Demand Interrelationships of Organic and Non-Organic Nonalcoholic Beverages in the United States: An Application of Semiparametric Estimation of Censored Demand System

Senarath Dharmasena*
Oral Capps, Jr.*

*Agribusiness, Food and Consumer Economics Research Center (AFCERC)
Department of Agricultural Economics
Texas A&M University
College Station
TX 77843-2124
USA

Email: sdharmasena@tamu.edu and ocapps@tamu.edu
Phone: (979) 862-2894

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Orlando, Florida, February 2-6, 2013

Demand Interrelationships of Organic and Non-Organic Nonalcoholic Beverages in the United States: An Application of Semiparametric Estimation of Censored Demand System

JEL Classification: D11, D12

***Background Information*:**

There are many different types of nonalcoholic beverages available in the United States today compared to decade ago. Functionality and health dimensions of beverages have changed over the years. On top of conventional hydration and refreshment functions, beverages now are fortified with numerous vitamins, minerals, proteins, antioxidants, favorable fatty acids, etc (BMC, 2010; 2011, 2012). Organically produced nonalcoholic beverages are another burgeoning segment of beverage marketplace that competes with their conventional counterparts (BMC, 2012). For example, U.S. retail sales of organic milk have been growing since mid 1990s and as of 2005 organic milk and cream sales were $1 billion and as of 2007 organic milk and cream made up of 6% of retail milk sales (USDA-ERS, 2007). Currently, in addition to organic milk, we find host of other organic beverages in the market, such as organic fruit beverages, organic dairy alternative beverages, organic tea and coffee, organic carbonated soft drinks and organic alcoholic beverages (BMC, 2012).

Most of past research on organic beverages has been centered on investigating demand for organic milk. For example Alviola and Capps (2010) estimated demand for organic and conventional fluid milk in the United States through Heckman two-step procedure to uncover own-price, cross-price and income elasticities and purchase responses to selected demographic variables associated with organic milk. Chang *et al*., (2011) used weekly milk scanner data from six stores of national supermarket chain located in Central Ohio to empirically estimate purchase patterns of suburban and inner-city residents for conventional and organic milk. Bernard and Bernard (2009) used auction experiments to examine demand relationships and willingness to pay for organic and conventional milk. Additionally, we found one study centered attention on

investigating consumer preferences for attributes of organically produced soymilk (Zheng et al., 2011).

Given this backdrop, it is clear that demand interrelationships and demographic profiles for other organic beverages, such as organic fruit beverages, organic dairy alternative beverages, organic tea and coffee, organic carbonated soft drinks and organic alcoholic beverages are yet to be uncovered, hence worth exploring. This knowledge of price sensitivity, substitutes and complements and demographic profiling in particular is important for manufactures, retailers and advertisers of beverages from a competitive intelligence standpoint and making strategic decisions.

In this censored demand system analysis, we use expenditure, quantity and demographic information obtained from 2010 Nielsen Homescan scanner panel. Novelty also spans across the application of semiparametric estimation procedure suggested by Sam and Zheng (2010) in estimating consumer demand systems with micro data.

General objective of this study is to determine demand interrelationships between organic and non-organic beverages using almost ideal demand system (AIDS) estimated using semiparametric procedure suggested by Sam and Zheng (2010). Specific objectives are (1) to estimate compensated and uncompensated own-price and cross-price elasticities, and expenditure elasticities for organic beverages and their non-organic counterparts; (2) to determine demographic factors affecting the purchase of organic and non-organic beverages; (3) to shed light on the use of semiparametric estimation procedure to estimate consumer demand with micro data, showing non-normal error distributions of censored decision equations.

***Data and Methodology*:**

We use quantity, expenditure and household demographic characteristics with respect to purchase of selected set of organic and non-organic beverages obtained from 2010 Nielsen Homescan scanner panel. This panel consists of approximately 60,000 representative households from across the United States. Selected beverages are organic and non-organic carbonated soft drinks, organic and non-organic milk, organic and non-organic fruit beverages, organic and non-organic tea and coffee, organic and non-organic dairy alternative beverages like soymilk.

A Semiparametric procedure applied to estimate censored micro demand systems suggested by Sam and Zheng (2010) is used to obtain unbiased and consistent parameter estimates when the disturbances in the binary censoring equations are heteroscedastic or have non-normal joint distributions. As such, in the first stage, parameters of the binary censoring equations are estimated using a distribution-free single-index model suggested by Klein and Spady (1993) instead of a probit used in alternative two-step estimators such as Shonkwiler and Yen (1999). In the second stage, the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer, 1980) is used to model the conditional demand for organic and non-organic nonalcoholic beverages.

The paper uses a two-step semiparametric approach suggested by Sam and Zheng (2010) for the estimation of censored demand system. This is exempt from distributional misspecification (does not assume a normally distributed error in the first-stage equation) and accommodates a certain form of heteroskedasticity. We use Klein and Spady (1993) semiparametric single-index model instead of probit in the first-stage equation to model the decision to purchase a beverage. The advantage of Klein and Spady (1993) is that, without relying on distributional assumptions, this method generates consistent and efficient estimates and furthermore accommodates heteroskedasticity of certain from in the error term.

Methodology explained below is borrowed from Sam and Zheng (2010). For *n* goods and *j* (cross-sectional) observations, binary (0-1) (d_{ij}) indicator function *I* can be expressed as follows:

(1) $d_{ij} = I(W'_{ij}\gamma_i + v_{ij})$ where W'_{ij} is vector of regressors, γ_i is model parameter and v_{ij} is zero mean and finite variance error process. The conditional response variable, Y_{ij} in the second-stage equation is as follows:

(2) $Y_{ij} = d_{ij} * (g(X_{ij}, \beta_i) + \epsilon_{ij})$ where X_{ij} is vector of regressors, β_i is model parameter and ϵ_{ij} is zero mean and finite variance error. Given equations (1) and (2), the conditional mean can be expressed as follows:

(3) $E(Y_{ij}|X_{ij}, W_{ij}) = E(Y_{ij}|X_{ij}, W_{ij}; d_{ij} = 1) * prob(d_{ij} = 1)$

The unknown cumulative distribution function of the error term v_{ij} is denoted by $F_i(W'_{ij}\gamma_i)$. Then we can write the system of equations of interest as follows:

(4) $Y_{ij} = \left(g(X_{ij}, \beta_i) + \lambda_i(W'_{ij}\gamma_i) \right) * F_i(W'_{ij}\gamma_i) + \eta_{ij}.$

The parameters of the first step are estimated using Klein and Spady (1993) semiparametric single-index model.

The second stage conditional demand system (the AIDS model) can be expressed as follows:

(5) $w_i = \left(\alpha_i + \beta_i(log\frac{x}{P}) + \sum_{k=1}^{n} \gamma_{ik} log p_k + \sum_{l=1}^{L} \tau_{il} (W'_i\hat{\gamma}_i)^{l-1} \right) * \hat{F}_i(W'_i\hat{\gamma}_i)$

***Expected Results and Discussion*:**

As such, we are in position to obtain own-price, cross-price and expenditure elasticities with respect to organic nonalcoholic beverages and their non-organic counterparts. Also, through this analysis, we are able to determine demographic factors affecting the purchase of organic and non-organic nonalcoholic beverages. In addition to that, we will be able to test for normality of

the errors of each binary censored equation using Horrowitz and Hardle (1994) to lend support the use of semiparametric approach.

***References*:**

Alviola IV, P.A., and O.Capps, Jr. 2010 "Household Demand Analysis or Organic and Conventional Fluid Milk in the United States Based on the 2004 Nielsen Homescan Panel." *Agribusiness,* 26(3):369-388

Bernard, J.C., and D. J. Bernard, 2009, "What is it About Organic Milk? An Experimental Analysis." *American Journal of Agricultural Economics,* 91(3):826-836

BMC, 2010, 2011, 2012, Beverage Marketing Corporation Multiple Beverage Marketplace Reports

Chang, C-H., N.H.Hooker, E. Jones, A. Sam, 2011 "Organic and Conventional Milk Purchase Behaviors in Central Ohio." *Agribusiness,* 27(3):311-326

Deaton, A., and J. Muellbauer, 1980, "An Almost Ideal Demand System." *American Economic Review,* 70:312-26

Horowitz, J.L., and W. Hardle, 1994, "Testing A Parametric Model against a Semiparametric Alternative." *Economic Theory,* 10:821-48

Klein, R. L., and R.H. Spady, 1993, "An Efficient Semiparametric Estimator for Binary Response Models." *Econometrica,* 61:387-421

Sam, A. G., and Y. Zheng, 2010, "Semiparametric Estimation of Consumer Demand Systems with Micro Data." "*American Journal of Agricultural Economics,* 92(1):246-257

Shonkwiler, J.S., and S.T. Yen, 1999, "Two-Step Estimation of a Censored System of Equations." *American Journal of Agricultural Economics,* 81:972-82

USDA-Economic Research Service, 2007, Retail and Consumer Aspects of the Organic Milk Market, LDP-M-155-01

Zheng, Y., H.H. Peterson, and X. Li, 2011, "Consumer Preferences for Attributes of Organic Processed Foods: The Case of Soymilk in the United States." Poster presented at the Agricultural and Applied Economics Association Annual Meetings, Pittsburgh, PA