Consumer's Specie Knowledge and the Values of Natural Christmas Tree Characteristics

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Abstract

Consumers' willingness to pay for natural Christmas tree characteristics are estimated. Differences in willingness to pay for characteristics by specie knowledge and lack of specie knowledge are tested. Differences in willingness to pay for characteristics by specie are also tested. The results suggests that willingness to pay measures differ by these separations of the sample and, ceteris paribus, sellers of natural Christmas trees could benefit by altering characteristics in accordance with the results of these sample separation tests.

Key Words: Christmas trees, hedonic, sample separation

Natural Christmas trees are not usually thought of as a major agricultural crop, but annual total revenue is estimated to be over one billion dollars.[1] The natural Christmas tree market, however, is becoming more competitive because the share of U. S. households displaying artificial trees continues to increase, and increased natural tree plantings in the early 1980s continue to put downward pressure on prices (American Christmas Tree Journal 1989, 1990). Because of this increased competition, growers have recently become more interested in marketing research (American Christmas Tree Journal 1989). Unfortunately, no research has attempted to measure how consumers value natural Christmas tree characteristics. This paper addresses this problem.

Past Christmas tree marketing research has been of one type: household characteristic analysis. The most sophisticated household characteristic analysis has been done by Hamlett, et al., who estimated a sequential probit model to determine the probability that a household would buy a tree. They found the most important household characteristics were age, income, race, household size, marriage, religion, exchanging gifts, hanging wreaths, hanging stockings, having a special meal and the amount of time spent away from home during the holidays. Many other regional studies have also concentrated on household characteristics but have only conducted frequency analysis of the data (e.g. Hildebrandt; Ishler and Herrmann). This is also true at the national level where the American Christmas Tree Association contracted the Gallup Poll Company to conduct a national survey. Again, the emphasis was consumers' characteristics and only frequencies were reported.

While consumers' characteristics are important, they are beyond the control of the producer, and therefore are of limited value in decision making. Growers are more interested in variables they can control, such as tree characteristics, and they need to know how consumers value these characteristics. This study is designed to determine how consumers value natural

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Appreciation is expressed to David Eastwood, Luther Keller and Paul Jakus for comments on an earlier draft of this paper, and to R.O. Herrmann for the data.

J. Agr. and Applied Econ. 25 (July, 1993): 266-277

Christmas tree characteristics and to determine if these valuations depend on specie knowledge. The tests of characteristic valuation differences by specie knowledge will be referred to as sample separation tests.

Theoretical Model

The most popular model used for analyzing product characteristic values is the hedonic price function. This function is consistent with two models: Lancaster and Rosen. The Lancaster model interprets the hedonic price function as an inverse demand function. In Lancaster's model, the product's price is exogenously determined and the individual alters consumption of the quantity of the product and characteristics until the first order conditions are satisfied. Alternatively, Rosen derives the hedonic price function by considering the demand and supply for product characteristics. Rosen's consumer problem is different from Lancaster's in two important ways. First, Rosen makes the price the consumer pays a function of the level of characteristics chosen. Second, Rosen does not explicitly represent the consumption technology.

While the hedonic price function for both the Rosen and Lancaster models will be observationally equivalent, the partial derivatives of the hedonic price function (the marginal prices) will have different interpretations. On the demand side, however, the marginal prices from both models can be interpreted as measures of consumers' willingness to pay for product characteristics. Estimating a hedonic price function and evaluating its derivatives will therefore generate a measure of consumers' willingness to pay for Christmas tree characteristics.

Data

The data were obtained by surveying 558 households in the Washington, D.C., Northern Virginia, Southern Maryland and Philadelphia, Pennsylvania areas in the winter of 1986. Of the 558 households surveyed, 214 (38%) purchased a natural Christmas tree in 1985. Each person was asked seven questions about tree characteristics. Table 1 lists the variables used in this study and their definitions. Three of the explanatory variables were treated as continuous: height, needle length and color. Four were discrete: needle texture, trunk, branch spacing and full shape. The height variable was measured in half-foot increments between two and eleven feet. Needle length was measured in one-inch increments between one and three inches. The color variable was originally a polychotomous variable for bluish, bluish-green, green and yellow. Because color perception is a relative measure, the relativity was captured by converting the color variables to a continuous scale.[2] This conversion was done by taking the range of the visible spectrum measured in wavelengths (nanometers) and normalizing on the lower violet limit of 400 (see

Table 1. Variable Definitions

Variable	Definition	Measuring Unit
p	Price	Dollars per tree
z_1	Height	Half-feet
z_2	Needle Length	Inches
z_3	Needle Texture	1 if soft; 0 otherwise
z_4	Color	Wavelength (nanometers)
z_5	Trunk	1 if straight; 0 otherwise
z_6	Branch Density	1 if thick; 0 otherwise
z_7	Full Shape	1 if fullshape; 0 otherwise

Colour: Encyclopedia Britannica). The variable full-shape was constructed from an open ended question which asked: What are the most important characteristics your household looks for in selecting a tree? If a household reported fullness or shape as one of the first two reasons for buying a tree, the household was assigned a value of one for full-shape and zero otherwise.

Table 2 gives the summary statistics associated with the data. There were a total of 41 missing observations which were assumed to occur at random (Heckman). These observations were deleted leaving a sample size of 173. Of these 173 individuals, 79 (45%) did not know the specie of the tree they purchased. Of the 94 knowledgeable consumers, 33 (35%) purchased a Fir-tree, 27 (29%) purchased a Spruce-tree and 34 (35%) purchased a Pine-tree.

The overall average price paid for a natural tree was $30, with the greatest average price being paid by those who knew they bought a Fir-tree ($37) and the least average price being paid by those who knew they bought a Pine-tree ($27). Simple pooled *t*-tests revealed that at the five percent level there is a difference in the mean price paid for the unknown and known species. At the one percent level, there are statistical differences in the mean Fir- and Spruce-tree prices, and Fir and Pine-tree prices, but no differences in the Spruce and Pine-tree prices. The most frequently observed height is six feet. Seventy-seven percent of the trees are in the 4.5 to 7.5 feet range. The most frequently observed needle length is two inches, with the exception of knowledgeable Spruce-tree consumers (one inch) and knowledgeable Pine-tree consumers (three inches). The most frequently observed normalized color wavelength is for a green tree (1.37), with the exception of knowledgeable Spruce-tree consumers who purchased bluish-green trees (1.25). Considering the mode percentages and the small standard deviations, it is apparent that the vague color definition, green, represents the majority of trees in the sample. The summary statistics for the dichotomous variables are rather straightforward. About 80 percent of the sample reported straight trunks, thick branch density and trees with full-shape. About one-half (49%) of the sample reported a soft needle texture. While these summary statistics are informative, only by estimating the hedonic price function can willingness to pay measures be obtained.

Specie Knowledge Results

As with any empirical study, the functional form specification is debatable. Possible specification bias was minimized by following the advice of Cropper, et al. In a Monte Carlo study they found if the hedonic price function was known to be misspecified, the linear hedonic price function produced the smallest maximum bias in the marginal prices.[3] A linear hedonic specification is therefore used and it is assumed that the variance of the error term is finite.

To test for sample separation (different marginal prices) between those knowledgeable and those lacking knowledge of the specie purchased, the following hedonic price equation was estimated.

$$P_i = \alpha_o + \sum_{j=1}^{7} \alpha_j z_{ij} + \beta_0 d_i + \sum_{j=1}^{7} \beta_j d_i z_{ij} + \epsilon_i \quad i = 1,\ldots,173. \qquad (1)$$

P_i is the price paid for a natural Christmas by the i^{th} individual, z_{ij} are the j characteristics defined in table 1 for the i^{th} individual, d_i is a dummy variable that is one if the individual did not know the specie of the tree purchased and zero if the specie was known. The parameters of the model represent discounts (premiums) if the variable is dichotomous and marginal prices if the variable is continuous. The α are the parameters of the hedonic price function for those knowledgeable of the specie, and the sum of the α_j's and β_j's are the parameters of the hedonic price function for those not knowing the specie purchased. As Kmenta (pp. 420-21) discusses, the specification given by equation (1) is more flexible than the Chow test and provides a simple method of testing the equality of parameter estimates (marginal prices) across samples. This formulation permits the use of F and t-tests for sample separation, as done in the housing market literature (e.g. Butler or Edmonds).

Table 2. Summary Statistics

Variable	All (n=173)	Unknown Specie (n=79)	Known Specie (n=94)	Fir (n=33)	Spruce (n=27)	Pine (n=34)
Price						
Mean	30.00	28.00	32.00	37.00	31.00	27.00
Mode	30.00	30.00	30.00	35.00	30.00	25.00
Mode %	16.00	15.00	16.00	18.00	22.00	17.00
Std. Dev.	12.17	11.73	12.29	14.09	9.67	10.85
Height						
Mean	6.17	5.84	6.46	6.81	6.38	6.17
Mode	6.00	6.00	6.00	6.00	6.00	6.00
Mode %	35.00	35.00	35.00	39.00	33.00	33.00
Std. Dev.	1.44	1.49	1.32	1.63	1.25	.95
Needle Length						
Mean	1.79	1.72	1.86	1.63	1.55	2.37
Mode	2.00	2.00	2.00	2.00	1.00	3.00
Mode %	45.00	49.00	42.00	51.00	51.00	50.00
Std. Dev.	.71	.65	.75	.60	.64	.76
Color						
Mean	1.33	1.35	1.32	1.34	1.26	1.34
Mode	1.37	1.37	1.37	1.37	1.25	1.37
Mode %	72.00	81.00	64.00	73.00	48.00	79.00
Std. Dev.	.06	.04	.07	.05	.64	.06
Trunk						
Mean	.83	.87	.80	.79	.77	.85
Mode	.83	.87	.80	.79	.77	.85
Mode %	1.00	1.00	1.00	1.00	1.00	1.00
Std. Dev.	.36	.33	.39	.41	.42	.35
Needle Texture						
Mean	.49	.48	.50	.45	.48	.55
Mode	.00	.00	.00	.00	.00	.01
Mode %	.51	.52	.50	.54	.51	.56
Std. Dev.	.50	.50	.50	.50	.50	.50
Branch Density						
Mean	.81	.73	.87	.87	.96	.79
Mode	1.00	1.00	1.00	1.00	1.00	1.00
Mode %	.81	.73	.87	.87	.96	.79
Std. Dev.	.39	.44	.33	.33	.19	.41
Full Shape						
Mean	.78	.79	.77	.75	.88	.70
Mode	1.00	1.00	1.00	1.00	1.00	1.00
Mode %	.79	.79	.77	.75	.88	.71
Std. Dev.	.41	.40	.41	.43	.32	.46

Table 3 illustrates several results. Equation (1) was first estimated in its unrestricted form with the results shown under model 1 and then in its restricted form with results shown under model 2. We discuss these results in order. Overall, many variables in model 1 believed to be significant a priori were not. It was suspected that the fixed production technology between product characteristics, such as needle texture and length, could cause near collinearities in the regressor matrix which would degrade parameter quality. Before drawing any inference from these regressions, these near collinearities were checked according to the criteria suggested by Belsley, et al. (p. 112, 117) and found to be non-degrading.

Table 3 shows that three variables are significant at the one percent level (height, needle length and branch density), one variable is significant at the five percent level (branch density difference), and three variables are significant at the ten percent level (color, height difference and needle length difference). Knowledgeable specie consumers are willing to pay $1.95 per half-foot increase in the height of a natural tree. Unknowing specie consumers are willing to pay $3.61 (1.95 + 1.66) per half-foot increase in the height of a natural tree. The marginal price of $3.61 has a *t*-value of 4.22 and is significant at the one percent level. Needle length is considered a bad characteristic by knowledgeable specie consumers and they are willing to pay $4.10 for a one-inch decrease in the length of the needles.[4] Alternatively, unknowing specie consumers do not assign, in a statistical sense, any value to needle length because their marginal price -$.74 (-$4.10 + $3.36) is not significantly different from zero at the ten percent level. The marginal price for color implies that knowledgeable consumers are willing to pay $21.37 for a one unit move up the spectrum scale. In our sample this means a move from a bluish-green tree towards a green tree. The unknowing specie consumers' marginal price for color is the same as the knowledgeable consumers', since the color difference variable (d_u z_4) is not significantly different from zero. Knowledgeable specie consumers are willing to pay a premium of $10.53 for a tree with dense-branch spacing; unknowing specie consumers are not because the premium $2.89 is not significantly different from zero (t = 1.01).

The second *F*-test in table 3 shows the test results of the null hypothesis that all parameters not significant at the five percent level are not significantly different from zero. The *F*-value of .74 implies that the null hypothesis cannot be rejected at the ten percent level of significance. The most statistically important characteristics influencing the price of natural trees are therefore; the height of the tree, the needle length, dense-branch spacing and the difference in dense-branch spacing between knowledgeable and unknowing specie consumers.

Model 2 in table 3 shows the results of adopting the restrictions implied by the second *F*-test. Height and branch density are significant at the one percent level, whereas needle length is significant at the five percent level and the branch density difference measure is significant at the ten percent level. The willingness to pay measures have changed as expected since all other regressors were not orthogonal to these. With the restricted model, knowledgeable specie consumers are willing to pay $2.89 for a half-foot increase in the height of a tree. They are also willing to pay $2.14 for a one-inch decrease in the length of the needles and a $7.08 premium for dense-branch spacing. Because of the restrictions, unknowing specie consumers value all of these characteristics the same as the knowledgeable specie consumers, except with regard to branch density. Unknowing specie consumers do not place as high a premium on branch density and are only willing to pay a $4.15 for dense-branch spacing (t = 1.73), which is significant at the five percent level.

Specie Type Analysis

The final objective of this paper was to determine if marginal prices differ across species for those who knew the species. For those who knew what specie they bought, three specie groups were formed: Fir, Spruce and Pine. Dummy variables were constructed for those who purchased Spruce and Pine-trees. As before, differences in intercept and slope parameters were tested using *F* and *t*-tests. The base intercept and slope parameters represent those of a Fir-tree consumer. The model estimated was,

Table 3. Specie Knowledge and Unknown Specie Results

	Models	
	1	2
Intercept	-13.12	11.23
	(21.83)	(4.63)***
Height (z_1)	1.95	2.89
	(.90)***	(.59)***
Needle Length (z_2)	-4.10	-2.14
	(1.66)***	(1.18)**
Neddle Texture (z_3)	1.55	
	(2.44)	
Color (z_4)	21.37	
	(15.37)*	
Trunk (z_5)	2.63	
	(2.95)	
Branch Density (z_6)	10.53	7.08
	(3.51)***	(2.29)***
Full Shape (z_7)	-.54	
	(2.90)	
Differences for Unknown Specie		
Intercept (d_u)	22.74	
	(43.76)	
Height ($d_u z_1$)	1.66	
	(1.24)*	
Needle Length ($d_u z_2$)	3.36	
	(2.57)*	
Needle Texture ($d_u z_3$)	-3.21	
	(3.59)	
Color ($d_u z_4$)	-23.29	
	(32.27)	
Trunk ($d_u z_5$)	-4.32	
	(4.89)	
Branch Density ($d_u z_6$)	-7.64	-2.93
	(4.53)**	(1.94)*
Full Shape ($d_u z_7$)	1.83	
	(4.39)	
R^2	.24	.20
SSE	19201	20194
SEE	11.05	10.96
n	173	173
F-tests	*F*-calculated	
1. H_o: All parameters equal zero	3.42	
2. H_o: All parameters not significant at 5% level equal zero	.74	

Standard Errors in parenthesis. ***Indicates significant at 1% level; **significant at 5% level and * significant at 10% level.

$$P_i = \gamma_0 + \sum_{j=1}^{7} \gamma_j z_{ij} + \theta_0 d_s + \sum_{j=1}^{7} \theta_j d_s z_{ij} + \pi_0 d_p + \sum_{j=1}^{7} \pi_j d_p z_{ij} + u_i \quad i = 1,...,94. \quad (2)$$

All variables are the same as before except $d_s = 1$ if the tree bought was a Spruce and $d_s = 0$ otherwise. $d_p = 1$ if the tree bought was a Pine and $d_p = 0$ otherwise.[5]

Table 4 shows the results of the specie type analysis. The first model estimated was the unrestricted form of equation (2). Only six of the variables are significant at the five percent level: tree height, branch density, the full shape difference for Spruce-tree consumers and the needle texture difference for Pine-tree consumers. Once again, regression diagnostics were performed to determine if there existed any parameter degrading near collinearities in the data and none, of any significance, were found.

Model 1 in table 4 shows that Fir-tree consumers are willing to pay $3.60 per half-foot increase in the height of a tree and a premium of $11.17 for dense-branch spacing. The branch-density difference parameter for Spruce-tree consumers is not significantly different from zero, so Spruce-tree consumers are willing to pay the same premium for dense-branch spacing as Fir-tree consumers ($11.17). The same dense-branch spacing premium applies to Pine-tree consumers. Spruce-tree consumers do not value the height characteristic, since the marginal price of $-0.23 is not significant at any reasonable levels (t= .11). Spruce-tree consumers unsuspectingly discount the value of full shape by $19.43. Pine-tree consumers in model 1 are willing to pay a $12.27 premium for soft needle texture. The second F-test in table 4 shows that all of the parameters in the model which are not significant at the five percent level are not significantly different from zero. The second model included these restrictions.

The restricted model 2 shows that for Fir-tree consumers the willingness to pay measures for height and branch density have decreased from model 1 to $1.98 and $7.95, respectively. Spruce- and Pine-tree consumers once again value dense-branch spacing the same as Fir-tree consumers. Model 2 also implies that Spruce-tree consumers are willing to pay $1.98 per half-foot increase in the height of a tree compared to zero in model 1, and the full shape variable is no longer significant at the ten percent level. Pine-tree consumers still do not value height as a characteristic in a statistical sense, because the marginal price of .08 has a t-value of .06. Pine-tree consumers do assign a premium of $6.81 to soft needles. The third F-test in table 4 shows that in the second model the parameters for height and full shape for Spruce-tree consumers are significantly different from zero at the one percent level.

Even though there exists no easy comparison between a multiple parameter F-test and the individual t-tests, the third model imposes only the restriction that the difference in the marginal price for height for spruce-tree consumers is zero. The third model shows almost identical results for Spruce-tree consumers, when compared to model 2. In model 3, the discount associated with full shape trees is significantly different from zero at the one percent level but is much less ($7.36) than in the first model for Spruce-tree consumers.

Qualitative Summary

Which marginal prices are accepted will depend on one's philosophical stance regarding the appropriateness of imposing restrictions based on statistical tests. Nevertheless, some general qualitative results across models do emerge and are given in table 5. In general those who knew the specie placed a positive value on height, branch spacing and color, and a negative value on needle length. Those who did not know the specie consistently valued only color the same as knowledgeable consumers. It is hard to determine from table 5 which of these two consumer types value the totality of characteristics more, yet within the Rosen model this determination is possible. In the Rosen model the price paid for a tree equals the marginal rate of substitution between money and the Christmas tree, and it also equals the weighted total valuation of all characteristics, so a higher price paid implies a higher total valuation for all characteristics. Therefore, at the mean price level (table 1) knowledgeable consumers value the sum of

Table 4. Specie Type Analysis

	Models 1	2	3
Intercept	-22.34 (50.68)	16.85 (6.65)	17.00 (6.48)***
Height (z_1)	3.60 (1.29)***	1.98 (.90)***	1.95 (.86)***
Needle Length (z_2)	-.11 (3.91)		
Needle Texture (z_3)	-4.80 (4.44)		
Color (z_4)	16.37 (36.95)		
Trunk (z_5)	.95 (4.89)		
Branch Density (z_6)	11.17 (6.26)***	7.95 (3.51)	7.94 (3.49)
Full Shape (z_7)	5.61 (4.82)		
Difference for Spruce			
Intercept (d_s)	41.57 (64.99)		
Height (d_sz_1)	-3.83 (2.33)**	-.09 (.83)	
Needle Length (d_sz_2)	-.49 (5.54)		
Needle Texture (d_sz_3)	4.53 (6.51)		
Color (d_sz_4)	-.41 (46.76)		
Trunk (d_sz_5)	-.90 (7.82)		
Branch Density (d_sz_6)	-4.69 (14.09)		
Full Shape (d_sz_7)	-19.43 (9.19)***	-6.81 (5.66)	-7.36 (2.88)***
Difference for Pine			
Intercept (d_p)	66.47 (73.67)		
Height (d_pz_1)	-6.06 (2.63)***	-1.09 (.56)***	-1.90 (.55)***
Needle Length (d_pz_2)	-5.25 (4.84)		
Needle Texture (d_pz_3)	12.27 (6.57)***	6.81 (3.93)**	6.82 (3.91)**
Color (d_pz_4)	-17.73 (50.48)		
Trunk (d_pz_5)	2.13 (7.61)		
Branch Density (d_pz_6)	-1.89 (8.21)		
Full Shape (d_pz_7)	-7.18 (7.20)		

*** Significant at 1% level, ** significant at 5% level and significant at 10% level. Standard errors in parenthesis.

Table 4. Continued

	Models		
	1	2	3
R^2	.37	.26	.26
SSE	8763	10344	10345
SEE	11.18	10.90	10.84
n	94	94	94
F-tests		*F*-calculated	
1. H_o: All parameters equal zero		1.83	
2. H_o: All parameters not significant at 5% level equal zero		.74	
3. H_o: Height and full shape parameters for spruce are zero.		3.21***	

*** Significant at 1% level, ** significant at 5% level and significant at 10% level. Standard errors in parenthesis.

all characteristics more than those lacking knowledge of the tree specie.

Table 5 also gives the qualitative results by specie type. In general, Fir and Spruce-tree consumers value height positively, but Pine-tree consumers do not value height. Pine-tree consumers value soft needle texture, where as Spruce- and Fir-tree consumers do not. Dense-branch spacing is valued positively and equally by Fir,- Spruce- and Pine-tree consumers. Fir- and Pine-tree consumers do not value full shape, whereas Spruce-tree consumers value full shape negatively. The negative value is probably due to measurement error in this variable due to the design of the question (see p. 3). Again different characteristics are valued differently across species; but the mean price levels imply that knowledgeable Fir-tree consumers value the sum of all characteristics more than knowledgeable Spruce-tree consumers, and knowledgeable Spruce-tree consumers value the sum of all characteristics more than knowledgeable Pine-tree consumers.

Conclusions

This paper represents the first attempt to measure the values of natural Christmas-tree characteristics. Like all statistical results, definitive conclusions should be made cautiously. The results presented, however, suggest marketing opportunities for natural Christmas-tree sellers based on the samples analyzed. In the context of the knowledgeable versus unknowledgeable specie analysis, the overall greater willingness to pay by knowledgeable consumers suggests that the natural Christmas-tree industry would benefit from a generic educational campaign on natural Christmas-tree species and their characteristics. A specie educational campaign would go beyond the present "real tree" campaign and emphasize the differences in the species. On a smaller scale, retailers could benefit by providing information on the specie of tree sold and its characteristics, ceteris paribus. Such educational programs would remove specie and therefore characteristic uncertainty; and provide information, which by implication, consumers value.

Table 5. Sample Separation Qualitative Summary

	Specie Knowledge Analysis	
Variable	Model 1 Willingness to Pay	Model 2 Willingness to Pay
Height	Unknowing > Knowing > 0	Unknowing = Knowing > 0
Needle Length	Knowing < Unknowing = 0	Unknowing = Knowing < 0
Color	Unknowing = Knowing > 0	Unknowing = Knowing = 0
Branch Density	Knowing > Unknowing = 0	Knowing > Unknowing > 0

	Specie Type Analysis		
Variable	Model 1 Willingness to Pay	Model 2 Willingness to Pay	Model 3 Willingness to Pay
Height	Fir > Spruce = Pine = 0	Fir = Spruce > Pine = 0	Fir = Spruce > Pine = 0
Needle Texture	Pine > Fir = Spruce = 0	Pine > Fir = Spruce = 0	Pine > Fir = Spruce = 0
Branch Density	Fir = Spruce = Pine > 0	Fir = Spruce = Pine > 0	Fir = Spruce = Pine > 0
Full Shape	Spruce < Fir = Pine = 0	Fir = Spruce = Pine = 0	Spruce < Fir = Pine = 0

In the context of the specie-type analysis, the overall greater willingness to pay for Fir-trees relative to Spruce-trees, and Spruce-trees relative to Pine-trees, suggests producers could benefit from producing more Fir-trees, ceteris paribus. There are, of course, two important caveats masked by the ceteris paribus assumption. First, a redistribution of trees produced will induce relative price changes which could change these results. Second, different species require different agronomic conditions, so many producers have small output substitution elasticities, and these producers should pay attention to certain characteristics. If a producer can grow only Fir or Spruce-trees, then there are premiums attached to taller trees and increased branch density. If he can grow only Pine-trees, there are premiums attached to softer needles and increased branch density. In either case the potential for increased profitability exists, ceteris paribus.

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Endnotes

1. This number is calculated by using $35 as the average price of a natural Christmas tree multiplied by the number of households in the U.S. who displayed a natural Christmas tree in 1992 (35.7 million: American Christmas Tree Journal, April 1992).

2. This relativity is important because of the effect known as metamerism. Metamerism refers to perceived color being different than true color due to differences in lighting (see Colour: Encyclopedia Britannica).

3. Other measures of bias were also considered by Cropper, et al. In most cases the simpler forms, such as the linear or linear Box-Cox performed best.

4. It should be pointed out that negative marginal utilities are not prohibited in the Rosen framework. The only restriction that applies in this linear framework can be derived from the first order conditions. These conditions, coupled with the linear hedonic price specification, imply that the marginal utility of a tree is equal to the sum of the marginal utilities of the tree's j characteristics times the j characteristics divided by the number of trees bought. Therefore, on the consumption side, a characteristic may be considered as bad and the tree (model) would still be bought. These results, however, imply that producers could benefit from shearing needles, but the reason we do not see this prevalent in the market place is probably due to the prohibitive cost of such an activity, in terms of labor and opportunity cost of altering other characteristics which may be considered goods, such as needle texture and color. This last point does not invalidate Rosen's model, but rather highlights its inability to address joint products in production.

5. One reviewer felt a more appropriate manner in which to do the analysis was by considering a hybrid of equations (1) and (2), where dummies would be created for each specie and for those who did not know the specie. This approach unfortunately would give misleading results because we do not know what specie the unknowing consumers purchased and therefore would not know with respect to which specie parameter we should make the unknowledgeable adjustment or test for significance. The exact relationship between the parameters in equations (1) and (2) is completely analogous to the relationship between "macro" and "micro" parameters in Theil's classic work on aggregation theory.