Are Organic Beverages Substitutes for Non-Organic Counterparts? Household-Level Semi-parametric Censored Demand Systems Approach

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Background

Nonalcoholic beverage market in the United States today is growing at a pace that has never been before, adding a wide variety of beverage products to beverage isles. More specifically, the functionality and health dimensions of beverages are important attributes today compared to decade ago (BMC, 2010; 2011, 2012, 2013). Organically produced nonalcoholic beverages are a burgeoning segment of beverage marketplace that competes with their conventional (or nonorganic) counterparts (BMC, 2013). 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 (USDA-ERS, 2007). Organic milk and cream made up of 6% of retail milk sales as of year 2007 (USDA-ERS, 2007). Currently, in addition to organic milk, we find an array of other organic beverages in the market. Some of them are organic fruit juices, organic dairy alternative beverages such as soymilk and almond milk, organic tea and coffee, and organic carbonated soft drinks (BMC, 2013).

We could find only few studies from the extant literature that dealt with demand for organic nonalcoholic beverages. Alviola and Capps (2010) estimated demand for organic and conventional fluid milk in the United States through Heckman-type model to uncover own-price, cross-price and income elasticities and purchase responses of 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. Zheng *et al.*, (2011) centered attention to investigating consumer preferences for attributes of organically produced soymilk.

Therefore, it is clear that demand interrelationships and demographic profiles for other organic beverages, such as organic fruit juice, organic dairy alternative beverages, organic tea and coffee, and organic carbonated soft drinks are yet to be determined. This knowledge of price sensitivity, substitutes and complements and demographic profiling in particular is important for manufacturers, retailers and advertisers of these beverages from a competitive intelligence standpoint and making strategic decisions. Additionally, this knowledge will be useful for policy analysts to determine impact at farm level as a result of increase in consumer demand for organically produced beverage products.

Objectives

The general objective of this study is to determine demand interrelationships between organic and non-organic beverages using censored quadratic almost ideal demand system (C-QUAIDS) estimated using semiparametric procedure suggested by Sam and Zheng (2010). Specific objectives are to:

(1) estimate compensated and uncompensated own-price and cross-price elasticities, and expenditure elasticities for organic beverages and their non-organic counterparts;

(2) determine demographic factors affecting the purchase of organic and non-organic beverages; and

(3) shed light on the use of semi--parametric procedures 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 2012 Nielsen Homescan scanner panel. This panel consists of approximately 65,000 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 juices, organic and non-organic tea and coffee, organic and non-organic dairy alternative beverages like soymilk and almond milk.

The paper uses a two-step semi-parametric 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 the Klein and Spady (1993) semi-parametric single-index model instead of the conventional probit model used in alternative two-step estimators such as Shonkwiler and Yen (1999) in the first-stage equation to model the decision to purchase any beverage. The advantage of the Klein and Spady (1993) model is that, without relying on distributional assumptions, this method generates consistent and efficient estimates and furthermore accommodates heteroskedasticity of a certain form in the error term. In the second stage, the QUAIDS (Banks *et al*, 1997) is used to model the conditional demand for organic and non-organic non-alcoholic beverages.

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

(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

(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 aforementioned equations, the conditional mean can be expressed as

(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

(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 QUAIDS model) can be expressed as

(5) $w_i = \left(\alpha_i + \beta_i \left(ln \frac{m}{a(P)}\right) + \sum_{k=1}^{n} \gamma_{ik} lnp_k + \sum_{l=1}^{L} \tau_{il} \left(W_i^{'}\hat{\gamma}_i\right)^{l-1} + \frac{\lambda}{b(P)}\left(ln \frac{x}{a(P)}\right)^2\right) * \hat{F}_i(W_i^{'}\hat{\gamma}_i)$

Expected Results and Discussion

Through this study, we are in position to obtain own-price, cross-price and expenditure elasticities with respect to organic and nonorganic beverages considered. Demographic factors affecting the purchase of organic and non-organic beverages are also determined. Preliminary analysis of data reveals that own-price elasticity of demand for organic and nonorganic fruit juices is -0.75 and -0.83 respectively. Nonorganic fruit juice was found to be a substitute for organic fruit juice. Own price elasticity of demand for organic and nonorganic tea was estimated to be -1.01 and -0.85. Nonorganic tea was found to be a substitute for organic tea and this observation was similar to that of organic and nonorganic coffee in terms of substitutability. Own price elasticity of demand for organic and nonorganic coffee was estimated to be -0.93 and -1.01. Overall, households with high income, with household head's age between 45-64 years, with college and post college educated household heads, with Asian households live in the Western United States, with children less than 6 years of age consumer more organic nonalcoholic beverages. Also, preliminary results indicate that use of Horrowitz and Hardle (1994) procedure in the binary censored equation lends support to the use of semi-parametric approach in estimating C-QUAIDS.

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