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Consumers' Willingness to Pay for Washington Apples with Respect to Sensory Attributes

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Abstract

To evaluate consumers' willingness to pay (WTP) for Washington apples, the effects of firmness and sweetness as the representative sensory attributes are investigated in addition to those of consumer demographics and preferences. A tasting survey was conducted in Portland, Oregon on two varieties of apples, Gala and Red Delicious. Survey data is analyzed by employing a dichotomous-choice contingent valuation method, the double-bounded model, and maximum likelihood estimates are obtained. This study shows that firmer and sweeter apples induce more WTP. Age is also an important factor affecting WTP for apples. Education, eating frequency, and race affect WTP in the Gala model but not the Red Delicious. Other variables, such as gender, annual household income level, and whether they buy organic food, do not add significant explanatory power in estimating consumers' WTP.

I. Introduction

In assessing consumers' willingness to pay (WTP) for apples, the usual approach is to investigate what would have a deterministic impact upon WTP among objective characteristics of apples (such as cultivar, size, grade), consumer demographics (such as age, income, education level), and/or consumption (frequency of purchasing/consuming apples). Little has been done to take into consideration the sensory characteristics of apples, such as taste, texture, and juiciness. In fact, sensory quality is one of the major factors that affect consumers' perception of a product, which in turn affects their purchase behavior for the product. By performing an experiment on cheese tasting, Grunert, et al. (2004) verifies that a positive tasting experience helps improve European consumers' acceptance for genetically modified organisms in food production. Additionally, Brennan and Kuri (2002) discover that once people have developed a preference for a product based on sensory characteristics, it is very unlikely for them to change it. Thus, sensory characteristics have a great influence on sustaining consumers' repeated purchases.

As a result, sensory attributes reflect more and more significance in consumers' preferences of apples. Carew (2000) points out that consumers' demand for apples has shifted from the traditional varieties to newer cultivars due to their taste even though they are not as red and shapely. Therefore, in order to capture these changing preferences, the grading system that is mainly based on apples' appearance needs to be modified to include other standards. Kajikawa (1998) finds that Japanese apple consumers are willing to pay higher prices for higher quality pertaining to characteristics such as weight, brix (sugar level), acidity, firmness, juiciness, color, flavor, texture, etc.

However, in a study of how label characteristics and sensory characteristics relate to prices for Bordeaux wine, Combris, et al. (1997) conclude that the label characteristics have

major impact on the market prices while the sensory characteristics essentially determine the quality of Bordeaux wine, which is graded by a jury of professional wine tasters, but generally does not affect the market price.

The objective for this study is to develop a predictive model that determines the relationship between sensory attributes and WTP for apples. Owing to their importance as internal attributes of apples, sweetness and firmness are chosen to be the representative tasting factors. Their effects on WTP are to be examined along with a series of consumers' demographics and preferences.

A double-bounded dichotomous choice contingent valuation model is employed to estimate the WTP. Its theoretical derivation is presented in Section II. In Section III, the data collecting procedure is explained, and the data statistics are summarized. Estimation results are shown and discussed in Section IV, and then conclusions are drawn in Section V.

II. Methodology

The contingent valuation method (CVM) is frequently applied to discrete survey responses to elicit opinions or preferences on various matters. Single-bounded and double-bounded dichotomous choice are two widely-used bidding methods in CVM for assessing market products or non-market resources (Hanemann, et al. 1991). When performing the single-bounded method, each respondent is asked one dichotomous choice question, which typically sets a dollar-value threshold for a product or service. The response is usually a simple "yes" or "no," depending on the individual's willingness to pay the proposed price for the product or service. The double-bounded method is an extension of the single-bounded method and improves statistical efficiency over the single-bounded method by engaging respondents in two

bids instead of one. A second question associated with higher or lower value is asked based on responses from the first question. If the initial offer is accepted, a premium will be asked; while if the initial offer is rejected, a discount will be offered. Using two sequential bidding questions, boundaries of WTP are therefore observed. Hanemann, et al. (1999) point out that the double-bounded method causes bias when responses to the first and second bid are inconsistent. Nonetheless, as Hanemann et al. conclude, the gain in efficiency largely prevails over the loss in bias, which, furthermore, tends to be moderate.

Answers to the two sequential questions can be sorted into four intervals: $(-\infty, B_D)$ when the first and second answers are both "no", $[B_D, B_I)$ when a discount offer is accepted at the second bid, $[B_I, B_P]$ when a premium is rejected, and $[B_P, +\infty)$ when both answers are "yes". Note that B_I, B_D, and B_P denote initial bid, bid with discount, and bid with premium respectively. Since consumers' WTP is a latent variable and not subject to direct observation, the sequential questions serve to place upper and lower bounds on the true WTP. The outcomes of the bidding procedure can be categorized into the following indices for WTP:

$$Y = \begin{cases} 1 & if \;\; WTP < B_D \\ 2 & if \;\; B_D \le WTP < B_I \\ 3 & if \;\; B_I \le WTP < B_P \\ 4 & if \;\; WTP \ge B_P \end{cases} \qquad (1)$$

The WTP can be expressed as a linear function of explanatory variables and a random effect. The linear functional form is a rational choice. As stated by Kennedy (2003), from past experience, nonlinear functional form has hardly ever provided much improvement. The WTP function for the i th individual is specified as follows.

$$WTP_i = \alpha - \rho B_i + \lambda' x_i + \varepsilon_i \qquad i = 1, 2, \ldots, n \qquad (2)$$

where x represents a vector of explanatory variables such as consumers' demographics and preferences. ε is an error term, which captures unmeasured characteristics and is assumed to follow a certain cumulative distribution F with mean 0 and variance σ^2. B is the final bid that a respondent reaches. In order to be more effective in eliciting consumers' true WTP, different prices, higher or lower than the initial price depending on the first response, were offered to respondents. For example, \$1.19, \$1.29 and \$1.49 were randomly assigned to consumers who responded affirmatively to the initial price, \$0.99 per pound for Gala apples. ρ, λ' are unknown parameters that need to be estimated, as well as the intercept α. As for ρ, it is natural to expect lower willingness to pay associated with higher bids and higher willingness to pay associated with lower bids, thus a negative relationship (i.e. the negative sign in front of ρ) is proposed. Consequently, probabilities for the above choice indices can be specified as:

$$\begin{cases} prob(Y=1) = F(\tilde{\alpha} - \tilde{\rho}B_D + \tilde{\lambda}'x) \\ prob(Y=2) = F(\tilde{\alpha} - \tilde{\rho}B_I + \tilde{\lambda}'x) - F(\tilde{\alpha} - \tilde{\rho}B_D + \tilde{\lambda}'x) \\ prob(Y=3) = F(\tilde{\alpha} - \tilde{\rho}B_P + \tilde{\lambda}'x) - F(\tilde{\alpha} - \tilde{\rho}B_I + \tilde{\lambda}'x) \\ prob(Y=4) = 1 - F(\tilde{\alpha} - \tilde{\rho}B_P + \tilde{\lambda}'x) \end{cases} \tag{3}$$

Note that the tildes indicate that the coefficients are estimated parameters.

Subsequently, the log likelihood function is structured as:

$$LnL = \sum_i \begin{cases} I_{Y_i=1} \ln F(\tilde{\alpha} - \tilde{\rho}B_{D_i} + \tilde{\lambda}'x_i) \\ + I_{Y_i=2} \ln\left[F(\tilde{\alpha} - \tilde{\rho}B_{I_i} + \tilde{\lambda}'x_i) - F(\tilde{\alpha} - \tilde{\rho}B_{D_i} + \tilde{\lambda}'x_i)\right] \\ + I_{Y_i=3} \ln\left[F(\tilde{\alpha} - \tilde{\rho}B_{P_i} + \tilde{\lambda}'x_i) - F(\tilde{\alpha} - \tilde{\rho}B_{I_i} + \tilde{\lambda}'x_i)\right] \\ + I_{Y_i=4} \ln\left[1 - F(\tilde{\alpha} - \tilde{\rho}B_{P_i} + \tilde{\lambda}'x_i)\right] \end{cases} \tag{4}$$

where $I_{Y_i=j}$ is an indicator function for the occurrence of $Y_i = j$ (j =1, 2, 3, 4), and subscript i denotes the i th individual observation.

Assuming the error term follows a cumulative logistic distribution (for computational convenience), the probabilities of WTP indices can be expressed as:

$$\begin{cases} prob(Y=1) = \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}} \\ prob(Y=2) = \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}} - \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}} \\ prob(Y=3) = \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}} - \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}} \\ prob(Y=4) = 1 - \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}} \end{cases} \tag{5}$$

Therefore, the specific log likelihood function is in the following form:

$$LnL = \sum_i \begin{cases} I_{Y_i=1} \ln \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}} \\ + I_{Y_i=2} \ln\left(\dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}} - \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_D+\tilde{\lambda}'x}} \right) \\ + I_{Y_i=3} \ln\left(\dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}} - \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_I+\tilde{\lambda}'x}} \right) \\ + I_{Y_i=4} \ln\left(1 - \dfrac{e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}}{1+e^{\tilde{\alpha}-\tilde{\rho}B_P+\tilde{\lambda}'x}} \right) \end{cases} \tag{6}$$

III. Data

The data in this study came from a cooperative project executed by the Tree Fruit Research and Extension Center at Washington State University and the Food Innovation Center at Oregon State University.

The data was collected through a consumer tasting survey using Gala and Red Delicious apples conducted at an outside public venue, the Portland Saturday Market in April 2004. The survey took 2 days, and on each day only samples of a single variety were distributed to participants. Each participant tasted slices from half of only one apple and then gave answers to a questionnaire inquiring information on consumers' demographic information and apple eating habits, as well as consumer ratings on apples such as scale of liking, acceptability for the firmness and sweetness, and WTP. Overall, 487 responses from the Gala apple tasting and 290 responses from the Red Delicious tasting were obtained. All the responses were collected using ballots on tablet and laptop computers equipped with Compusense 4.5.2 data collection software. The questionnaire that was loaded in Compusense is presented in Appendix.

As presented in Table 1, the majority of the survey respondents for Gala were female (59.8%), as were the majority of the respondents for Red Delicious (58.6%). Among the seven age categories, ages 25 to 34 have the highest percentage of respondents for both Gala (21.1%) and Red Delicious (23.4%). Other age groups all have a considerable share except for ages 65 and above, which only capture 4.7% of the respondents for Gala and 2.1% of the respondents for Red Delicious. Answers to the question on the highest level of formal education show that people with a 4-year college degree accounted for the highest percent of the respondents for both Gala (29.8%) and Red Delicious (23.4%). Of the respondents for the Gala survey, 21.8% reported education level as high school, 17% reported as 2-year college or technical degree,

19.90% reported as advanced degree, and 11.5% declined to answer. Among the Red Delicious respondents, 22.80% of them reported education level as high school, 22.8% of them reported as 2-year college degree, 16.2% of them reported as advanced degree, and 14.80% of them declined to answer. The mode annual household income level is less than $20,000 for Gala and $20,000 to $39,000 for Red Delicious. For the Red Delicious survey, the second highest percentage of the respondents are at $40,000 to $59,000, then as income level increases the percentage of the respondents decreases when it reaches the highest income level there is an increase in the percentage. The major ethnicity group was Caucasian, which accounts for 77% of the Gala survey respondents and 70% of the Red Delicious respondents.

In answering the questionnaire, respondents also revealed their attitudes toward apple consumption and purchase, as well as their tasting preferences. Consumer responses are summarized in Table 2. Participants responded generally positively to the apple samples they tasted. The mean of overall liking on a 0 to 10 scale is 6.96 for Gala and 6.80 for Red Delicious. In addition, 70.6% of the Gala respondents and 69.3% of the Red Delicious respondents expressed the intention for purchase. Most of the respondents agreed that the firmness and sweetness of both apple samples were acceptable. 79.7% of the respondents for Gala rated acceptable on firmness, and 83.0% of the respondents for Gala rated acceptable on sweetness, while for Red Delicious, 77.2% of the respondents rated acceptable on firmness and 86.2% of the respondents rated acceptable on sweetness. An overwhelmingly large portion of those who did not accept the firmness or sweetness of the samples stated that the apples were not firm enough or not sweet enough. The majority of the respondents for Gala (57.7%) and Red Delicious (59.0%) were willing to pay $0.99 per pound for the apples. This is also the amount that was usually paid for apples by the largest fraction of respondents for both Gala (18.5%) and Red

Delicious (18.3%). The distribution statistics of responses to various premiums and discounts for Gala and Red Delicious are available in Tables 3 and 4, respectively. Apple eating frequency indicated that eating more than once a week represented the behavior of the highest percentage of the respondents for both Gala (39.8%) and Red Delicious (33.4%). Only 0.4% of the respondents for Gala and 0.7% of the respondents for Red Delicious responded that they never ate apples. The respondents were also asked about choice of buying organic apples. The greater part of respondents for both Gala (67.1%) and Red Delicious (66.6%) declined it.

IV. Results and Discussion

To derive parameter estimates of models, one for each variety of apples, maximum likelihood is employed as the method of estimation and an optimization program is performed in GAUSS. The following model is used to determine the explanatory variables effect may have impact on consumers' WTP for Gala apples.

$$\begin{aligned} WTP_i^{Gala} &= \alpha - \rho B_i + \lambda_1 Firmness_i + \lambda_2 Sweetness_i + \lambda_3 Age_i + \lambda_4 Education_i \\ &\quad + \lambda_5 Frequency_i + \lambda_6 Race + \varepsilon_i \end{aligned} \tag{7}$$

where B denotes the second bid offered to each respondent and is random. $Firmness$ and $Sweetness$ are both indicator variables, taking the value of 1 when firmness or sweetness is acceptable and 0 otherwise. Age is an indicator variable representing ages 35 and above when it is 1 and representing ages 34 and under when it is 0. $Education$ is an indicator variable representing consumers' level of formal education. It is 1 when indicating 4-year degree college and advance degree, and 0 otherwise. *Frequency* is an indicator variable taking the value of 1 when the eating frequency is daily and more than once a week and 0 otherwise. *Race* is also an indicator variable representing Caucasian when it is 1 and races other than Caucasian when it is

0. As before, subscript i represents the ith individual observation. Surprisingly, consumers' gender does not play an important role in explaining WTP as a result of estimation. Also, buying organic or not seems to be irrelevant to apple consumption. It appears that annual house income does not have much effect over WTP either. Thus, eating apple as a random choice has little to do with income. The parameter estimates and their standard errors, z-tests, and p-values are displayed in Table 5a. The marginal effects of each variable except for the intercept are also estimated and presented in Table 5b. Most of the variables seem to have positive effects on consumers' WTP for Gala apples. Just as expected, *Bid* has a negative relationship with WTP, which is consistent with apple being a normal good. *Age* has a negative effect on WTP, implying that as people grow older they are less willing to accept higher prices for apples. It is confirmed that *Firmness* and *Sweetness* are important affecting factors when it comes to WTP. It is also shown in the results that higher education is associated with higher WTP.

Red Delicious model has fewer significant explanatory variables that may impact consumers' WTP. This time, *Education* , *Frequency*, and *Race* are no longer statistically significant as in the Gala model. The model is depicted in the following equation.

$$WTP_i^{Red\ Delicious} = \alpha - \rho B_i + \lambda_1 Firmness_i + \lambda_2 Sweetness_i + \lambda_3 Age_i + \varepsilon_i \qquad (8)$$

The explanatory variables are defined same as for the Gala model. The parameter estimates and their standard errors, z-tests, p-values are reported in Table 6a, and the marginal effects of each variable except for the intercept are also estimated and presented in Table 6b. *Firmness* and *Sweetness* have positive effects on consumers' WTP for Red Delicious apples. No surprise *Age* has a negative affect on WTP same as for Gala. Once again, it is confirmed that *Firmness* and *Sweetness* are important factors when it comes to consumers' WTP for apples.

V. Conclusion

This study supports the proposition that the sensory attributes, firmness and sweetness, have significantly determined consumers' perception of apples, and therefore greatly affect their WTP. It is clear from this study that firmer and sweeter apples induce more WTP. Age is also an important factor as to WTP for apples. People younger than 35 are more willing to accept higher apple prices. This age factor might not merely pertain to apple consuming. It is a common belief that younger people are less sensitive to higher prices than elder people. Meanwhile, education, eating frequency, and race may or may not have any effect on WTP. Other variables, such as gender, annual household income level, and whether or not they buy organic food, do not add significant explanatory power in estimating consumers' WTP.

Further study can be pursued to examine the interactions among the explanatory variables, and incorporate other explanatory variables that might have been left out in this study. Suppose that one is interested in observing if people in a higher age group with higher education would consume more apples than those that are younger but less educated, thus an interaction with age and education could be added to the model, and its statistical significance would be examined.

Notice that sweetness and firmness are the only apple characteristics taken into account as factors that determine consumers' perception of apples and consequently affect consumers' WTP. Whereas, in fact, there may be other attributes, such as color and juiciness, that also possess such crucial influence. However, due to great subtlety in sensory attributes other than sweetness and firmness, the accuracy of survey results could be problematic.

Interpreting the results should be taken with caution. All the survey objects were only asked hypothetical bidding questions without any budget constraint and no real shopping was

done. The results would have been more realistic and precise if the real shopping behavior instead of answers to the bidding questions was able to be observed. One way to make it happen is offering them gift cards or things in that nature and having them purchase apples so that their action could be recorded. Then again, the cost of executing such a survey with a reasonable number of participants might be intimidating.

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Table 1: Summary Statistics for Demographic Variables

Variable	Description and Coding	Distribution	
		Gala	Red Delicious
Gender	1 Female	59.80%	58.60%
	2 Male	40.20%	41.40%
Age	1 10-17	14.20%	14.80%
	2 18-24	18.30%	17.60%
	3 25-34	21.10%	23.40%
	4 35-44	12.50%	13.40%
	5 45-54	18.90%	18.60%
	6 55-64	10.30%	10.00%
	7 65+	4.70%	2.10%
Education	1 High School	21.80%	22.80%
	2 2-Year College or Technical Degree	17.00%	22.80%
	3 4-Year College Degree	29.80%	23.40%
	4 Advanced Degree	19.90%	16.20%
	5 Choose not to Answer	11.50%	14.80%
Annual Household Income	1 Less than $20,000	18.50%	15.50%
	2 $20,000-39,999	15.60%	22.10%
	3 $40,000-59,999	13.60%	19.70%
	4 $60,000-79,999	12.50%	9.70%
	5 $80,000-99,999	8.40%	5.50%
	6 Greater than $100,000	14.60%	13.10%
	7 Choose not to Answer	16.80%	14.50%
Race	1 Asian and Other Pacific Islander	7.40%	6.20%
	2 Black	0.80%	1.40%
	3 Caucasian, White, Non-Hispanic	77.00%	70.00%
	4 Hispanic	2.90%	7.60%
	5 Native American	1.80%	2.80%
	6 Some other Race/Ethnicity	1.80%	1.40%
	7 Choose not to Answer	8.20%	10.70%

Table 2: Summary Statistics for Consumer Responses

Variable	Description and Coding		Distribution	
			Gala	**Red Delicious**
Scale of Liking	Overall Liking on a 10cm Continuous Line Scale		Mean = 6.96 Std. = 2.17	Mean = 6.80 Std = 2.55
Firmness Acceptability	1 Firmness is Acceptable		79.70%	77.20%
	0 Firmness is Not Acceptable		20.30%	22.80%
	(Branch) 1 Too Firm		2.00%	4.50%
	0 Not Firm Enough		98.00%	95.5%
Sweetness Acceptability	1 Sweetness is Acceptable		83.00%	86.20%
	0 Sweetness is Not Acceptable		17.00%	13.80%
	(Branch) 1 Too Sweet		8.40%	15.00%
	0 Not Sweet Enough		91.60%	85.00%
Buy for $0.99/lb	1 Yes		57.70%	59.00%
	0 No		42.30%	41.00%
$/lb Usually Pay	Gala	Red Delicious		
	1 Less than $0.79	1 Less than $0.49	13.80%	6.90%
	2 $0.79	2 $0.49	9.40%	4.10%
	3 $0.89	3 $0.59	12.70%	6.20%
	4 $0.99	4 $0.69	18.50%	7.20%
	5 $1.09	5 $0.79	7.60%	10.70%
	6 $1.19	6 $0.89	4.90%	12.40%
	7 $1.29	7 $0.99	8.60%	18.30%
	8 $1.39	8 $1.09	2.50%	6.90%
	9 $1.49	9 $1.19	3.50%	6.90%
	10 $1.59	10 $1.29	0.80%	4.10%
	11 More than $1.59	11 More than $1.29	3.10%	3.40%
	12 Do not Know	12 Do not Know	14.60%	12.80%
Buy Organic	1 Yes		32.90%	33.40%
	0 No		67.10%	66.60%
Eating Frequency	1 Daily		19.10%	16.20%
	2 More than Once a Week		39.80%	33.40%
	3 Once a Week		16.80%	23.40%
	4 Every Few Weeks		15.80%	17.60%
	5 Once a Month		4.90%	4.80%
	6 Less than Once a Month		3.10%	3.80%
	7 Never		0.40%	0.70%

Table 3. Range and Distribution of Response Rates to the Randomly Assigned Premiums

	Premium (Prices)	**Gala**	**Red Delicious**
Yes to Premium	$1.19	12.96%	10.69%
	$1.29	8.85%	8.62%
	$1.49	5.97%	7.24%
No to Premium		30.04%	32.41%
Total		57.82%	58.97%

Table 4. Range and Distribution of Response Rates to the Randomly Assigned Discounts

	Discount (Prices)	**Gala**	**Red Delicious**
Yes to Discount	$0.79	3.50%	3.45%
	$0.69	7.82%	6.90%
	$0.49	9.88%	7.93%
No to Discount		20.99%	22.76%
Total		42.18%	41.03%

Table 5a. Parameter Estimates of WTP for Gala Apples

Parameter	Variable Description	Estimate	Standard Error	z-test	P-value
$\tilde{\alpha}$	*Intercept*	1.0538	0.4040	-2.6081	0.0091
$\tilde{\rho}$	*Final Bid*	-4.5341	0.2541	17.8461	0.0000
λ_1	*Firmness*	1.9581	0.2352	-8.3252	0.0000
λ_2	*Sweetness*	1.9013	0.2534	-7.5028	0.0000
λ_3	*Age*	-0.5363	0.1814	2.9574	0.0031
λ_4	*Education*	0.2975	0.1798	-1.6550	0.0979
λ_5	*Frequency*	0.4391	0.1776	-2.4727	0.0134
λ_6	*Race*	0.4860	0.2045	-2.3773	0.0174

Table 5b. Marginal Effects of Explanatory Variables for the Gala Model

Variable	Marginal Effects
Final Bid	-0.9189
Firmness	0.3968
Sweetness	0.3853
Age	-0.1087
Education	0.0603
Frequency	0.0890
Race	0.0985

Table 6a. Parameter Estimates of WTP for Red Delicious Apples

Parameter	Variable Description	Estimate	Standard Error	z-test	P-value
$\tilde{\alpha}$	*Intercept*	1.3656	0.4661	-2.9301	0.0034
$\tilde{\rho}$	*Final Bid*	-4.6398	0.3388	13.6956	0.0000
λ_1	*Firmness*	2.6627	0.3171	-8.3964	0.0000
λ_2	*Sweetness*	1.8795	0.3637	-5.1679	0.0000
λ_3	*Age*	-0.7024	0.2306	3.0461	0.0023

Table 6b. Marginal Effects of Explanatory Variables for the Red Delicious Model

Variable	Marginal Effects
Final Bid	-0.9197
Firmness	0.5278
Sweetness	0.3726
Age	-0.1392

Appendix

Survey Questionnaire

WELCOME to the

Washington State University
&
Food Innovation Center

Apple Taste Test

To start the test, click on the Continue button below:

You are finished.

Thank you
for your participation!

 © Compusense Inc. 1986-2001

Question Number: 1

Please take at least two bites of this apple, as you would do normally.

My overall opinion of this apple is

Overall Liking

Dislike Extremely	**Neither Like nor Dislike**	**Like Extremely**

Question Number: 2

Would you buy this apple to eat fresh?

	Value
I Would NOT BUY	0
I Would BUY	1

Question Number: 3

Is the firmness of this apple acceptable or not?

	Value
Firmness is ACCEPTABLE	0
Firmness is NOT ACCEPTABLE	1

Branch to 3a if response to Question 3 value =1.

Question Number: 3a

Please indicate why the firmness is NOT acceptable.

	Value
Apple is NOT firm enough	0
Apple is TOO firm	1

Question Number: 4

Is the sweetness of this apple acceptable or not?

	Value
Sweetness is Acceptable	0
Sweetness is NOT Acceptable	1

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Branch to 4a if response to Question 4 value =1.

Question Number: 4a

Please indicate why the apple sweetness is NOT acceptable.

	Value
Apple is NOT sweet enough	0
Apple is TOO sweet	1

Question Number: 5

Would you buy an apple to eat fresh like this one for $0.99 cents per pound?

	Value
Yes	0
No	1

Branch to 5a if response to Question 5 value =0.

Question Number: 5a

Would you buy an apple like this one for $1.19 (or $1.29, $1.49) per pound?

	Value
Yes	0
No	1

Branch to 5b if response to Question 5 value =1.

Question Number: 5b

Would you buy an apple like this one for $0.79 cents (or $0.69, $0.49) per pound?

	Value
Yes	0
No	1

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Question Number: 6

Please indicate the price per pound that you USUALLY pay for apples.

	Value
Less than $0.79 per pound	1
$0.79	2
$0.89	3
$0.99	4
$1.09	5
$1.19	6
$1.29	7
$1.39	8
$1.49	9
More than $1.49 per pound	10
Don't know	11

Question Number: 7

Do you usually buy organic apples?

	Value
Yes	0
No	1

Question Number: 8

How frequently do you eat apples?

Daily	1
More than once a week	2
Once a week	3
Every few weeks	4
Once a month	5
Less than once a month	6
Never	7

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Question Number: 9

Please indicate which apple varieties you regularly eat (check all that apply).

Braeburn	**1**
Fuji	**2**
Gala	**3**
Golden Delicious	**4**
Granny Smith	**5**
McIntosh	**6**
Pink Lady	**7**
Red Delicious	**8**

Please specify your annual household income.

Less than $20,000	**1**
$20,000-$39,999	**2**
$40,000-$59,999	**3**
$60,000-$79,999	**4**
$80,000-$99,999	**5**
$100,000 or more	**6**
I choose not to answer	**7**

Question Number: 10

What is the highest level of formal education you have completed?

High School	**1**
2-yea college or technical degree	**2**
4 year college degree	**3**
Advanced college degree (ie. MS, PhD, MD)	**4**
I choose not to answer	**5**

Question Number: 11

Please specify your age.

10-17 yrs.	**1**
18-24 yrs.	**2**
25-34 yrs.	**3**
35-44 yrs.	**4**
45-54 yrs.	**5**
55-64 yrs.	**6**
65+ yrs.	**7**

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Question Number: 12

Please specify your gender.

Female	**1**
Male	**2**

Question Number: 13

Please specify your race/ethnicity.

Asian & Other Pacific Islander	**1**
Black	**2**
Caucasian, White, Non-Hispanic	**3**
Hispanic	**4**
Native American	**5**
Some Other Race/Ethnicity	**6**
I choose not to answer	**7**

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