A Comparison of Consumer Willingness to Pay for Four Types of Sweeteners

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Abstract

As the U.S. consumption of sweeteners has increased, analysis of the demand for sweeteners has become more important. In this paper, consumer willingness-to-pay (WTP) for selected four types of sweeteners is evaluated. The four types of sweeteners are Kentucky grown pure maple syrup, artificially maple flavored syrup, sorghum syrup and molasses. Results suggest that consumers who are at high household income level (above $80,000) and with a smaller household size are likely to pay more for Kentucky grown maple syrup. Results show that there is no statistic difference for the annual household consumption among the four types of sweeteners.

Keywords: artificial sweeteners, Kentucky, maple syrup, molasses, sorghum,

willingness to pay

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Introduction

The study would focus on four sweetener products, addressing the question of what message should producers convey to consumers in order to get the highest premium for Kentucky grown maple syrup. The four types of sweeteners selected in the research are pure Kentucky grown maple syrup, artificially maple flavored syrup, sorghum syrup and molasses.

Maple Syrup is usually made from the xylem sap of sugar maple, red maple or black maple trees. Sucrose is the most prevalent sugar in maple syrup. Quebec, Canada, produces most of the world's supply of maple syrup. Almost all maple syrup in the United States and Canada is made by family-run businesses. Pure maple syrup could be made in Kentucky. Several farms in Kentucky produce maple syrup, like Morse Farm maple syrup, Vermont maple syrup, Federal Grove Kentucky maple syrup, Spring Valley Farms maple syrup and so on. In the United States, "maple syrup" must be made almost entirely from maple sap; small amounts of substances such as salt may be added (Eillot and Elaine, 2006). Artificially Maple Flavored Syrup ("Maple-flavored" syrups) contain maple, but also other less expensive ingredients. They are less expensive than maple syrup. Sorghum syrup is a natural sweetener made by processing juice squeezed from the stalks of certain types of sorghum (Sorghum bicolor) called sweet sorghum or sorgo. It is a dark sweet syrup similar in flavor to molasses without the bitterness associated with molasses. Molasses is a viscous by-product of the processing of sugar cane or sugar beets into sugar. The quality of molasses depends on the maturity of the sugar cane or sugar beet, the amount of sugar extracted, and the method of extraction.

Experiment surveys of a sample of Kentucky consumers are used to assess WTP for four

sweetener products: pure Kentucky grown maple syrup, artificially maple flavored syrup, sorghum syrup and molasses. Three features make this research distinctive from past literature. Past studies addressed a lot on production of sweeteners. The market research on sweeteners may help to get a better understanding of consumer demand and WTP for maple syrup, making clearer market positioning and improving revenues. Second, three attributes of maple syrup, including an organic product feature, a Kentucky-grown claim and a fat free content claim, makes pure Kentucky grown maple syrup a high quality sweetener. These attributes may have important implications to consumer WTP and product market share (Hu, cox, and Edwards; Bernard, Zhang, and Gifford). The three combining attributes may provide opportunities to add values to the pure Kentucky grown maple syrup. The information in the study may give some ideas to producers about market positioning and future development for business. Third, the four types of sweeteners are compared which has never been done in the research.

The study used OLS model and a Tobit model for comparing the variations of household annual consumption of the four types of sweeteners. An OLS model, a conventional one-step tobit model and a two-step Cragg's model are used to analyze the willingness to pay (WTP) for pure Kentucky grown maple syrup. The corresponding descriptive statistics are reported. Then the study describes the results of marginal effects of each variable for willingness to pay estimate and the last section provides a conclusion and suggestions for further study.

Background

British culinary expert Delia Smith described maple syrup as "a unique ingredient, smooth and silky textured, with a sweet, distinctive flavor - uniquely different from any other." The high quality of maple syrup makes it join the luxury good market. Retail prices can be the equivalent of over $100 a gallon in 2009, more than extra virgin olive oil, or decent Kentucky bourbon.

Discovering the right niche market for Kentucky grown maple syrup would help farmers in the business be more profitable. However, the task is complicated since demand is highly segmented among consumers who may be concerned with different attributes (such as local, calories content, labeling and other types) (Loureiro and Hine, 2001). Consumption of maple syrup may different among consumers, varying by age, gender, income, education level, health consciousness, and others.

Past literature has set the foundations of how to analyze the problem of market segmentation (Kwoka(1991), Elliehausen and Wolken(1990) and Baker(1999)). Theodore J. Angelopoulos and Joshua Lowndes (2009) stressed that the effect of syrup consumption on health problems. Also there are not short of research about maple syrup production (Gary W. Graham, P. Charles Goebel etc.) and tourism in the north American maple syrup industry (C. Clare Hinrichs). Research about comparisons of characteristics and production of maple syrup with other sweeteners also has been done (Jonathan W. White, Jr. J. Clyde Underwood). No research for the comparison of willingness to pay for sweeteners has published until now, whereas. In the study, different socio-demographic characteristics that affect consumer response toward different attributes of sweeteners were analyzed. This research has never been done. It would be interesting to fill the blank of the research field and give some information to local producers for business.

Methodology and Procedures

Data/Sample

Kentucky local maple syrup producers requested for a study about pure Kentucky grown maple syrup consumption. Under this request, survey (Online questionnaires) of Kentucky households

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in different locations of the state of Kentucky was conducted in 2008. There are 351 usable questionnaires are collected, in total. The data are cross sectional data.

The survey was divided into 2 sections. Section 1 focused on general demographic information about consumers with which to develop a target audience. Section 2 asked questions about the annual household consumption of the four types of sweeteners and their willingness to pay price for a 12.5 ounce bottle of Kentucky grown pure maple syrup.

86% of the respondents are female, and the mean age of the sample is 45 years. The mean education level indicates that respondents have a college degree or a University undergraduate degree. 61% of the respondents have no child in their household. The mean household size of respondents is 2 to 3. The employment status is between working full or part time and full or part time student. Almost all of the respondents are whites and 20% of them are from East Kentucky. Finally, among the respondents of the income question, the mean household income is at income lever 2, which means household income before taxes are between $40,000 and $79,999. 14% of the household has diabetes, 6.8% of the household has heart disease, 38.8% has high blood pressure and 27.2% has high cholesterol. The figures are comparable in terms of household size, income, and education to the Kentucky Census projection. However, the percentage of female respondents is much higher than the Census figures for Kentucky and the U.S., with 50.9% and 50.7%, respectively. (Table 1 shows the key characteristics of the sample)

As in all surveys, a representative sample is always of concern to the researcher. There could also be some degree of sample selection bias, in which the people who were more interested in Kentucky products elected to participate in the survey. Those who could access a computer also are elected to participate. Researchers (Edward, Anderson 1987) found significant differences between the characteristics of survey respondents and non-respondents. What's more,

Messonnier et al. (2000) found that unit non-responses seriously affected welfare measures. The findings of this research are limited in the ability to be applied to a fully generalized broader population, given the reasons above.

Model Specification and Variable Definition

<u>Variables selection</u>

Health problem variable

Sweeteners may cause many health problems. According to Brown, Dulloo and Montani, fructose consumption is linked to the type 2 diabetes (2008). One of the causes of cardiovascular disease is believed to be the consumption of high-fructose corn syrup. Also, consumption of high Fructose sweeteners may contribute to high blood pressure and high cholesterol (science news and nature news). Four types of diseases are included in the survey to see if the health problems have effect on the consumption of sweeteners. They are Diabetes, HeartDisease, Highbloodpressure and Highcholesterol. Whereas we found that these diseases are highly correlated in the survey and maple syrup may help treat diabetes (2011) so only Diabetes variable was selected in the models.

Child variables

There are four child variables in the sample. All of them are dummy variables. Nochild: with no child=1, with child=0. Child1yes: with 1 to 4 years children=1, else=0. Child2yes: with 5 to 11 years children=1, else=0. Child3yes: with 12 to 17 years children=1, else=0. We analyzed child variables' effects on average household annual consumption number of containers for the four sweeteners. The results showed none of the child variables would affect the consumption amount. Therefore, models won't include any child variable.

Income variables

There are three income dummy variables in the sample, Incomelow, Incomemiddle and Incomehigh. We compared the income level effects on WTP for Kentucky Pure Maple Syrup. Average WTP prices are different among different income levels so that *Income* variables could be used in models. Select *incomemiddle* and *incomehigh* variables in the models to avoid multicollinearity.

Model

Model for variations in quantity-comparing consumption of four types of sweeteners

(1)$Q_j = \beta_0 + \beta_1 female1 + \beta_2 age + \beta_3 people + \beta_4 abovehighschool + \beta_5 workpaid + \beta_6 incomemiddle + \beta_7 incomehigh + \beta_8 Diabetes + \varepsilon_i$;

Q_j stands for consumption of four types of sweeteners. Where j is 1 to 4, with 1=Pure, 2= Artificial, 3=Sorghum, and 4=Molasses. ε_i is normally distributed with mean 0 and standard deviation σ. Supposing x'_i is a vector of explanatory variables that potentially affect consumers' annual consumption for different syrup, with socio-demographic characteristics of the respondents included, such as age, income, education, employment etc. *Female1* is a dummy variable, with female=1 and male=0. *Age* is a continuous variable of actual ages. *People* is a count variable of the household size. *Abovehighschool* is a dummy variable, with education level higher than high school graduate=1, else=0. *Workpaid* is a dummy variable, with the employment status as working full or part time or as full or part time student=1, else=0. *Incomemiddle* is a dummy variable, with pretax household income between $40,000 and $79,999=1, else=0. *Incomehigh* is a dummy variable, with pretax household income above $80,000=1, else=0. *Diabetes* is a dummy variable, with diabetes=1, without diabetes=0.

The tests comparing the four dependent variables, *Pure, Artificial, Sorghum* and

Molasses show that the mean of them are not significantly different. The four vaiables are highly correlated. We decide to use OLS and the conventional Tobit model to show the consumption of four sweeteners. Authors could use a two-step model if the mean of dependent variables are significantly different and not correlated. Probit model could be used for the purchase decision in the first step. Truncated Poisson model could be used for the consumption amount decision in the second step.

Models for willingness to pay price for a 12.5 ounce bottle of Kentucky pure maple syrup

OLS Model

(2)Pay=β_0+β_1*female1*+β_2*age*+β_3*people*+β_4*abovehighschool*+β_5*workpaid*+β_6*incomemiddle*+ β_7*incomehigh*+ β_8*Diabetes*+ ε_i;

One-step Tobit Model and a two-step Cragg's model

When the sample has limited dependent variable, if use OLS, the parameter estimates will be biased and inconsistent. The degree of bias will also increase as the number of observations that take on the value of zero increase (Cynthia, Yoram, 1986).

Tobit model is censored regression model. Censored regression models refer to model in which we observe the dependent variable only if it above or below some cut off level. We were interested in studying how much consumers are willing to pay for the Kentucky pure maple syrup. For many people the amount we observe is zero, i.e. they are willing to pay nothing. For others, we observe the actual amount they are willing to pay. Thus the data is censored data and censored at zero. Tobit model is the most common censored regression model which expresses the observed level of in terms of an underlying latent variable y*(Censored Regressions Models in reference):

(3) y_i*=β_0+$\beta_1$$x_i$+ ε_i;

(4) $y_i = \begin{cases} \beta 0 + \beta 1 xi + \varepsilon i & \text{if } yi* > 0 \\ 0 & \text{if } yi* <= 0 \end{cases}$

Tobit model = Probit + truncated regression

Probit model for the discrete deision:

(5) $Prob(y > 0) = \Phi(x'\beta)$

Truncated regression model for the continuous decision (uncensored observations):

(6) $E(y|y > 0) = x'\beta + \sigma\lambda(\frac{x'\beta}{\sigma})$

The coefficients on the probit model and on the truncated regression are restricted to be the same in the Tobit model.

However, the one-step tobit model assumes that personal characteristics influence the purchase decision and the quantity consumed, willingness to pay price decisions in the same way (Lin and Schmidt). That is to say, a variable that increases (decreases) the probability of purchase also increases (decreases) the quantity consumed and willingness to pay price. This assumption is not always reasonable. For instance, a consumer may like to purchase a product but want a good deal and pay less. Also, it is likely that the consumer doesn't consume so much this product even if he/she makes the purchase decision. The one-step tobit model isn't appropriate to use in this case by assuming that a consumer's decision of buying a product is made simultaneously with the willingness to pay price decision. In this paper, we consider to use the two-step model assuming that the willingness to pay price decision is made conditional on the purchase decision. Modeling consumption quantity, willingness to pay price decisions conditional on, rather than jointly with, their purchase decision overcomes the major shortcoming of the one-step tobit model. A two-step model allows same or different independent variables to influence these

decisions, and to influence these decisions in the same or opposite direction.

Cragg's model two step estimation procedure

Probit model for the discrete deision:

(7) $Prob(y^* > 0) = \Phi(x \ ' \ \gamma)$

Truncated regression model for the continuous decision (uncensored observations):

$$(8)E(y|y^* > 0) = x \ ' \ \beta + \sigma\lambda(\frac{x \ ' \ \beta}{\sigma})$$

In the Cragg's two-step model, the coefficients could be different (γ) and (β) in the two steps.

Also we could analyze different variables x and z in the first and second step of the model.

The Tobit model could be tested against Cragg's model by estimating the log-likelihood ratio of a probit, a truncated regression and a Tobit model:

(9) $\lambda = 2(\ln L_{probit} + \ln Ltruncated \ regression - \ln L_{Tobit})$ (Greene)

Where λ is distributed as chi-square with R degrees of freedom (R is the number of independent variables and a constant). The Tobit model would be rejected in favor of Cragg's model if λ exceeds the appropriate chi-square critical value (Katchova and Miranda).

Results

Model for variations in quantity-comparing consumption of four types of sweeteners

Results of regressions for consumption of four types of sweeteners are showed in Table 2. Consumption of Kentucky Pure Maple Syrup is not significantly different when compared with other three sweeteners. From the coefficients estimates, female are likely to not purchase and if they purchase they would consume less for all the sweeteners. This makes intuitive sense. It may

be due to that women are recommended to eat less added sugar than men from the American Heart Association. Other demographic characters don't significantly affect consumers' consumption for sweeteners.

Models for willingness to pay price for a 12.5 ounce bottle of Kentucky Pure Maple Syrup

A comparison of results of Willingness to Pay Regressions for Kentucky pure maple syrup among the OLS model, the conventional one step Tobit model and two step Cragg's model is showed in Table 3.

Results for the probit model of purchase decision are given in table 3. Only the estimate for female is statistically significant. Female are less likely to purchase the Kentucky pure maple syrup. People are older, with a full time or part time job, education above high school, pretax annual household income above $40,000, with diabetes are less likely to purchase the Kentucky pure maple syrup. Respondents with a college education or above, have a bigger household size are more likely to purchase the product, but the estimates are not statistically significant.

The one step Tobit parameter estimates for the joint decision of purchase and willingness to pay price are given in table 3. The Tobit model has the same significance and generally the same sign as in the probit model. In the Tobit model, a variable that increases the probability of purchase also increases the willingness to pay price.

The Tobit model is tested against the more general Cragg's model of a separate probit model and a truncated regression model. Same independent variables are used in the three models. The log-likelyhood of the Tobit model is compared to the sum of those in the probit and the truncated regression models. The likelihood ratio test statistics strongly reject the Tobit model. Therefore, the purchase decision and the willingness to pay price decision are not necessarily influenced in the same way by the same personal characteristics as in the Tobit model.

The parameter estimates and marginal effects for the willingness to pay price for the truncated regression models are given in table 3. Respondents' characteristics like female, older, with a larger household size, and employed full or half time are negatively affect the willingness to pay price. Characters like education above high school, pretax income above $40,000, with diabetes positively affect the willingness to pay price. Significant variables are *People* and *Incomehigh*.

Marginal effects of truncated regression for WTP (positive expenditures)

Intercept - Intercept is 6.400 with an associated p-value of < 0.01. We reject the null hypothesis and conclude that the Intercept has been found to be statistically different from zero given other variables in the model are evaluated at zero. If all of the predictor variables in the model are evaluated at zero, the predicted willingness to pay price would be $6.400. For subjects with positive willingness to pay price, if they are female, age zero, household size zero, education level below high school, either do unpaid work or retired and don't have diabetes, the predicted pay price would be $6.400, but subjects age zero are out of the range of plausible values for age.

People - The household size increases 1, the willingness to pay price will decrease $0.022, holding other variables constant. This makes intuitive sense, the pure maple syrup is relatively expensive as a sweetener. Even the respondents purchase the syrup, they might be willing to pay less such that the same amount of money they could buy more to meet the need for a larger household size family..

Incomehigh - If the subjects are in the income level incomehigh(above $80,000), the willingness to pay price will be $0.477 more compared with the subjects who are not in this level, holding other variables constant. This makes sense because the price of maple syrup is higher

compared with other sweeteners, the more income subjects have, the more they are likely to pay more for this good.

Female may be willing to pay $0.144 less for the sweetener compared with male when holding other variables constant. Women are recommended to eat less added sugar than men from the American Heart Association. *Age*- If the age of subjects increase one year, they are willing to pay $0.002 less, holding other variables constant. It may be because they are concerned more about health problems induced probably by too much sugar and consume less amount sweeteners. *Abovehighschool*- Education level above high school, people may have a higher pay and willing to pay $0.194 more for the Kentucky pure maple syrup compared with education below high school when holding other variables constant. *Workpaid* - If subjects are working full or part time or as a full or part time student, they are willing to pay less compared with unpaid or retired worker. It may be due to they do not cook so often themselves relatively so they are willing to pay less. *Incomemiddle* - If subjects are in the income level middle, they are willing to pay $0.068 more compared with subjects not in this income level probably whose income levels are low. This makes sense, as we can see respondents in the high income level even likely to pay more. *Diabetes*-Subjects have diabetes are likely to pay $0.366 more for Kentucky pure maple syrup than subjects don't have diabetes, holding other variables constant. This maybe because the product may help treat diabetes and is healthier compared with other substitutes like corn syrup, artificial maple flavored syrup and etc. However, *female1*, *age*, *abovehighschool*, *workpaid*, *incomemiddle*, *diabetes* variables are not statistically significant.

Conclusions

In this paper, we assess consumer annual consumption of four types of sweeteners, Kentucky grown pure maple syrup, artificially maple flavored syrup, sorghum syrup and molasses. Also,

we try to measure the willingness to pay price for Kentucky grown pure maple syrup in order to identify the best niche market for it. Producers of Kentucky grown pure maple syrup are trying to find a way to create a niche market presently. There are 351 usable questionnaires are collected totally. Data are analyzed using a two-step model for WTP that fits limited dependent variables and using OLS model and conventional one-step Tobit model for comparison. We didn't find any differences for the consumption of Kentucky grow pure maple syrup compared with other sweeteners, though we expected the artificially maple flavored syrup consume more for its low price. For the willingness to pay price for Kentucky grown pure maple syrup, female respondents are not likely to purchase this product. And if the respondents make the decision to purchase, characteristics like high household income level and with a smaller household size are likely to have positive effects for the pay price. The subjects are male, have a younger age, education above high school, work unpaid or retired, have diabetes may also potentially pay more if they purchase the product. Characteristics like household size, income and diabetes have opposite effects on the decisions of purchase and willingness to pay price.

This finding can be useful for the Kentucky grown pure maple syrup producers who are both trying to identify consumers and hope to obtain a good price. The Kentucky grown maple syrup is 100% pure, a natural organic sweetener rich in minerals (calcium, potassium and iron), vitamins (B2, B5, B6, and niacin), and of course it's fat free and listed as one of the Kentucky proud products. Producers may need to convey this information to the consumers identified in this research.

All over Kentucky, but probably especially in the eastern part of the state, woodland owners may find that they have many maple trees in their woodlots and might want to think about making maple syrup as a possibility for increasing income from their woodlots. Kentucky

is not likely to become a major syrup producer, but potential producers can find good opportunities for producing Kentucky or southern maple syrup on a small scale, especially as a cooperative or what is called a "cottage industry," meaning small-scale production (2010). There may be also opportunities for woodland owners to just supply maple sap if they are not interested in seeing it through to a final product.

For further studies, it may be more informative if the survey was conducted not only online but also include people in supermarkets or other spots as well. What's more, the survey could ask more specific questions to identify the attributes that could help the Kentucky grown pure maple syrup has a premium, like its local produced, organic, fat free, good taste, good nutrition and etc. In addition, it may be more helpful if could know the main sweeteners consumed in the household other than only included the four types of sweeteners. Also, it may be convenient to compare whether the findings hold for other products and other states around the country.

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Table 1. Sample Key Statistical Characteristics

Variable	Description	Mean	Std. Dev.
Female1	Dummy variable, 1=female, 0=male	0.860	0.347
Age	Age of consumer	45.367	13.3584
People	Household size	2.662	1.269
abovehighschool	Education level, Dummy variable, 1=above high school, 0=below high school	0.866	0.341
workpaid	Employment status, Dummy variable, 1=working full or part time or is a full or part time student, 0= else	0.789	0.408
incomemiddle	Dummy variable, 1= pretax household income between $40,000 and $79,999, 0= else	0.442	0.497
incomehigh	Dummy variable, 1= pretax household income above $80,000, 0= else	0.279	0.449
Diabetes	Dummy variable, 1= with diabetes, 0= without diabetes	0.123	0.328
Pure	Annual household consumption of Kentucky pure maple syrup, discrete variable	0.809	1.434
Artificial	Annual household consumption of Artificial flavored maple syrup, discrete variable	0.798	1.419
Sorghum	Annual household consumption of Sorghum, discrete variable	0.798	1.419
Molasses	Annual household consumption of Molasses, discrete variable	0.798	1.419
Pay	Willingness to pay price for Kentucky pure maple syrup	3.688	3.056

Table 2. Results of regressions for consumption of four types of sweeteners

Coefficients	Pure		Artificial		Sorghum		Molasses	
	OLS	Tobit Mfx	OLS	Tobit Mfx	OLS	Tobit Mfx	OLS	Tobit Mfx
Intercept	1.061 *		0.977*		0.977*		0.977*	
Female1	-0.448 **	-0.401**	-0.457**	-0.406**	-0.457**	-0.406**	-0.457**	-0.406**
Age	0.001	0.002	0.003	0.003	0.003	0.003	0.003	0.003
People	0.017	0.006	0.027	0.009	0.027	0.009	0.027	0.009
Abovehighschool	0.023	-0.026	0.020	-0.035	0.020	-0.035	0.020	-0.035
Workpaid	0.032	-0.026	0.037	-0.028	0.037	-0.028	0.037	-0.028
Incomemiddle	-0.066	-0.034	-0.083	-0.028	-0.083	-0.028	-0.083	-0.028
Incomehigh	-0.032	0.017	-0.033	0.032	-0.033	0.032	-0.033	0.032
Diabetes	-0.013	-0.014	-0.005	-0.007	-0.005	-0.007	-0.005	-0.007

Significant levels are 0.1 *; 0.05 **. Mfx is marginal effects.

Table 3. Willingness to Pay Regressions for Kentucky Pure Maple Syrup

Pay	OLS (pay)	Tobit (pay)		Cragg's two step model(pay)		
Coefficients	Coeff.	Coeff.	Marginal effects for censored sample	Probit	Truncated regression	Truncated regression marginal effects
Intercept	5.166 ***	4.800 **		0.860	6.400***	
Female1	-0.883 *	-1.326*	-0.964*	-0.375*	-0.144	-0.144
Age	-0.014	-0.022	-0.016	-0.006	-0.002	-0.002
People	-0.067	-0.030	-0.022	0.041	-0.241**	-0.241**
Abovehighschool	0.350	0.508	0.370	0.108	0.194	0.194
Workpaid	-0.211	-0.314	-0.228	-0.083	-0.073	-0.073
Incomemiddle	-0.128	-0.223	-0.162	-0.081	0.068	0.068
Incomehigh	0.283	0.308	0.224	-0.007	0.477*	0.477*
Diabetes	-0.252	-0.544	-0.395	-0.205	0.366	0.366
Sigma		4.496			1.347	

Significant levels are 0.1 *; 0.05 **; 0.01 ***.