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Relative Importance of Factors Affecting Customer's Decisions to Buy Pick-Your-Own Versus Preharvested Fruit at North Carolina Farms

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This study identifies the most important factors affecting customers' decisions to buy pick-your-own versus prepicked strawberries and muscadine grapes at direct-market operations in North Carolina. The relative importance analysis identified the region of location of the operations and prices as the explanatory variable explaining most of the variation observed in the customer's decision to choose the type of fruit to purchase. The estimated price elasticities indicate that sales of each type of fruit are very sensitive to prices.

Key Words: conditional and random parameters logit models, demand analysis, pick-your-own fruit, relative importance

JEL Classifications: D12, Q13

According to the U.S. Department of Agriculture the number of direct-market outlets operated by U.S. farmers continues to grow. Results from the U.S. Census of Agriculture indicate that the value of agricultural products sold directly to individuals for human consumption more than doubled from 1992 to 2002, increasing from $404 million to $812 million. The number of farms selling products directly to the consumer also increased during the same period, from 86,432 to 116,733 farms (U.S. Department of Agriculture, 2002 Census of Agriculture). The most common farmer-to-consumer direct markets are pick-your-own (PYO) operations, roadside stands, farmers' markets, and direct farm markets. The major difference between PYO operations and the other direct-market outlets is that customers are allowed to harvest their own produce at the PYO farms, whereas the farmer harvests the produce for the other outlets.

The focus of this paper is on customers who visit strawberry and muscadine grape PYO operations in North Carolina. These two commodities were selected for this study because North Carolina consumers have a long tradition of purchasing these fruits at direct-market outlets. Strawberries are also increasingly popular with all U.S. consumers (U.S. Department of Agriculture, 2005), whereas the market for muscadine grapes (*Vitis rotundifilia*) is concentrated in the southeast.

Our study identifies the factors affecting customers' decisions to purchase prepicked or

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PYO strawberries and muscadine grapes. A major contribution of this paper is estimation of price effect on customers' decisions to buy PYO versus preharvested fruit at the farm. A review of the literature indicates that little attention has been paid to the analysis of price effects in the context of PYO marketing, despite the relevance and importance of this aspect in economics and marketing analysis.

Another contribution of this paper is the assessment of the relative importance of the factors affecting customers' decisions. This information is important for the design and implementation of marketing strategies for these operations.

Literature Review

Demand for PYO Fruit

Only a few studies are found in the economics, horticulture, rural sociology, ethnography, geography, and extension literature that examine farmers' markets in the United States (Brown). In fact, our literature review identified only 11 studies in the last 20 years that looked at the demand for PYO products.[1] These studies have mainly focused on characterizing the type of customers visiting PYO operations and exploring their motivations and shopping behavior.

According to these studies, customers who visit PYO operations have higher incomes and education levels than the average of the population. The majority of customers come from a distance of about 20 to 25 miles from the farm. During the 1980s the average age of the consumers was between 35 and 45 years, but in the most recent surveys the average age was around 50 years. Finally, most of the shoppers are women, it is common for couples to shop, and children are frequent members of the shopping parties. These studies also consistently report that the main factors that motivate customers to visit PYO farms are the freshness of the products, the quality of the produce, prices, and the experience of visiting the farm.

The majority of the studies only report the results of the surveys and in general do not quantify the effects of factors affecting the customers' decisions. The literature review revealed one study that assesses the effect of both customers' characteristics and motivations in their decision of whether or not to visit the operation (Govindasamy and Nayga). Even though four of the studies analyze the effect of socioeconomic characteristics on the amount of fruit purchased (Ott, Hubbard, and Maligaya; Safley et al.; Safley, Wohlgenant, and Suter; Toensmeyer and Ladzinski), it is only Ott, Hubbard, and Maligaya who quantify the effects of demographics on the quantity of PYO fruit purchased.

Govindasamy and Nayga analyze the factors affecting the decision to visit different types of direct-market facilities in New Jersey. They found that those customers who expect more variety and lower prices at PYO operations than in supermarkets are 12% more likely to visit a PYO farm. Ott, Hubbard, and Maligaya use regression analysis with the quantity of blueberries picked on Georgia farms as the dependent variable and several socioeconomic characteristics as independent variables. In this study, only family size was found to be an important determinant of the quantity of berries purchased.

Relative Importance of Explanatory Variables

The determination of the relative importance of the explanatory variables is an important aspect of regression analysis. However, the literature is quite sporadic, and the concept of relative importance still remains ambiguous (Soofi; Soofi, Retzer, and Yasai-Ardekani). For example, Kruskal and Majors studied the concept of the relative importance of explanatory variables in the scientific literature and found that 20% of the studies misused statistical significance (*p*-values) as a measure of the relative importance of variables. In this paper we implement special procedures devel-

[1] Courter and Kitson; Govindasamy and Nayga; Govindasamy, Italia, and Adelaja; Leones et al.; Manalo et al.; Ott, Hubbard, and Maligaya; Pulsue 1983, 1984; Safley et al.; Safley, Wohlgenant, and Suter; and Toensmeyer and Ladzinski.

oped to assess the relative importance of variables in the context of logistic regression.

Theoretical and Econometric Model

The theoretical framework in this study uses a random utility model. This type of model arises when one assumes that although a utility function is deterministic for the consumer, it also contains elements that are unobservable to the investigator. Following Hanemann, the utility of the consumer is defined over the quantity and the consumer's perceived quality for each of the goods. The first good is available in R alternative forms, which can represent different brands, varieties, or types of a product. The second good is a numeraire, which can be interpreted as the consumption of all other goods. The utility function has the following form:

$$(1)\qquad u(\mathbf{x},z,\boldsymbol{\psi},\mathbf{b},\mathbf{s},\boldsymbol{\varepsilon}) = u\left(\sum_{i=1}^{R}\psi_i(\mathbf{b_i},\mathbf{s},\varepsilon_i)x_i,z\right),$$

where $\boldsymbol{\psi} = [\psi_1, \psi_2, \ldots, \psi_R]$ is an R-dimensional vector where ψ_i represents the consumer evaluation of quality for the ith alternative, $\mathbf{x} = [x_1, x_2, \ldots, x_R]$ is an R-dimensional vector where x_i represents the quantity of the ith variety of the first good, and z represents the quantity of the numeraire good. It is assumed that $\mathbf{b}_i = [b_{i1}, b_{i2}, \ldots, b_{ik}]$ is a k-dimensional vector defining k different dimensions of quality, where b_{ik} is the amount of the kth characteristic associated with a unit of consumption of alternative i. The R-dimensional vector $\boldsymbol{\varepsilon} = [\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_R]$ is a random vector representing the unobservable characteristics of the consumer or attributes of the commodities. Finally, $\mathbf{s} = [s_1, s_2, \ldots, s_L]$ is an L-dimensional vector with observed characteristics of the consumer.

The consumer's problem is to choose x and z to maximize utility subject to the budget constraint:

$$(2)\qquad \sum_{i=1}^{R} p_i x_i + z = y,$$

where p_i is the price for the ith alternative of the first good and y is income. The form of the utility function (1) implies linear indifference curves between the different varieties, implying the consumer prefers to buy only one alternative at a time.[2] Alternative i is preferred to alternative j if:

$$(3)\qquad \frac{\psi_i(.)}{p_i} > \frac{\psi_j(.)}{p_j}, \quad \forall j = 1,\ldots,R \text{ and } i \neq j.$$

To complete the stochastic specification of the random utility model a specific functional form for the ψ_js needs to be selected. The following form is assumed:

$$(4)\qquad \psi_i(\mathbf{b}_i,\mathbf{s},\varepsilon_i) = \exp(\boldsymbol{\alpha}'\mathbf{s} + \boldsymbol{\gamma}'\mathbf{b}_i + \varepsilon_i),$$

where $\boldsymbol{\alpha}_l$ and the $\boldsymbol{\gamma}$ are parameter vectors. Substituting Equation (4) into Equation (3), taking natural logarithms on both sides of condition (3) and rearranging terms, the condition specifying the choice of the ith alternative is as follows:

$$(5)\qquad \begin{aligned}\varepsilon_i - \varepsilon_j > {} & [\alpha'\boldsymbol{s} + \gamma'\boldsymbol{b}_i - \log p_i] \\ & - [\alpha'\boldsymbol{s} + \gamma'\boldsymbol{b}_j - \log p_j].\end{aligned}$$

If we denote π_i as the probability of selecting alternative i, and make $v_i = \boldsymbol{\alpha}'\mathbf{s} + \boldsymbol{\gamma}'\mathbf{b}_i - \log p_i$, then

$$(6)\qquad \begin{aligned}\pi_i &= \text{Prob}(\varepsilon_i - \varepsilon_j > v_i - v_j) \\ &= 1 - \text{Prob}(\varepsilon_i - \varepsilon_j < v_i - v_j) \\ &= 1 - F(v_i - v_j),\end{aligned}$$

where $F(.)$ is the frequency distribution of $\varepsilon_i - \varepsilon_j$. If the ε_js are assumed to be independent and identically distributed according to an extreme value distribution, then π_i follows a conditional multinomial logit model of discrete choice (Hanemann):

$$(7)\qquad \pi_i = \frac{\exp\left[\bar{\boldsymbol{\alpha}}'\mathbf{s} + \bar{\boldsymbol{\gamma}}'\mathbf{b}_i - \frac{1}{\mu}\log p_i\right]}{\sum_{j=1}^{R}\exp\left[\bar{\boldsymbol{\alpha}}'\mathbf{s} + \bar{\boldsymbol{\gamma}}'\mathbf{b}_j - \frac{1}{\mu}\log p_i\right]}$$

[2] In our study, although it is possible for a customer to buy both types of fruits, only 12 of 1,052 customers attending strawberry operations and only 2 of the 396 customers attending grape operations purchased both prepicked and pick-your-own fruit.

where μ is a parameter defining the extreme value distribution, $\bar{\boldsymbol{\alpha}} = \boldsymbol{\alpha}/\mu$, $\bar{\gamma} = \gamma/\mu$. One important feature of Equation (7) is that the term $\bar{\boldsymbol{\alpha}}$**'s** does not vary across alternative choices; therefore it should be dropped from the model. However, to allow for individual specific effects, a set of dummy variables for the choices can be created and multiplied by $\bar{\boldsymbol{\alpha}}$**'s**. To avoid singularity, one set of the interaction terms, including the dummies, has to be eliminated (Greene).

An alternative functional form to Equation (4) is

$$(8) \quad \psi_i(\mathbf{b}_i,\mathbf{s},\varepsilon_i) = \exp\Big(\gamma(\mathbf{s})'\mathbf{b}_i + \varepsilon_i\Big).$$

Under this specification, the parameter vector $\gamma(\mathbf{s})$ is not fixed for all individuals, but varies as a function of the observed characteristics of the individuals. A derivation similar to the one used to derive Equation (7), but using Equation (8) instead of Equation (4), results in the random parameter logit model (Train):

$$(9)\ \pi_{in} = \int \left(\frac{\gamma'(s_n)\boldsymbol{b}_i - \frac{1}{\mu(s_n)}\log p_i}{\sum_{j=1}^{R}\left[\bar{\gamma}'(s_n)\boldsymbol{b}_j - \frac{1}{\mu(s_n)}\log p_i\right]} \right) f(\beta|\boldsymbol{b},\boldsymbol{W}),$$

where π_{in} is the probability that an individual n would choose the ith alternative, $\bar{\gamma}'(\mathbf{s}_n)$ and $\mu(\mathbf{s}_n)$ are random parameters that depend on the observed characteristics of the individuals, $\bar{\gamma}'(\mathbf{s}_n) = \gamma'(\mathbf{s}_n)/\mu(\mathbf{s}_n)$, $f(\boldsymbol{\beta}|\mathbf{b},\mathbf{W})$ is a density function with mean **b** and covariance **W** that need to be estimated. From this formulation two types of parameters can be identified: the parameter vector $\boldsymbol{\beta} = [\bar{\gamma}'(\mathbf{s}_n), 1/\mu(\mathbf{s}_n)]$, which enters the logit formula and has density $f(\boldsymbol{\beta})$, and the parameters **b** and **W**, which describe the density $f(\boldsymbol{\beta})$. Estimation of the parameters **b** and **W** can be performed using simulation procedures (Train).

Data and Empirical Model

Strawberry Data

The data used in this study are from a consumer survey conducted by the North Carolina Strawberry Association in cooperation with the North Carolina Department of Agriculture and Consumer Services, and the Department of Agricultural and Resource Economics at North Carolina State University. The survey was conducted at eight direct-market strawberry operations throughout the state during the spring of 1999. The operations were selected on the basis of three factors. First, the growers would cooperate with the survey. For example, the strawberry survey lasted for 6 days (Monday through Saturday) and not all growers wanted to put up with the disruption that goes with conducting a survey for that length of time. Second, the operations offered both PYO and prepick berries. Finally, the cooperating growers were spread out over the production region. Since normal harvest dates vary by region, the surveys were completed in April in the Coastal (eastern) area, early May in the Piedmont (central) region, and late May in the Southern Foothills (western) region.[3]

Each operation offered customers two options for buying strawberries: they could either pick their own strawberries (PYO strawberries, PYOS) from the growers' field, or they could buy prepicked strawberries (PPS) at the grower's fruit stand. A total of 1,701 customers were interviewed, but only 1,072 valid surveys were used in the analysis.

Table 1 provides the descriptive statistics of the characteristics of the sample of customers visiting the strawberry operations. Slightly more than half of these customers (51%) bought PPS, whereas 49% bought PYOS. On average, PYOS customers paid 52 cents less than PPS customers. The average shopper traveled 17 miles and was 51 years old. About half of the customers (52%) lived in rural areas and 70% of the buyers were repeat customers.

Grape Data

A consumer survey was conducted during September 2001 at four muscadine grape

[3] The Southern Foothills of North Carolina are a transition zone between the Piedmont and Mountain regions.

Table 1. Summary Statistics of Variables of the Sample of Strawberry Customers

	Pick-Your-Own Strawberries (PYOS) Customers (532 Customers)				Prepicked Strawberries (PPS) Customers (540 Customers)			
Variable	Mean	Std.	Min.	Max.	Mean	Std.	Min.	Max.
Price PPS ($/lb.)	1.35	0.31	0.90	1.71	1.46	0.22	0.90	1.71
Price PYOS ($/lb.)	0.86	0.11	0.70	1.05	0.88	0.07	0.70	1.05
New customers (1 = Yes, 0 = No)	0.36	0.48	0.00	1.00	0.24	0.43	0.00	1.00
Age (years)	48.85	16.18	18.00	88.00	53.71	15.36	21.00	92.00
Children in household (1 = Yes, 0 = No)	0.47	0.50	0.00	1.00	0.30	0.46	0.00	1.00
Distance traveled (miles)	14.25	46.62	1.00	250.00	19.45	50.17	14.49	24.24
No. people in household working >40 hours	1.10	1.11	0.00	5.00	1.01	1.01	0.00	5.00
No. people in household working <40 hours	0.36	1.34	0.00	5.00	0.18	0.45	0.00	3.00
No. retired members in household	0.48	0.77	0.00	3.00	0.59	0.83	0.00	3.00
Current residence in urban area (1 = Yes, 0 = No)	0.50	0.50	0.00	1.00	0.46	0.50	0.00	1.00
Residence of parents in urban area (1 = Yes, 0 = No)	0.38	0.48	0.00	1.00	0.37	0.48	0.00	1.00
Eastern region[a] (1 = Yes, 0 = No)	0.20	0.43	0.00	1.00	0.50	0.50	0.00	1.00
Central region (1 = Yes, 0 = No)	0.37	0.48	0.00	1.00	0.12	0.32	0.00	1.00
Western region (1 = Yes, 0 = No)	0.39	0.49	0.00	1.00	0.38	0.48	0.00	1.00
Visit during weekend (1 = Yes, 0 = No)	0.23	0.42	0.00	1.00	0.26	0.44	0.00	1.00
Children in household (1 = Yes, 0 = No)	0.46	0.50	0.00	1.00	0.31	0.46	0.00	1.00

[a] The mean values corresponding to the region of location dummies indicate the proportion of PYOS or prepick berries customers attending operations located in each region.

operations throughout North Carolina. These operations also offered customers the options of picking their own grapes (PYO grapes, PYOG) from the grower's vineyard, or buying prepicked grapes (PPG) at the grower's fruit stand. The grape operations were selected using the same criteria used to choose the strawberry operations and located in the same regions identified previously. A total of 429 customers was randomly selected to participate in the survey, but only 365 valid surveys were used in the analysis.

Table 2 shows the descriptive statistics for the sample of customers who visited the grape operations. Only about one-third of the customers bought PPG (35%), whereas the other two-thirds of the customers purchased PYOG (65%). On average, PYOG customers paid 18 cents less than PPG customers. The average customer was 51 years old and traveled 28 miles to the farm. Thirty-eight percent of the customers had children, 49% had at least one retired person in the household, and 70% of the buyers were repeat customers.

The dissimilarity between some of the characteristics of consumer groups visiting the strawberry and grape operations indicates that they are distinctly different fruits. For example, muscadine grape operations seem to rely more on repeat customers than strawberry operations (76% versus 70%, respectively). A reviewer suggested that this might be due to the unique sensory characteristics of muscadines that require consumers to develop a taste for them (see also Leong). This result also points to the need for muscadine grape producers to include consumer education as a component of their marketing efforts, especially with respect to North Carolina residents who have migrated from other (nonsouthern) states. Also, the proportion of grape customers purchasing PYO fruit was higher than the proportion of strawberry

Table 2. Summary Statistics of Variables of the Sample of Muscadine Grapes Customers

	Pick-Your-Own Grapes (PYOG) Customers (219 Customers)				Prepicked Grapes (PPG) Customers (146 Customers)			
Variable	Mean	Std.	Min.	Max.	Mean	Std.	Min.	Max.
Price PPG ($/lb.)	1.12	0.11	1.00	1.25	1.14	0.10	1.00	1.25
Price PYOG ($/lb.)	0.95	0.05	0.90	1.00	0.96	0.05	0.90	1.00
New customers (1 = Yes, 0 = No)	0.22	0.42	0.00	1.00	0.25	0.44	0.00	1.00
Age (years)	50.02	15.21	19.00	85.00	52.00	15.86	23.00	96.00
Children in household (1 = Yes, 0 = No)	0.39	0.49	0.00	1.00	0.32	0.47	0.00	1.00
Distance traveled (miles)	32.43	72.60	0.00	250.00	16.80	18.32	0.00	120.00
No. people in household working >40 hours	1.23	0.85	0.00	4.00	1.15	0.99	0.00	4.00
No. people in household working <40 hours	0.22	0.53	0.00	3.00	0.29	0.57	0.00	3.00
No. retired members in household	0.71	0.85	0.00	3.00	0.75	0.93	0.00	4.00
Eastern region[a] (1 = Yes, 0 = No)	0.32	0.47	0.00	1.00	0.12	0.32	0.00	1.00
Central region (1 = Yes, 0 = No)	0.47	0.48	0.00	1.00	0.61	0.49	0.00	1.00
Western region (1 = Yes, 0 = No)	0.21	0.41	0.00	1.00	0.27	0.44	0.00	1.00
Visit during weekend (1 = Yes, 0 = No)	0.23	0.42	0.00	1.00	0.25	0.43	0.00	1.00
White[b] (1 = Yes, 0 = No)	0.38	0.50	0.00	1.00	0.62	0.49	0.00	1.00
African American (1 = Yes, 0 = No)	0.61	0.48	0.00	1.00	0.37	0.48	0.00	1.00
Visit during weekend (1 = Yes, 0 = No)	0.23	0.42	0.00	1.00	0.26	0.44	0.00	1.00
Children in household (1 = Yes, 0 = No)	0.46	0.50	0.00	1.00	0.31	0.46	0.00	1.00

[a] Mean values corresponding to the region of location dummies indicate the proportion of PYO or prepick fruit customers attending operations located in each region.

[b] Mean values corresponding to white and African-American customers indicate the proportion of PYO or prepick fruit customers of those ethnic backgrounds. Because of space limitations, data for other races were not included in the table.

customers harvesting their own fruit. This finding suggests that muscadine grapes are more conducive to PYO marketing than strawberries.

Brown's inventory of literature on direct-market operations found that the most important factor in the composition of the customer base of farmers' markets was location. This finding is confirmed in these surveys since the average strawberry customer only traveled 17 miles, whereas the average grape customer traveled 26 miles.

The studies reviewed by Brown also revealed that most of the customers at farmers' markets are Caucasian, middle-aged, middle-income or above, well-educated women. The survey on strawberry operations did not report race; however, the survey on grape operations indicated that about 50% of the customers were African American. These surveys also showed that most of the customers were middle aged. The average income of the strawberry customers was much higher than the average income of the grape customers. In general, these results indicate that although there are some common characteristics shared by customers attending direct-market operations, it is very difficult to make generalizations.

The Income Variable

Both surveys reported income in intervals (discrete) form rather than continuous form. The income variable falls only in a certain interval, with both end intervals being open ended. Transforming the data from discrete to continuous saves degrees of freedom in the estimation and facilitates the interpretation of the coefficients. A procedure developed by Stewart was used to transform the variables. This method assigns each observation its conditional expectation:

$$E(I_i|A_{k-1} < I \leq A_k, \mathbf{w}_i) = \mathbf{w}'_i\boldsymbol{\beta} + \sigma\left[\frac{\phi(Z_{k-1}) - \phi(Z_k)}{\Phi(Z_k) - \Phi(Z_{k-1})}\right], \tag{10}$$

where I_i is the unobserved income for the ith household, $\mathbf{w}_i$ and $\boldsymbol{\beta}$ are both $kx1$ vectors representing regressors and unknown parameters respectively, A_k and A_{k-1} are the boundary values for the kth interval, $Z_k = (A_k - \mathbf{w}'_i\,\boldsymbol{\beta})/\sigma$, σ is the standard deviation, and Φ and ϕ are the normal cumulative and normal probability density functions. Parameter estimates for $\boldsymbol{\beta}$ and σ can be obtained by using maximum likelihood estimation procedures (Bhat; Stewart). The vector of regressors $\mathbf{w}_i$ included age, race, location of residence, number of household members working more than 40 hours, number of household members working less than 40 hours, and number of retired persons in the household. Estimation results were robust to the choice of values for the upper and lower end intervals. Detailed results from these auxiliary regressions are available from the authors upon request.

Empirical Model

The empirical implementation of model Equations (7) and (9) did not include any quality characteristic b_{ik}. The only variables included in the models were the natural logarithm of the price of the two types of fruit and several sociodemographic characteristics of the consumers (Table 3), including the region of location of the operations. Even though it can be argued that the difference in prices also reflects difference in quality characteristics, other quality measures could also have been collected during the surveys (e.g., grape variety), but were not.

The variables related to work status, visits during the weekend, and income are thought to capture the customer's opportunity cost of time. Households where several of the members work more than 40 hours per week, visiting the operations during the weekdays, and with higher incomes were hypothesized to be less likely to buy PYO fruits. Other variables were included to capture the customers' valuation of the visit as a recreational activity, as well as cultural factors and habits affecting their decisions. For example, it was expected that a family with children living in an urban area would value more picking their own fruit than buying it at the stand. However, variables such as the presence of children in the household might also capture the opportunity cost of time effect.[4] Therefore, the parameter estimates corresponding to each sociodemographic variable should be interpreted as the effects of the variables in a reduced-form discrete-choice model.

To avoid singularity problems, of the three dummy variables created to represent the location of the operations (eastern, central, and western) regions, only the eastern and central regions were included in the model. Likewise, of the three dummy variables created to identify the race of the respondents, only the dummies for white and African-American respondents were included in the grapes model. The dummy variable for other races (Asian, Hispanic or Latino origin, and other), which represented less than 1% of the customers, was excluded from the choice model.

Results

Random parameter[s] logit models using the price parameter as the random parameter were initially estimated (Equation [9]). However, the statistical tests did not reject the null hypothesis that the random parameters logit and the conditional logit models (Equation [7]) are equal ($\chi^2[14] = 10.32$, $p = 0.73$ for the strawberry model; and $\chi^2(12) = 10.22$, $p = 0.60$ for the grapes model). Therefore the conditional multinomial logit models were selected for further analysis (Table 3). This result suggests that the price parameter is constant across groups of individuals belonging to different sociodemographic groups and the region of location of the operations.

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[4] We thank a reviewer for making this point.

Table 3. Conditional Logit Models for the Decision to Buy Prepicked or Pick-Your-Own (PYO) Strawberries and Grapes

	Strawberries Model		Grapes Model	
Variable	Coefficient	Std. Error	Coefficient	Std. Error
PYO_Constant	−5.257***	1.682	−1.110***	2.442
PYO_Const. × first visit to the farm	0.243*	0.158	−0.352	0.299
PYO_Const. × miles traveled	0.001	0.001	0.008*	0.005
PYO_Const. × no. people in household working >40 hr.	0.092	0.085	−0.143	0.183
PYO_Const. × no. people in household working <40 hr.	0.306**	0.133	−0.236	0.235
PYO_Const. × no. retired members in household	0.188*	0.128	−0.080	0.174
PYO_Const. × age of the respondent	−0.021***	0.007	0.011	0.010
PYO_Const. × eastern region	3.162***	0.459	1.592***	0.399
PYO_Const. × central region	3.912***	0.386	−0.136	0.291
PYO_Const. × white	n.a.[a]	n.a.	−0.906*	0.684
PYO_Const. × African American	n.a.	n.a.	−0.094	0.674
PYO_Const. × urban residence	0.391**	0.161	n.a.	n.a.
PYO_Const. × urban residence of parents	−0.385**	0.166	n.a.	n.a.
PYO_Const. × visit during weekend	−0.506***	0.178	0.124	0.280
PYO_Const. × children in household	0.516***	0.184	0.336	0.296
PYO_Const. × ln (income)	−0.204*	0.120	−0.097	0.219
Ln(price)	−13.361***	1.451	−12.839***	3.053
Log-likelihood function	−574.740		−201.080	

[a] n.a., not available.
***, **, and *, significance levels of 0.01, 0.05, and 0.10, respectively.

Marginal Effects and Elasticities

Strawberry model. Table 4 displays the elasticities and marginal effects of the explanatory variables for the strawberry model. The fact that both the own-price and cross-price elasticities are equal is an implication of the conditional multinomial logit for the case where only two alternatives are available. The own-price elasticity values imply that a 1% increase in own price would decrease the probability that the customer will buy that type of strawberry by 7%, and it also increases the probability that the customer will buy the other type of strawberry by 7%. With an average price of around $1/lb. of strawberries, these elasticities suggest that customers are very sensitive to prices.

The marginal effects of the explanatory variables are the effects in relation to an individual with characteristics of the dummy variables, which were not included in the model (that is, an individual who is a repeat customer, in the western region of North Carolina, currently living in a rural area, with parents living in a rural area, visiting the operation during the weekdays, and without children). Relative to this type of customer, a customer in the central region and one in the eastern region are, respectively, 55% and 33% more likely to buy PYOS. This indicates a very important effect for region of location of the operations in the decision to buy PYOS or PPS. This effect might be capturing characteristics of the individuals living in that area and also of the farms located in that region. Unfortunately, characteristics of the operations were not included in the survey. All of the other dummy variables included in the model only change the probability of buying PYOS or PPS (positively or negatively) by less than 10%.

The marginal effects of the continuous variables represent the change in the probability of choosing an alternative by one unit change in

Table 4. Elasticities and Marginal Effects from the Logit Models for the Decision to Buy Prepicked (PPS) or Pick-Your-Own Strawberries (PYOS)

	PYOS		PPS	
Variable	Parameter	Std. Error	Parameters	Std. Error
	Elasticities			
Price PYOS	−6.719***	1.117	6.642***	1.111
Price PPS	6.719***	1.117	−6.642***	1.111
Income	−1.026***	0.069	1.026***	0.069
	Marginal Effects			
First visit to farm	0.046*	0.032	−0.046*	0.032
Miles traveled	0.000	0.915	−0.000	0.915
No. people in household working >40 h	−0.017	0.017	0.017	0.017
No. people in household working <40 h	0.057**	0.027	−0.057**	0.027
No. retired members in household	0.035*	0.026	−0.035*	0.026
Age of the respondent	−0.004***	0.001	0.004***	0.001
Eastern region	0.331***	0.053	−0.331***	0.053
Central region	0.556***	0.055	−0.556***	0.055
Urban residence	0.073**	0.032	−0.073**	0.032
Urban residence of parents	−0.071**	0.033	0.071**	0.033
Visit during weekend	−0.094***	0.036	0.094***	0.036
Children in household	0.098***	0.038	−0.098***	0.038

***, **, and *, significance levels of 0.01, 0.05 and 0.10, respectively.

the variable. Each additional person in the household working less than 40 hours a week and each additional person in the household who is retired increases the probability that the household will buy PYOS by 6% and 4%, respectively. These effects do not seem to be very important given the fact that most of the households are only composed of one or two adults. With regard to the age of the respondent, a 1-year increase in the age of the respondent decreases the probability of purchasing PYOS by only 0.04%. The marginal effects of the other variables included in the model are not statistically significant and the values of marginal effects are not economically important.

Finally, notice that the marginal effects (and the elasticities) of the characteristics of the individuals are equal in absolute value but with different signs for both alternatives. This is another implication of the conditional logit model. For example, the income elasticity implies that a 1% increase in income would result in a 1% increase in the probability of buying PYOS and a decrease of 1% in the probability of buying PPS.

Muscadine grape model. Elasticities and marginal effects for the muscadine grape model are shown in Table 5. PPG are more elastic than PYOG. A 1% increase in the own price decreases the probability of buying PYOG and PPG by 5% and 8%, respectively. As in the case of strawberries, this implies that customers are very responsive to price changes. With an average price of about $1/lb., a small price change will have a very large effect on the probability of buying any of the two types of grapes. The intercept term in the grape model reflects an individual who went to an operation in the western part of the state, of a race different from white or African American, without children in the household, and who visited the farm during a weekday. Compared with this customer, a customer visiting an operation in the eastern part of the state is about 30% more likely to buy PYOG. The dummy variable for white households, although not statistically significant, represents an 18% increase in the probability of buying PYOG compared with the type of customer reflected in the intercept. The value

Table 5. Elasticities and Marginal Effects of the Explanatory Variables from Logit Models for the Decision to Buy Prepicked (PPG) or Pick-Your-Own Grapes (PYOG)

	PYOG		PPG	
Variable	Parameter	Std. Error	Parameters	Std. Error
	Elasticities			
Price PYOG	−5.027***	1.861	7.812***	2.342
Price PPG	5.027***	1.861	−7.812***	2.342
Income	−0.038	0.098	0.038	0.098
	Marginal Effects			
First visit to farm	−0.069	0.062	0.069	0.062
Miles traveled	0.002*	0.001	−0.002*	0.001
No. people in household working >40 h	−0.028	0.037	0.028	0.037
No. people in household working <40 h	−0.045	0.048	0.045	0.048
No. retired members in household	−0.015	0.035	0.015	0.035
Age of respondent	−0.002	0.002	0.002	0.002
Eastern region	0.287***	0.081	−0.287***	0.081
Central region	−0.026	0.059	0.026	0.059
White	0.181	0.144	−0.181	0.144
African American	−0.018	0.133	0.018	0.133
Visit during weekend	0.024	0.057	−0.024	0.057
Children in household	0.064	0.059	−0.064	0.059

***, **, and *, significance levels of 0.01, 0.05, and 0.10, respectively.

of the marginal effect for miles traveled indicates that each additional mile that a customer drives to get to the operation increases the probability of buying PYOG by 0.2%. The marginal effects of all the other variables included in the models are not statistically significant and their values seem not to be economically important.

Relative Importance of Explanatory Variables

Even though the values of the marginal effects and the elasticities of the explanatory variables are measures of the importance of these variables explaining an outcome (i.e., the dependent variable), they have at least two problems. First, these measures are conditional on the contribution of the other variables. For example, in this study price elasticities measure the percentage change in the probability of choosing one type of fruit given a 1% change in the price, "all else being equal." Therefore, they do not take into account the fact that some of the explanatory variables are correlated. The second problem with the use of marginal effects and elasticities as a measure of relative importance is the fact that their values are difficult to compare given the different units in which the variables are measured, the different ranges of variation, and the presence of both discrete and continuous explanatory variables.

Methods developed to analyze the relative importance of explanatory variables focus mainly on the linear regression model and are used mainly in psychometrics and management science (Johnson and Lebreton). Relative importance analysis for logistic regression has received some attention in medicine (e.g., Heinze and Schemper).

In this study we follow the procedures proposed by Soofi and Soofi, Retzer, and Yasai-Ardekani to analyze the relative importance of the explanatory variables included in our models of PYO versus prepicked fruit choice. Using concepts of information theoretic statistics, Soofi proposes a set of diagnostics for the evaluation of the relative importance of attributes in the logit model. These diagnostics are based on several information indices. The joint importance of a set of M explanatory variables in a conditional logit model is given by the information index $I_{\pi*}(1,.., M)$:

$$I_{\pi^*}(1,\ldots,M) = \frac{H(\pi*) - H(U)}{H(U)} = 1 - \frac{H(\pi*)}{H(U)}, \tag{11}$$

where $H(\pi^*)$ is the negative of the log-likelihood function of the conditional logit model evaluated at the estimated maximum likelihood estimates, and $H(U)$ is the negative of the log-likelihood function of a conditional logit model with no covariates and no constant term.[5] Soofi, Retzer, and Yasai-Ardekani interpret this index as the contribution of the explanatory variables to the reduction of uncertainty (total entropy) about the prediction of the alternatives. This information index corresponds to McFadden's likelihood ratio index, which is bounded between 0 and 1 and is used as a common measure of goodness of fit of the conditional logit model (Greene). Since maximum likelihood estimation attempts to minimize the likelihood function, this index can be seen as the proportional reduction in the −2 log-likelihood statistic (Menard).

Other information indices defined by Soofi are the simple information index and the partial information index. The simple information index of an explanatory variable $I_{\pi*}(m)$, $m = 1, \ldots, M$, measures the contribution in the reduction of uncertainty of each explanatory variable when there is only a single explanatory variable in the model. The partial information index measures the contribution to the uncertainty reduction of the mth attribute over and above the other M − 1 attributes. This can be expressed as:

$$I_{\pi^*}(m;1,\ldots,m-1) = \frac{H[\pi^*(1,\ldots,m-1)] - H[\pi^*(1,\ldots,m)]}{H(U)}, \tag{12}$$

where $H[\pi^*(1, \ldots, m)]$ is the negative of the log-likelihood function of a model containing m explanatory variables. As pointed out by Soofi, the information index, the simple information index, and the partial information indices are similar to the multiple, simple, and partial correlation coefficients used in linear regression. The information index can be decomposed as the sum of simple and partial information indices:

$$I_{\pi^*}(1,\ldots,M) = I_{\pi*}(1) + I_{\pi*}(2;1) + (3;1,2) + \ldots + I_{\pi*}(M;1,\ldots,M-1). \tag{13}$$

This decomposition can then be used to characterize the relative importance of the M explanatory variables if the order $1, \ldots, M$ is the relevant order. However, since in most of the cases a relevant order for the explanatory variables is not present, Soofi proposes using the $M!$ decompositions of type (13). The relative importance of each variable is measured using the average of the simple and partial information indices over all possible $M!$ decompositions.

Three other features of Soofi's procedure to analyze the relative importance of explanatory variables in the conditional logit are worth mentioning. First, the procedure is robust to the presence of multicollinearity. As shown in Grömping (2006, 2007), averaging over orders procedures of relative importance analysis such as Soofi's method are well suited for the case where regressors are correlated. Second, relative importance analysis can be performed not only for individual variables but also for groups of explanatory variables. Finally, confidence intervals for the relative importance indices can be obtained using bootstrapping procedures.

Bootstrapping procedures have been proposed to obtain confidence intervals of relative importance measures in the context of linear regression models (Azen and Budescu; Johnson) and we adopt this approach here. A total of 599 bootstrap samples was obtained and then used to calculate 95% confidence intervals.

Tables 6 and 7 show the summary of the analysis of relative importance for the strawberry and muscadine grape models. Table 6

[5] $H(\pi^*) = -\sum_{j=1}^{N}\sum_{r=1}^{R}\ln\hat{\pi}_{ir}$, where N is the number of individuals in the sample, R is the number of alternatives, $\delta_{ir} = 1$ if individual n chooses alternative r, and 0 otherwise, and $\hat{\pi}_{ir}$ is given in Equation (7). $H(U) = -N\ ln R$.

Table 6. Relative Importance of Explanatory Variables in the Strawberries and Grapes Models

	Strawberries Models			Grapes Model		
Variable	Simple Index	Partial Index	Relative Importance Index	Simple Index	Partial Index	Relative Importance Index
Intercept	0.000	0.007	0.013 (0.010–0.019)[a]	0.034	0.000	0.014 (0.008–0.028)[a]
Price	0.004	0.072	0.043 (0.030–0.060)	0.051	0.038	0.038 (0.015–0.073)
Region of location of operations (eastern, western and central regions)	0.088	0.114	0.098 (0.075–0.127)	0.080	0.055	0.058 (0.028–0.106)
Sociodemographic characteristics	0.050	0.043	0.057 (0.045–0.090)	0.107	0.044	0.072 (0.059–0.146)

[a] Numbers between parentheses are the lower and upper bounds of a 95% confidence interval.

displays the relative importance indices for the intercept, the price variable, the region of location of the operations, and the group of sociodemographic characteristics of the consumers. The region of location of the operation variables were considered separately from the sociodemographic variables since they also capture characteristics of the operation. Table 7 contains the relative importance indices of the sociodemographic characteristics separately.

The relative importance index in Table 6 identifies the region of location of the operation as the most important group of variables explaining the variability in the PYOS versus PPS model, followed by the group of sociodemographic characteristics, the price variable, and the intercept. According to this index, the regional variables are about twice as important as price and the other sociodemographic characteristics. The group of sociodemographic characteristics is found to be more important than the region of location of the operations and the price in the grape model (Table 6).

When the explanatory variables are analyzed separately (Table 7), the region of location of the operation variables also appear as the most important explanatory variables in both models, followed by price. Even though the group of sociodemographic characteristics is the second most important group in Table 6, when the sociodemographic characteristics are considered individually in Table 7, price is more important than all the sociodemographic characteristics. However, in the grape model, race of the household is almost as important as the price.

The regional variables appear as the most important variables in the models. As mentioned previously, the regional variables capture characteristics of the individuals and the operations located in that region. Therefore it is possible that the omission of other relevant variables cause the regional dummy variables to appear as relatively more important than other variables. For example, most of the operations in the central part of the state are located in counties comprising the Research Triangle, home to numerous high-tech companies and enterprises and three major research universities. The region of location variable might be capturing some demographic characteristics common to individuals living in the region not included in the models. In the case of the strawberry survey, the region of location variable could also be capturing the timing of the survey, since the surveys were completed in different time periods.

Summary and Conclusions

This study utilizes cross-sectional data to identify the most important factors affecting

Table 7. Relative Importance of Explanatory Variables in the Strawberries and Grapes Models

	Relative Importance Index	
Variable	Strawberries Model	Grapes Model
Price	0.046	0.036
Region of location of operations (eastern, western, and central regions)	0.097	0.054
Work status of household members (number of people in household working more or less than 40 h and retired)	0.011	0.008
Residence (current residence and residence of parents)	0.004	n.a.[a]
Race (white, African American)	n.a.	0.033
First visit to operation	0.006	0.002
Visit during weekend	0.005	0.007
Children in household	0.011	0.005
Age of respondent	0.010	0.005
Miles traveled to operation	0.001	0.021
Income	0.010	0.007

[a] n.a., not available.

customers' decisions to buy PYOS and PYOG versus PPS and PPG at direct-market operations in North Carolina. A major contribution of this paper is the analysis of price effects, a topic not considered in previous studies. Data obtained from surveys conducted at direct-market operations are used to estimate logit models for discrete choice. This paper also highlights the value of differentiating between statistical and economic significance and the usefulness of assessing the relative importance of the explanatory variables in a model.

The results of the relative importance analysis and the calculated price elasticities reveal the significance of prices in the customers' decision to choose PYO versus prepicked fruit. The estimated price elasticities (own-price and cross-price) indicate that sales of each type of fruit are very sensitive to prices. These findings contrast with the customer response to another part of the survey where customers indicated price as one of the least important factors in their decision to buy or pick fruit behind freshness, taste, firmness, fruit color, and fruit size (Safley et al.; Safley, Wohlgenant, and Suter). Therefore, even though customers indicate that price is not important in their purchase decisions, our study shows that the price differential between the two types of fruits can increase or decrease the proportion of fruit that is sold at the stand or picked by the customer. This result underscores the relevance of analyzing relative importance using revealed preferences rather than relying uniquely on customers' stated responses.

The relative importance analysis identified the region of location of the operations followed by changes in the relative prices of fruit at the alternative outlets as the most important variables affecting the customer's decision to choose the type of fruit to purchase. The consistency of the results across two different data sets provides strong support for the robustness of the results. These results suggest that farmers interested in starting PYO operations should analyze carefully the characteristics of their local markets rather than relying only on national or state market trends. However, future research on the subject should include more detailed characteristics of the operations such as the presence of recreational amenities other than the picking experience.

Examination of the marginal effects and the relative importance analysis identify the sociodemographic characteristics that explain most of the variation in the customers' selection of PYO or prepicked fruit. For customers visiting the strawberry operations the most important sociodemographic characteristics are work status, the presence of children in the household, the age of the respondent, and income level. The respondent's race and miles traveled are the most important sociodemographic characteristics for grape farm visitors.

This information should be helpful in the design and implementation of marketing strategies to target potential customers. For example, because the presence of children in the household was found to be an important determinant in the decision to buy PYOS, strawberry producers could increase the number of customers buying PYO fruit by making the farm more attractive to families with children. Some restaurants have adopted similar strategies with the addition of playgrounds. The sociodemographic information can be used to optimize advertising efforts by focusing on neighborhoods (or using radio stations) with the most desirable customer profile.

Direct sales of fruits by farmers can be a very important source of income. For example, in 2006 the average price received by North Carolina muscadine grape farmers from processors was only \$0.28/lb., which is well below the average prices of \$0.87/lb. and \$1.39/lb. observed in the survey for PYOG and PPG, respectively.

The differences between the characteristics of consumer groups visiting the strawberry and grape operations and the different effects of explanatory variables found as important determinants of the decision to buy PYO versus prepicked fruit in the strawberry and muscadine grape models provide some evidence that consumer groups attending direct-market operations may differ depending on the type of direct-market outlet (e.g., roadside stands versus PYO operations) and even between the different types of agricultural products being sold at these markets. This result points to the need for more research studying customers attending the different types of farmer-to-consumer direct markets.

Since consumers' tastes and preferences change over time, it is possible that the results of this study may no longer represent current market conditions. However, these are the only data sets available to analyze consumer behavior at PYO operations. Over time, as newer data become available, researchers can make use of our results to compare and monitor changes. The methodology developed and presented in this paper should prove useful in understanding consumer behavior and in updating the effects of current and future market conditions on PYO fruit operations.

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