ranked 6 or less, and 1 if the product was ranked 7, 8, or 9;

$DELIV_i$, binary dummy variable for delivery days after order is placed:

0, if the delivery of plants occurs 2–3 days after order is placed, or order is picked up,
1, if delivery of plants occurs 10–14 days after order is placed;

$FCCU_i$, binary dummy variable for flower color:

0, if flower color is red or white (typical colors),
1, if flower color is yellow (a hypothetical color);

$ORIG_i$, binary dummy variable for origin of plant:

0, if plant comes from the West Coast,
1, if plant comes from the Northeast;

$PRICE_i$, price of plant;

$RANGE_i$, binary dummy variable for range of products offered:

0, if selling firm offers a limited variety (3–4 others) of plants,
1, if selling firm offers a wide variety of plants;

$SIZEH_i$, binary dummy variable for plant height:

0, if plant is 15″–18″,
1, if plant is 18″–24″;

$SIZEG_i$, binary dummy variable for container size:

0, if 2 gallon,
1, if 3 gallon;

$QUALEG_i$, binary dummy variable for quality:

0, if quality is low,
1, if quality is good or excellent.

Note that in Model I the size variable (specified in the general model) is divided into two components, one for container size (*SIZEG*) and the second for plant height (*SIZEH*). This variable is partitioned to determine if either of the two size components is relatively more important. However, when the size variable is decomposed, perfect multicollinearity exists between the *TERMS* variable and *SIZEH*. Therefore, Model I excludes the *TERMS* variable and includes both size variables. To analyze the effect of the variable for payment terms, *DTERM* is included in Model II while the *SIZEH* variable is eliminated from this model.

Model II is represented as follows:

$$RANK_i = b_0 + b_1\, DELIV_i + b_2\, FCCU_i + b_3\, ORIG_i + b_4\, PRICE_i + b_5\, RANGE_i + b_6\, SIZEG_i + b_7\, DTERM_i + b_8\, QUALEG_i + V_i,$$

where all variables previously defined have the same meaning and b_n represents the parameters to be estimated; V_i is the error term; $DTERM_i$ is the binary dummy variable for payment terms (0, if cash on delivery; 1, if 30 days credit).

In the ordinary least squares technique (OLS), the dependent variable (*RANK*) has a limited range (1–9); thus, estimation of Models I and II with this technique can result in inefficiency and inconsistent standard errors (Judge, Hill, Griffiths, Lutkepohl, and Lee). Use of the logit model circumvents these problems. The application of logit models in conjoint analysis is discussed by Green and Srinivasan. In the logit regression the following equation is estimated:

$$P_{ij} = F(I) = 1/[1 + \exp^{-(I_n)}],$$

where P_{ij} is the probability that the *i*th plant is ranked in the *j*th group ($j = 1$ implies the upper third or a ranking greater than 6, and $j = 0$ implies the lower two-thirds or a ranking less than 7); I_n is the equation represented by Model I or Model II depending on which model is being estimated; and exp is the base of the natural logarithm.

One assumption of logit models is the independence of irrelevant alternatives or that alternative choices do not have close substitutes. If choices representing plants that differ only slightly in description were utilized in formulating the model, this assumption may be violated. To deal with this problem the rankings of each individual were divided into two groups. Thus, the dependent variable in the logit model takes on two values. For rankings of 1 to 6, the dependent variable is assigned a value of 0, and for rankings from 7 to 9, the dependent variable is 1. The decision to use the upper third of plant rankings is not arbitrary. When survey participants ranked plants, the descriptive cards were divided into three categories representing those they would not want to purchase, those marginally acceptable, and those they would purchase. Most respondents selected three cards for the "would purchase" category. Further, it is unlikely that wholesalers would want to know what attributes would move their product from fifth to fourth place in a buyer's ranking, but would be interested in knowing how they can consistently rank in the top third of buyers' preferences.

Results

In the OLS models, parameter estimates for the dummy variables indicate, ceteris paribus, the amount the rank of the product would increase if that product has the attribute represented by the relevant variable (Table 4). For example, the coefficient of 0.56 for *SIZEH* suggests that, other things

Table 4. Estimated Coefficients for Product Attributes Affecting Nursery Stock Purchases

	Ordinary Least Squares Estimation		Logit Analysis	
Variable	Model I	Model II	Model I	Model II
Intercept	2.07	2.63	−4.11	−3.32
	(.972)[a]	(1.02)	(1.82)	(1.85)
Delivery (*DELIV*)	−0.083	−0.083	−0.335	−0.335
	(0.270)	(0.270)	(0.438)	(0.438)
Flower color (*FCCU*)	0.182	0.182	−0.007	−0.007
	(0.310)	(0.310)	(0.522)	(0.522)
Origin (*ORIGIN*)	0.688**	0.688**	0.323	0.323
	(0.313)	(0.460)	(0.460)	
Price (*PRICE*)	−0.097*	−0.097*	−0.046	−0.046
	(0.052)	(0.052)	(0.085)	(0.085)
Range of products (*RANGE*)	1.23***	1.23***	1.54***	1.54***
	(0.311)	(0.311)	(0.385)	(0.385)
Plant height (*SIZEH*)	0.561*		0.796*	
	(0.310)		(0.466)	
Container size (*SIZEG*)	0.067	0.067	0.549	0.549
	(0.311)	(0.522)	(0.522)	
Quality (*QUALEG*)	4.19***	4.19***	3.25***	3.25***
	(0.310)	(0.310)	(0.555)	(0.555)
Payment terms (*DTERM*)		−0.561*		−0.796*
		(0.310)		(0.466)
Adj. R^2	.48	.48		
F Statistic	25.8	25.8		
Pseudo R^2			.26	.26
Log-likelihood			−102.1	−102.1
Restricted log-likelihood			−137.5	−137.5
Chi-square			70.8	70.8
Sample size	216	216	216	216

[a] Numbers in parentheses are standard errors; *** implies significance as the .01 level, ** implies significance at the .05 level, and * implies significance at the .10 level.

being equal, a plant that is 18″–24″ in height would be ranked 0.56 units higher (on the 1–9 scale) than a plant that is 15″–18″ tall.

The OLS estimated parameter for *QUALEG* has a value of 4.19. The magnitude of this parameter, relative to others, suggests that quality has a substantial impact on buyer rankings. The coefficient for *RANGE* suggests that firms offering a wide variety of plants to buyers are preferred to those offering little choice. The value of this coefficient is greater than those for *ORIGIN*, *SIZEH*, and *DTERM*, indicating that the option of purchasing several plants from one source has a greater impact on rank than the product-origin and plant-height attributes.

The estimated coefficient for *ORIGIN* suggests that plants originating from the Northeastern region of the country are preferred to those from the West Coast. In fact, Northeastern plants would be ranked 0.69 points higher than those coming from the West Coast. Three other attributes, represented by *PRICE*, *SIZEH*, and *DTERM*, appear to impact on buyer preferences. Coefficients for *SIZEH* and *DTERM* are interpreted in the same manner as those for quality, origin, and product range. However, the negative coefficient for *DTERM* should be noted. This coefficient indicates that retailers and landscapers prefer to purchase rhododendrons by paying cash on delivery (COD) rather than obtaining credit. A plausible explanation for this is that even though it was not explicitly stated that wholesalers would provide buyers a cash discount, buyers have implicitly assumed so because it is a common practice in the industry. Thus, the implied cash discount makes COD payments an attractive attribute. Compounding this result is the fact that 81% of the respondents reported that they purchase on a 30-day credit basis (see Table 2); however, it may be that buyers settle accounts prior to 30 days in order to receive a cash discount.

Since *PRICE* was specified as a continuous variable, its coefficient is interpreted differently. The *PRICE-RANK* elasticity is −0.26. Thus, if the price of a rhododendron plant declined by 10%, the rank of that plant would increase by 2.6%. Alternatively, if the *PRICE-RANK* elasticity is evaluated at the mean, a price decline of 20%, from $14.98 to $11.98, increases the rank of that product by approximately 5% or 0.45 points on the 1–9 scale. Therefore, price has a moderate impact on product ranking. As previously discussed, this *PRICE-RANK* elasticity is only applicable within the \$11.95–\$17.95 range considered in this study. Finally, based on the OLS results, it appears that products having the short delivery time (*DELIV*), unusual flower color (*FCCU*), or larger container size (*SIZEG*) attributes would not improve the ranking of that product by a buyer.

It would be useful for wholesalers to know if retail garden centers prefer different attributes than do landscapers, or whether firms with more experience have different preferences than those with less. To determine this, the sample was divided into retailer and landscaper groups, and firms with twenty or more years of operation and firms with less than twenty years of operation. Using these two sets of data, two F tests were conducted. The first test was to determine if there was a statistical difference between retailer and landscaper preference functions, and the second test was to determine if there was a difference between the preferences of older and younger firms. It was found that the two buyer groups have the same preferences when making nursery-stock purchases; thus, the aggregation of respondents is reasonable.

The OLS results were also used to perform two robustness tests of the model. In the first test, the data were sorted on each of the independent variables. Using each of these sorted data sets, two regressions were run. The first regression omitted the initial observation and the second regression deleted the last observation. The estimated parameters from these regressions were compared statistically to the parameters estimated with the full data set. There were no significant differences between the parameters estimated from the full data set and those of the sets when one observation was dropped. The second test was a straightforward application of the jackknife procedure for model robustness. Using the SAS jackreg procedure (Hambi, Chilko, and Hobbs), it was found that the parameters estimated using the OLS procedure are the same as the coefficients estimated in the jackknife regression procedure. The results of the two tests indicate that the model is robust.

In the logit estimation, four variables—*QUALEG*, *RANGE*, *SIZEH*, and *DTERM*—are statistically significant. *QUALEG*, *RANGE*, and *SIZEH* have a positive effect on the probability that a plant is ranked in the top third of the group of plants. *DTERM* has a negative impact on the probability. These findings are similar to those of the OLS procedure. Contrary to the OLS results, the variables *PRICE* and *ORIGIN* are insignificant in the logit models, yet these two coefficients and others which are insignificant have the expected signs.

Parameters of the logit model provide estimates of the changes in the log of the odds that a plant is ranked in the top third of the sample plants associated with changes in the corresponding independent variables. All of the significant coefficients are associated with discrete dummy variables. To determine the effect of these variables on the probability of a plant being ranked in the upper third, the estimated function I_n is evaluated with each of the discrete variables taking on a value of zero and price specified at its mean. A probability corresponding to this evaluation is calculated. The function I_n is then evaluated with the variable of interest specified at 1. A second probability is calculated and the difference between this probability and the first provides an estimate of the change in probability that would result when a plant has the attribute of interest. This procedure is used to obtain the changes in probability associated with the significant coefficients and selected combinations of these variables. It should be noted that the change in probability is a function of the initial probability (Pindyck and Rubinfeld). Thus, it is possible to calculate a number of changes in probability whose values would be dependent on the initial value of the function.

Nursery stock with the *QUALEG*, *RANGE*, and *SIZEH* attributes would increase the probability of being ranked in the top division by 30%, 6%, and 1%, respectively (in Model I). Thus, the probability of a good- to excellent-quality plant being ranked in the upper third would be 30% greater than one with low quality. Alternatively, if a seller offered a full range of plants to a buyer, chances are 6% greater that the seller's plant would be preferred to another who offered a limited number of plants. The effect of *SIZEH* is evaluated in the same manner.

The other significant variable, *DTERM*, suggests that offering nursery stock with a 30-day credit option and not a COD option would reduce the probability of being ranked in the top third by 1%. A rationale for the negative impact of *DTERM* was presented in the OLS discussion. This result indicates that buyers prefer to pay cash for nursery stock. Note that the change in probability associated with the *DTERM*, *QUALEG*, *RANGE*, and *SIZEH* variables is calculated at a low level of initial probability; thus, the effects of these variables on the change in probability are reduced. Evaluations at higher initial probabilities would result in greater changes in probability associated with each variable.

The joint effect of the variables on the probability of being ranked in the top third can also be estimated. A plant having the desired quality, product range, and height attributes would have a 68% greater chance of being a top-ranked plant than one without these attributes. Rhododendron stock with good to excellent quality, the availability of additional plants, and 30 days of credit increases the probability of being ranked in the upper third by 48% over stock not having these attributes. Since the joint effect of variables is estimated to be greater than the sum of the individual probability changes, it is critical that wholesalers try to provide buyers with products having as many of the preferred attributes as possible.

The benefit of the OLS procedure is the straightforward interpretation of the results, the ability to apply the F test to determine if there were preference differences between landscapers and retailers or older and younger firms, and the applicability of the robustness tests. However, the OLS results should be interpreted with caution due to the underlying statistical problems associated with this procedure when applied in the present analysis. The logit analysis offers models with preferred statistical properties. Besides the pseudo R^2 and chi-square statistics reported in Table 4, the logit model may be evaluated by determining how accurately it predicts. In this analysis, both logit models predicted 165 of the 216 observations, or 76%, correctly.[2]

Discussion

Several implications may be drawn from this analysis. First, wholesalers and producers should concentrate on producing and selling high-quality, larger plants. Quality appears to be the single most important attribute in determining buyer preferences for rhododendron plants. If quality is also an important factor for buyers outside of Connecticut, there are implications for grades and standards in the sector. Currently, grades and standards are not utilized; however, if they were, transaction costs between buyers and sellers could be reduced resulting in improved efficiency within the industry. Moreover, marketing at the consumer level could be enhanced by informing consumers about quality products using grades and standards.

Second, wholesalers should offer Connecticut retailers and landscapers a wide variety of nursery stock. This would provide purchasers with the opportunity to obtain several plants from one source rather than having to "shop around" when procuring landscape plants. Wholesale growers that do not grow a full range of plants can purchase nursery stock from other growers to fill out their product line. Based on the OLS result which indicates that Northeastern-grown stock may be desirable, these purchases should be made within the Northeast region. When firm size limits the possibility of offering a full range of products, it becomes critical that the other attributes affecting buyer preferences be offered by sellers.

A third implication concerns credit and discount pricing. To be competitive with other firms, cash discounts should be offered by sellers to buyers. Even though the effect of a price change on buyer preferences is estimated to be minimal, a cash discount for prompt payment is viewed by buyers as a desirable attribute. The 30-day credit option should also be offered to buyers, particularly to new entrants in the industry.

Summary

In recent years, the nursery and greenhouse sectors have grown faster than any other agricultural-based industry in the nation. Many states in the Northeast have experienced this growth. One way to ensure the success of wholesalers in the region is for them to provide buyers with products that have desirable characteristics. However, it is not apparent to wholesalers which attributes are important to the landscapers and retailers purchasing from them.

The objective of this paper was to identify those product characteristics which influence the decisions of Connecticut landscapers and retailers when purchasing rhododendron nursery stock from wholesalers. To complete this objective, conjoint analysis procedures were used to obtain data from a sample of Connecticut buyers. These data were analyzed with ordinary least squares regression and logit techniques.

Of the eight product attributes studied, it was found that the dominant characteristic affecting buyer preferences is plant quality. Other factors which significantly influence purchases are the offering of a full line of plants to buyers, height of the plant, and the option to pay for purchases on a cash basis. Factors which were hypothesized to be relevant, yet found not to influence purchases, are delivery days from time of placing order, unusual flower color, and container size.

Although this study focused on the preferences of Connecticut retailers and landscapers, the results may be applicable in other Northeastern states hav-

[2] Additional tests of the temporal, predictive, or discriminant validity of preferences were beyond the scope of this research. The interested reader is referred to Teas and Perr for a discussion of these validity tests.

ing similar marketing conditions. Finally, this study represents an introductory step in the study of nursery product marketing. Further research related to this study could focus on the inclusion of marketing risks when ordering plants, the desirable product attributes for other plants, sales, important attributes at the consumer level, and the identification of factors which buyers prefer in different regions of the country.

References

Addelman, Sidney. "Orthogonal Main-Effect Plans for Asymmetrical Factorial Experiments." *Technometrics* 4(1962): 21–46.

American Association of Nurserymen. September 1985. "Nursery Industry Research Needs." Washington, DC. Mimeo.

Gineo, Wayne M., and S. Were Omamo. "An Analysis of Household Expenditures on Nursery Products in the United States." Paper presented at the 1988 Northeast Agricultural and Resource Economics Association Meeting, Orono, ME, June 1988.

Green, Paul E. "On the Design of Choice Experiments Involving Multifactor Alternatives." *Journal of Consumer Research* 1(1974): 61–68.

Green, P. E., K. Helsen, and B. Shandler. "Conjoint Internal Validity Under Alternative Profile Presentations." *Journal of Consumer Research* 15(1988): 392–97.

Green, Paul E., and Vithala R. Rao. "Conjoint Measurement for Qualifying Judgmental Data." *Journal of Marketing Research* 8(1971): 355–63.

Green, Paul E., and V. Srinivasan. "Conjoint Analysis in Consumer Research: Issues and Outlook." *Journal of Consumer Research* 5(1978): 103–23.

Green, Paul E., and Yorum Wind. "New Way to Measure Consumers' Judgement." *Harvard Business Review* 53(1975): 107–15.

Hambi, P., D. M. Chilko, and G. Hobbs. "The JACKREG Procedure." In *SAS Supplemental Library Users Guide*. Version 5. SAS Institute, 1986.

Johnson, Richard M. "Trade-Off Analysis of Consumer Values." *Journal of Marketing Research* 11(1974): 121–27.

Judge, G. G., R. C. Hill, W. E. Griffiths, H. Lutkepohl, and T. C. Lee. *Introduction to the Theory and Practice of Econometrics*. John Wiley & Sons, 1982.

Lancaster, Kelvin. "A New Approach to Consumer Theory." *Journal of Political Economy* 74(1966): 132–57.

Pindyck, R. S., and D. L. Rubinfeld. *Economic Models and Economic Forecasts*. McGraw-Hill Book Co., 1976.

Teas, R. K., and A. L. Perr. "A Test of a Decompositional Method of Multiattribute Measurement." *Journal of Consumer Research* 16(1989): 384–91.

U.S. Department of Agriculture. Economic Research Service. "Ornamental Horticulture Industry is Blooming." *Agricultural Outlook* (July 1988): 12–15.

———. "Economic Indicators of the Farm Sector: State Financial Summary, 1988." October 1989.

Appendix: Sample Profile of Products Ranked by Buyers

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #2, 15″–18″; PRODUCT RANGE: LIMITED, 3–4 additional cultivars available from this source; QUALITY: GOOD, good color, healthy roots, good top, no pathogens; PRICE: $14.95; ORIGIN: WEST COAST (California or Oregon); FLOWER COLOR: WHITE; DELIVERY: within 2–3 days of ordering or pick up at yard; TERMS: 30 days from delivery, full payment.

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #3, 18″–24″; PRODUCT RANGE: VARIED, several additional cultivars available from this source; QUALITY: LOW, slight discoloration, healthy roots, leggy top, possible evidence of pathogens; PRICE: $17.95; ORIGIN: WEST COAST (California or Oregon); FLOWER COLOR: WHITE; DELIVERY: within 10–14 days of ordering; TERMS: COD.

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #3, 15″–18″; PRODUCT RANGE: LIMITED, 3–4 additional cultivars available from this source; QUALITY: GOOD, good color, healthy roots, good top, no pathogens; PRICE: $17.95; ORIGIN: NORTHEAST; FLOWER COLOR: YELLOW; DELIVERY: within 10–14 days of ordering; TERMS: 30 days from delivery, full payment.

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #3, 15″–18″; PRODUCT RANGE: VARIED, several additional cultivars available from this source; QUALITY: LOW, slight discoloration, healthy roots, leggy top, possible evidence of pathogens; PRICE: $14.95; ORIGIN: NORTHEAST; FLOWER COLOR: RED; DELIVERY: within 2–3 days of ordering or pick up at yard; TERMS: 30 days from delivery, full payment.

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #3, 18″–24″; PRODUCT RANGE: LIMITED, 3–4 additional cultivars available from this source; QUALITY: GOOD, good color, healthy roots, good top, no pathogens; PRICE: $11.95; ORIGIN: NORTHEAST; FLOWER COLOR: RED; DELIVERY: within 10–14 days of ordering; TERMS: COD.

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #3, 18″–24″; PRODUCT RANGE: VARIED, several additional cultivars available from this source; QUALITY: BEST, excellent color, healthy roots, bushy top, no pathogens; PRICE: $14.95; ORIGIN: NORTHEAST; FLOWER COLOR: YELLOW; DELIVERY: within 2–3 days of ordering or pick up at yard; TERMS: COD.

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #2, 15″–18″; PRODUCT RANGE: VARIED, several additional cultivars available from this source; QUALITY: LOW, slight discoloration, healthy roots, leggy top, possible evidence of pathogens; PRICE: $11.95; ORIGIN: NORTHEAST; FLOWER COLOR: YELLOW; DELIVERY: within 10–14 days of ordering; TERMS: 30 days from delivery, full payment.

PLANT: RHODODENDRON (broadleaf evergreen); SIZE: #3, 15″–18″; PRODUCT RANGE: VARIED, several additional cultivars available from this source; QUALITY: BEST, excellent color, healthy roots, bushy top, no pathogens; PRICE: $11.95; ORIGIN: WEST COAST (California or Oregon); FLOWER COLOR: WHITE; DELIVERY: within 10–14 days of ordering; TERMS: 30 days from delivery, full payment.

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