Christmas Tree Consumption Behavior: Natural vs. Artificial

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Artificial Christmas trees have gained an increasing market share, causing concern to natural Christmas tree producers. Primary data was used to test a hypothesized sequential probit model of buyer characteristics. The model predicted the probability of using or displaying a Christmas tree, then if a use decision was made, the probability of displaying a natural tree. The people who are likely to display trees are Christian, practice other secular Christmas rituals, have children, and spend Christmas at home. Those who use natural trees are younger, white, have a higher income, and live in a single-family dwelling.

The northeast region of the United States is a major production area for natural Christmas trees. Pennsylvania growers, supplying one out of every twenty natural trees sold, are national leaders. Between 1946 and 1964 approximately 40 million natural trees per year were sold nationwide but during the late 60's sales declined to 30 million even though the number of households was increasing. Artificial Christmas trees had begun to make inroads into the market, capturing an increasing market share (Anderson, Chapman and Wray).

The main objective of this paper is to identify socio-economic characteristics of households who use a natural Christmas tree and to predict the likelihood of natural-tree use based on the identified characteristics. The analysis is based on a survey of Christmas tree consumers in the Philadelphia and Washington D.C. areas. A sequential probit model is used to model the impact that the socio-economic variables have on the likelihood of natural-tree use.

The Model

With respect to Christmas-tree use, the household or individual has three options: display no Christmas tree, display an artificial tree or display a natural tree.[1] A sequential-probit model was hypothesized because the tree-use decision is thought to be made in two steps—first decide tree or no tree and then decide between natural and artificial.

The linear index of the propensity to display a tree is hypothesized to be a function of the socio-economic characteristics of the household where a tree is displayed. If the propensity index of individual (or household) i is above an individual (or household) critical value, the decision is to display a tree. Further, the propensity to display a natural tree rather than an artificial tree is hypothesized to also be a function of household characteristics. A probit model is assumed, implying that the probability of tree-use is the value of the standard normal distribution function evaluated at the estimate of household i's propensity index.[2] The sequential probabilities can be represented as follows:

$$(1) \quad P_{Ti} = F(X_{Ti}B_T) \qquad i = 1, \ldots, H,$$

$$(2) \quad P_{Ni} = F(X_{Ti}B_T)\, F(X_{Ni}B_N) \qquad i = 1, \ldots, H,$$

Where P_{Ti} and P_{Ni} are the probabilities that household i displays a tree and that household

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[1] A fourth option does exist—to display both an artificial and natural tree. But because primary interest of the study was on households using natural trees, for modelling purposes the use-both option was excluded as an alternative. The 24 respondents who reported displaying both an artificial and natural tree were included with the natural tree users.

[2] For a more detailed explanation of the probit model see Chow or Judge et al.

i displays a natural tree respectively.[3] The matrices X_T and X_N contain values for socio-economic characteristics. The function F is the standard normal distribution function. B_T and B_N are vectors of parameters to be estimated and H is the total number of households in the sample.

The parameter estimates are found by searching for values that maximize the likelihood functions constructed from equations (1) and (2). The sequential probit model can be estimated by finding the maximum of the likelihood function associated with $F(X_{Ti}B_T)$ first and then of the likelihood function associated with $F(X_{Ni}B_N)$. The estimation is simply maximizing the likelihood function of a dichotomous model twice (Amemiya). Note that the probability of not displaying is $(1 - P_{Ti})$ and $(1 - P_{Ni})$ respectively.

Empirical Results

Primary data were collected by telephone interviews in January 1986 for the 1985 holiday season. A total of 558 people in households in the greater Philadelphia and D.C. areas were reached with random-digit dialing techniques and interviewed (Ishler and Herrmann). Various questions were asked on Christmas activities, including whether a tree was displayed, and the socio-economic characteristics of the respondent and the respondent's household.

The telephone survey obtained a broad profile of each household. For the decision to display a Christmas tree, the following socio-economic variables were hypothesized to be important:[4]

(a) Marital status of the respondent. The married were hypothesized to be more likely to observe the Christmas ritual and thus more likely to display a tree.
(b) Location of Christmas celebration. If Christmas was celebrated at a different location than where the respondent lived, the full ritual was less likely to be observed and thus a tree was less likely to be used.
(c) Religious affiliation. A Christian respondent was thought to be more likely to observe the Christmas ritual and thus a tree is more likely to be used.
(d) Number of people in the household. A multi-person household was thought to be more likely to use a tree than a single-person household because children were more likely to be present.
(e) Additional celebrating or other rituals. If the respondent participated in other ritual behavior such as a holiday meal, hanging stockings, giving gifts, or hanging wreaths—a tree would be more likely to be part of the ritual.

The decision of whether to display a natural rather than an artificial tree was hypothesized to be related to the following variables:

(a) The income of the husehold. A higher income would favor a natural tree since it must be purchased each year while an artificial tree may be used for several years.
(b) The age of the respondent. An older person would be more likely to use an artificial tree since natural-tree use typically requires physical effort including a special shopping trip, transportation of the tree, fitting the tree in a stand, and setting the tree upright.
(c) The race of the respondent. Whites were thought to be more likely to use a natural tree than nonwhites because of the European origins of the tree ritual.
(d) The type of dwelling. A respondent who lived in a single family residence was thought more likely to purchase a natural tree, mostly because the house-dweller was thought to have a stronger sense of permanence and ritual than the more transient apartment dweller.

Table 1 contains definitions of the variables and their abbreviations. Correlation coefficients were calculated for all variables and

[3] P_{Ni}, the probability of displaying a natural tree, is estimated from cross-sectional data and is implicitly assumed to be independent of the type of tree displayed the previous year. The household that purchased an artificial tree may be more likely to display the same tree the next year because of the investment. A time series or data on past behavior would be needed to test whether the probability to display a natural or artificial tree is affected by the previous year's behavior.

[4] Several other variables were included in the initial model formulation and were not significant at the .10 level. The variables in the initial model for the use-tree, not-use-tree probability were age of respondent, income of the household, education level of the respondent, race of respondent, dummy variable for children under 16 in household, dwelling of respondent, and whether a poinsettia was purchased. For the decision of whether to use a natural or an artificial tree the variables included in the initial model but not included in the final function estimated were education level of respondent, marital status of respondent, location of Christmas celebration, religion of respondent, number of people in household, a dummy for children under 16 in the household, and the various other ritual behaviors such as special meal and wreath hanging.

Table 1. Relevant Variable Names and Definitions

Variable Name	Description
Married	1 if presently married or couple living together, 0 otherwise
Difhouse	1 if majority of holidays was spent in another household, 0 otherwise
Religion	1 if Christian, 0 otherwise
Household	Number of people in household
Smeal	1 if respondent had a special, holiday meal, 0 otherwise
Stocking	1 if stockings were hung, 0 otherwise
Gift	1 if gifts were exchanged, 0 otherwise
Wreaths	1 if wreaths were hung, 0 otherwise
Age	Age in years of respondent
Race	1 if white, 0 if any non-white race
Income	Entire household income, categorized as: 1 if under $10,000 2 if $10,001–$15,000 3 if $15,001–$20,000 4 if $20,001–$25,000 5 if $25,001–$35,000 6 if $35,001–$45,000 7 if $45,001–$60,000 8 if over $60,000
Dwelling	1 if live in single-family dwelling, 0 otherwise

no evidence of multi-collinearity existed. Results for the use-tree versus not-use-tree estimation are presented in Table 2. The asymptotic t statistics and probability levels for the t statistic of each estimate are also included. Based upon the results of the likelihood ratio statistic, the model had significant explanatory power.

The qualitative interpretations of the estimated coefficients matched the hypothesized signs for all variables. The resulting profile for a household that displays a Christmas tree was as expected: a married (or significantly paired) Christian couple who celebrate Christmas at home, who live in a household with three or more people, and who prepare a special holiday meal along with observing other secular Christmas rituals. For a four person household that matches the above characteristics, the probability of displaying a tree as predicted by the model is 0.99. This result can be compared to a single-person household celebrating the holidays elsewhere for which the probability of displaying a tree is 0.21.

Table 3 contains comparisons between the predicted decisions of the estimated model and the decisions reported by the respondents. The model predicted that a total of 374 people would decide to display a Christmas tree but only 366 people actually did display a tree. Any probability greater than .50 predicted by the model was considered to be a display decision. When comparing observations on an individual basis, the model predicted that 345 of the people would display a tree who actually did display. The model, however, predicted 29 display decisions for households that did not display a tree. The model predicted 86 not-display decisions that were reported as not-display decisions. The estimated model proved to be a good predictive tool with only a slight bias toward predicting a not-display decision when the respondents had actually displayed a tree.

Differentiating between households where a natural tree is selected over an artificial proved more difficult and less reliable. Four variables were hypothesized to be important and Table 4 contains the estimation results.

Table 2. Probit Results for the Display Versus Not-Display Decision

Variable Name	Coefficient	|t-statistic|	Probability for t = 0
Constant	−2.27	6.12	0.000
Married	0.31	1.83	0.067
Difhouse	−0.59	3.66	0.000
Religion	0.52	2.60	0.009
Household	0.29	4.15	0.000
Smeal	0.51	2.58	0.010
Stocking	0.97	5.46	0.000
Gift	0.72	2.39	0.017
Wreaths	0.62	3.63	0.000

Log Likelihood: −164.93
Likelihood Ratio Statistic: 219.19[a]
Number of Observations: 481

[a] The likelihood ratio statistic is distributed as a Chi-square with 8 degrees of freedom and is significant at the 0.01 level.

Table 3. Comparisons Between Model-Predicted Decisions and Actual Decisions on Whether to Display a Christmas Tree

Number Predicted by Model[a]	Number of Actual Decisions: Display Tree	Do Not Display Tree	Total
Display Tree	345	29	374
Do Not Display Tree	21	86	107
TOTAL	366	115	481

[a] Any probability greater than 50% was considered a display-tree decision.

Table 5. Comparisons Between Model-Predicted Decisions and Actual Decisions on Whether to Display a Natural Christmas Tree

Number Predicted by Model[a]	Number of Actual Decisions: Use Natural Tree	Do Not Use Natural Tree	Total
Use Natural Tree	141	99	240
Do Not Use Natural Tree	78	48	126
TOTAL	219	147	366

[a] Any probability greater than 50% was considered a use-natural-tree decision.

Again the model had significant explanatory power as measured by the likelihood ratio statistic. At the 0.10 significance level, all variables except the constant were significant. The signs matched the hypothesized relationships. Table 5 contains the comparisons between the model's predictions and actual responses. Use of a natural tree was predicted for 240 households versus the 219 households who displayed a natural tree. Upon further investigation, however, the model performs poorly. The number of wrong predictions is higher than the previous model with a relatively higher bias for predicting a natural tree would not be used when a natural tree was displayed.

The profile that emerges for households who use a natural tree is a younger white household with a single-family house. The household also has a higher income. Evidently a natural tree tends to be more of an "upscale" consumer good. The model predicted, for example, that a household in the highest income bracket (over $60,000), with the respondent in the mid-20's, who has chosen to display a tree will select a natural tree with probability 0.76. A two-person household in the same income bracket with the respondent age 57 has a probability of 0.57 of displaying a natural tree.

Conclusions

A probit analysis was used to estimate the probability of displaying a Christmas tree and then, if a tree was to be displayed, the probability of a natural tree being chosen. Primary data for 1985 from a telephone survey were used to test the models. Both models had significant explanatory power and the hypothesized signs of the independent variables were upheld. The model for displaying a tree versus not displaying a tree had a stronger predictive power than the model differentiating between natural and artificial tree use.

Table 4. Probit Results for the Natural Versus Artificial Decision

Variable Name	Coefficient	|t-statistic|	Probability for t = 0
Constant	−0.43	1.35	0.178
Age	−0.02	3.66	0.000
Income	0.08	2.38	0.017
Dwelling	0.32	1.74	0.081
Race	0.59	3.46	0.001
Log Likelihood: −234.35			
Likelihood Ratio Statistic: 24.43[a]			
Number of Observations: 366			

[a] The likelihood ratio statistic is distributed as a Chi-square with 4 degrees of freedom and is significant at the 0.01 level.

People who are likely to display a tree are Christian, practice other secular Christmas observances, have children, and stay at home for Christmas. The subset of the tree users that choose natural trees are often younger, white, have higher incomes, and live in a single-family dwelling. For the Christmas tree grower, this information should be helpful in developing marketing strategies and for predicting future trends based on demographic projections.

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