Micro-Demand Systems Analysis of Non-Alcoholic Beverages in the United States: An Application of Econometric Techniques Dealing With Censoring

by

Pedro A. Alviola IV
Program Associate
Department of Agricultural Economics
and Agribusiness,
University of Arkansas,
Fayetteville, AR 72701

Oral Capps Jr.
Executive Professor
Holder of the Southwest Dairy Marketing Endowed Chair
Department of Agricultural Economics,
Texas A&M University,
College Station, TX 77843-2124.

and
Ximing Wu
Associate Professor,
Department of Agricultural Economics,
Texas A&M University,
College Station, TX 77843-2124.

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Abstract

A censored Almost Ideal Demand System (AIDS) and a Quadratic Almost Ideal Demand System (QUAIDS) were estimated in modeling non-alcoholic beverages. Five estimation techniques were used, including the conventional Iterated Seemingly Unrelated Regression (ITSUR), two-stage methods such as the Heien and Wessells (1990) and the Shonkwiler and Yen (1999) approaches, the generalized maximum entropy method and the Amemiya-Tobin framework of Dong, Gould and Kaiser (2004). Our results based on various specifications and estimation techniques are quantitatively similar and indicate that price elasticity estimates have a greater variability in more highly censored non-alcoholic beverage items such as tea, coffee and bottled water as opposed to less censored non-alcoholic beverage items such as carbonated softdrinks, milk and fruit juices.

Key Words: Censored demand systems, AIDS, QUAIDS, two- step methods, generalized maximum entropy, Amemiya-Tobin Framework, and non-alcoholic beverages

The move towards different diets that favor nutritious foods has in recent years led to the emergence of healthier and natural food choices. In particular, manufacturers and retailers have been responsive in introducing new products to the non-alcoholic beverage industry, especially juices, energy drinks and others. This paper focuses on the interdependencies and demand for certain non-alcoholic beverages, namely; fruit juices, tea, coffee, carbonated soft drinks, milk and bottled water. In the case of the non-alcoholic beverage complex, these products have different levels of market penetration. Consequently, the consumption/expenditure variables associated with these non-alcoholic beverages are censored at zero. That is, certain households have zero expenditure, but the corresponding information on household characteristics, which forms the basis of the explanatory variables are often readily observed. Several competing estimation methods have been developed in order to address the censoring issue in the estimation of micro-demand systems. As microdata become increasingly available and more detailed, the estimation of micro-demand systems at the household level becomes problematic due to censoring. To our knowledge, no prior research has been done in terms of comparing these respective approaches with regard to a particular data set.

In this study, the demand systems employed were the Quadratic Almost Ideal Demand System (QUAIDS) (Banks, Blundell and Lewbel, 1997) and Almost Ideal Demand System (AIDS) (Deaton and Mulbauer, 1980). The advantages of the QUAIDS model are its flexibility in incorporating nonlinear effects and interactions of price and expenditures in the demand relationships. Since the data used are at the household level, censoring typically is observed as some households report expenditures of a beverage product say coffee and none on say bottled water. Thus, in order to model the censoring problem in demand systems, the research utilized estimation procedures including two-step estimators (Heien and Wessells, 1990; Shonkwiler and Yen, 1999), the maximum entropy method (Golan, Judge and Miller, 1996) and the maximum simulated likelihood estimation method (Dong, Gould and Kaiser, 2004). The iterated seemingly unrelated regression (ITSUR) estimation without adjustments for censoring serves as a baseline of comparison for the aforementioned estimation techniques. Finally, the source of data is the 1999 Nielsen Homescan Panel due to its vast array of household demographic information.

Literature Review

The Quadratic Almost Ideal Demand System (QUAIDS) commonly is used in applied work. For example, Dhar and Foltz (2005) utilized a Quadratic AIDS model to estimate values and benefits derived from *recombinant bovine somatotropin* (rBST)-free milk, organic milk and unlabelled milk. Their study relied on the use of time-series scanner data pertaining to milk consumption from 12 key cities in the United States. Their findings indicate that rBST-free milk and organic milk are complements, while conventional milk and rBST-free milk as well as conventional milk and organic milk are substitutes. The respective own-price elasticity estimates were -4.40 for rBST-free milk, -1.37 for organic milk and -1.04 for conventional milk.

Likewise, a study done by Mutuc, Pan and Rejesus (2007) investigated household demand for vegetables in the Philippines using the QUAIDS model. Their findings indicated significant differences in expenditure elasticities between rural and urban areas whereas for the respective own-price and cross-price elasticities, no significant variations across rural and urban areas were evident. Dhar and Foltz (2005) encountered no censoring issues, and subsequently used the Full Information Maximum Likelihood (FIML) estimator. In Mutuc, Pan and Rejesus (2007) work, censoring problems occurred because of the presence of zero expenditures on some vegetable commodities consumed by the sample of households. Hence they relied upon the the Shonkwiler and Yen (1999) two-step procedure to circumvent the censoring issue.

The Heien and Wessells (1990) approach mimics the Heckman two-stage method by first estimating probit models to compute inverse Mills ratios for each commodity. Subsequently, these ratios are incorporated into the second-step SUR estimation of the demand system. On the other hand, Shonkwiler and Yen (1999) proposed a consistent estimation procedure that utilizes a probit estimator in the first step. Subsequently, the cumulative distribution function (cdf) is used to multiply the covariates in the demand model and the probability density function (pdf) is included as an independent variable in the second step. Both methods fall under the purview of utilizing two-step estimators.

While the Shonkwiler and Yen approach worked well with the problem of zero expenditures, Arndt, Liu and Preckel (1999) claimed that it had limitations with respect to dealing with corner solutions. Several studies including Arndt (1999) and Golan, Perloff and Shen (2001) propose an alternative maximum entropy approach to estimate censored demand systems. This approach allows for consistent and efficient estimation of demand systems without putting any restrictions on the error terms. Other researchers such as Meyerhoefer, Ranney and Sahn (2005) use the general method of moments (GMM) estimator to address censoring problems in demand systems estimation.

Several studies have criticized the two-step methods stating that the "adding up" restriction in estimating share equations in censored demand systems is ignored (Dong, Gould and Kaiser, 2004; Yen, Lin and Smallwood, 2003). Together with Golan, Perloff and Shen (2001), these classes of estimators fall under the Amemiya-Tobin framework where the former does not employ maximum likelihood estimation in evaluating multivariate probability integrals. Dong, Gould and Kaiser (2004) and Yen, Lin and Smallwood (2003) utilize numerical methods such as maximum and quasi-maximum simulated likelihood estimation in approximating the likelihood function. The literature regarding the use of alternative estimation techniques such as Bayesian and non-parametric approaches on micro-demand system estimation have been limited (Tiffin and Aquiar, 1995).

Methodology

Almost Ideal Demand System (AIDS) Model

This research utilizes the AIDS (Deaton and Mulbauer, 1980) in the estimation of the demand for six non-alcoholic beverages, namely: fruit juices, tea, coffee, carbonated soft drinks, bottled water and milk. Equation (1) describes the general specification of the AIDS model where p_i and w_i are the price and budget share of the ith beverage commodity. The average budget share w_i is computed as p_iq_i/M *where* $M = \sum p_iq_i$ is the total expenditure on the six aforementioned non-alcoholic beverages. The parameters of this system are α_i, γ_i and β_i, respectively. One can also incorporate household demographic characteristics into the demand system thru the intercept parameter α_i. These variables include household size, household income, race and region. Also, a seasonality component was added.

(1) $$w_i = \alpha_i + \sum_{j=1}^{6} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{M}{a(p)}\right] + \varepsilon_i , \quad \text{i-1,2,..6}$$

where:

$$\ln a(p) = \alpha_o + \sum_{i=1}^{6} \alpha_i \ln p_i + 0.5 \sum_{i} \sum_{j} \gamma_{ij} \ln p_i \ln p_j , \text{ and,}$$

$$\alpha_i = \alpha_i^* + \alpha_{i1} HHsize + \alpha_{i2} Inc + \alpha_{i3} Race + \alpha_{i4} Season + \alpha_{i5} Rg$$

In our study, we incorporate selected demographic variables namely household size (*HHsize*), income (*Inc*), race (*Race*), seasonality (*Season*) and region (*Rg*) in the analysis. Likewise, the classical theoretical restrictions of adding up, homogeneity and symmetry were imposed in the estimation of the AIDS demand system:

Adding up: $\sum_{i=1}^{n} \alpha_i = 1$, $\sum_{i=1}^{n} \beta_i = 0$, $\sum_{j=1}^{n} \gamma_{ij} = 0$

Homogeneity: $\sum_{j=1}^{n} \gamma_{ij} = 0$

Symmetry: $\gamma_{ij} = \gamma_{ji}$

Quadratic Almost Ideal Demand System (QUAIDS) Model

The Quadratic Almost Ideal Demand System (QUAIDS) model (Banks, Blundell and Lewbel, 1997) also is utilized in this demand analysis. The advantages of using this model over competing flexible demand systems is its unparalleled capability of incorporating non-linear effects and interactions of price and expenditures on the demand specifications. The mathematical representation of the QUAIDS demand system is as follows:

(2) $$w_i = \alpha_i + \sum_{j=1}^{6} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{M}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left[\ln\left(\frac{M}{a(p)}\right)\right]^2 + \varepsilon_i \text{, i-1,2,.,6}$$

where:

$$\ln a(p) = \alpha_o + \sum_{i=1}^{n} \alpha_i \ln p_i + 0.5 \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j,$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i}, and$$

$$\alpha_i = \alpha_i^* + \alpha_{i1} HHsize + \alpha_{i2} Inc + \alpha_{i3} Race + \alpha_{i4} Season + \alpha_{i5} Rg.$$

The QUAIDS model is a generalization of the AIDS model. Also, if the null hypothesis that $\lambda_1 = \lambda_2 = \ldots = \lambda_6 = 0$ is rejected then the QUAIDS model is a superior model at least statistically relative to the AIDS model system. In this research, the intercept parameter α_i incorporates selected household demographic characteristics just as with the AIDS model. Adding up, homogeneity conditions and symmetry conditions also are imposed on the demand system as follows;

Adding up: $\sum_{i=1}^{n} \alpha_i = 1$, $\sum_{i=1}^{n} \beta_i = 0$, $\sum_{j=1}^{n} \gamma_{ij} = 0$, $\sum_{i=1}^{n} \lambda_i = 0$

Homogeneity: $\sum_{j=1}^{n} \gamma_{ij} = 0$

Symmetry: $\gamma_{ij} = \gamma_{ji}$

Elasticity Estimation in AIDS and QUAIDS Demand Systems

When the demand parameters of the AIDS and QUAIDS demand systems are estimated, the elasticity estimates subsequently, can be calculated. Following Green and Alston (1990) and Banks, Blundell and Lewbel (1997), the expenditure, uncompensated and compensated price elasticities are given by the following formulae;

(3) $$\eta_i = \frac{\beta_i}{w_i} + 1$$, for the AIDS model

(4) $$\eta_i = \frac{\beta_i + \frac{2\lambda_i}{b(p)}\left[\ln\left(\frac{m}{a(p)}\right)\right]}{w_i} + 1$$, for the QUAIDS model.

The Marshallian or uncompensated price elasticities are given by

(5) $$\varepsilon_{ij}^{u} = \frac{\gamma_{ij} - \beta_i(\alpha_j + \sum_k \gamma_{ik} \ln p_k)}{w_i} - \delta_{ik}$$, for the AIDS model, and

(6) $$\varepsilon_{ij}^{u} = \frac{\gamma_{ij} - \mu_i(\alpha_j + \sum_k \gamma_{ik} \ln p_k) - \frac{\lambda_i \beta_j}{b(p)}\left[\ln\left(\frac{m}{a(p)}\right)\right]^2}{w_i} - \delta_{ik}$$, for the QUAIDS model,

where $\mu_i = \beta_i + \frac{2\lambda_i}{b(p)}\left(\ln\left[\frac{m}{a(p)}\right]\right)$ and δ_{ik} = the Kronecker delta (1 if *i*=*k* and 0 otherwise)

Finally, from Slutsky's equation, the Hicksian or compensated elasticties are calculated via the formula; $\varepsilon_{ij}^{c} = \varepsilon_{ij}^{u} + \eta_i w_j$, where ε_{ij}^{u} is the uncompensated price elasticity of beverage i with respect to beverage j and η_i is the budget elasticity of beverage i. The term w_j is the mean budget share of beverage j.

Estimation Techniques That Address Censoring in a Demand System

Two-Step Estimators

A class of estimation techniques that deal with censored systems of equations is the two-step estimation procedure. In this paper we consider two approaches proposed in Heien and Wessells (1990) and Shonkwiler and Yen (1999) respectively. These techniques usually consist of estimating a binary choice model in the first step to account for the decision to purchase or not to purchase the particular beverage. Two important by products of the probit estimation include the calculation of the cumulative distribution function (cdf) and probability density function (pdf) from the binary choice model.

In the case of the Heien and Wessells (1990) approach, the calculation of the inverse Mills ratio (ratio of the pdf to the cdf) from the first step probit estimation now is included as an added regressor into the estimation of the demand system. We note however that for those households that consumed and did not consume the beverage item, the formula for the inverse Mills ratio (IMR) is given as:

(7) $$IMR_i = \frac{\phi(W_i^T\hat{\eta})}{\Phi(W_i^T\hat{\eta})}$$, for households that consume beverage i

(8) $$IMR_i = \frac{-\phi(W_i^T\hat{\eta})}{1-\Phi(W_i^T\hat{\eta})}$$, for households that did not consume beverage i

where, $\phi(W_i\hat{\eta})$, $\Phi(W_i\hat{\eta})$ and W_i correspond to the pdf , cdf and vector of socio-demographic variables including income, race and region. Thus, the Heien and Wessells (1990) two-step approach of estimating a demand system can be represented as:

(9) $$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{M}{a(p)}\right] + \upsilon_i IMR_i + \varepsilon_i$$, for the AIDS model

(10) $$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{M}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left[\ln\left(\frac{M}{a(p)}\right)\right]^2 + \upsilon_i IMR_i + \varepsilon_i$$, for the QUAIDS model.

On the other hand, the Shonkwiler and Yen (1999) consistent two-step approach utilizes the calculated cdf to multiply the entire right hand side variables of the share equation and include the pdf as an additional regressor in the system of budget shares. This formulation can be represented as:

(11) $$w_i = \Phi(W_i\eta)\left[\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{a(p)}\right)\right] + \phi(W_i\eta) + \varepsilon_i$$, for the AIDS model

(12) $$w_i = \Phi(W_i\eta)\left[\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left(\ln\left(\frac{M}{a(p)}\right)\right)^2\right] + \phi(W_i\eta) + \varepsilon_i$$,

for the QUAIDS model.

Dong, Gould and Kaiser Approach (2004)

We also used the Dong, Gould and Kaiser (2004) approach, a variant of the Amemiya-Tobin model in estimating a censored AIDS model. In this approach the AIDS demand model can be written as:

(13) $$w_i^* = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{M}{a(p)}\right] + \varepsilon_i ,$$

where $w_i^* = p_i q_i$ represents the latent budget share with p_i and q_i corresponding to the price and quantity of the ith beverage. As pointed out by Stockton, Capps and Dong (2007), the censored system will take into account the latent budget share if the vector mapping of the latent shares to its corresponding actual shares addresses the following conditions concerning the latent share, w_i^*. These conditions are i) $0 \le w_i \le 1$ and ii) $\sum_i w_i = 1$. Thus, Dong, Gould and Kaiser (2004) proposed an approach that addresses both restrictions by applying the following mapping condition;

(14) $$w_i = \frac{w_i^*}{\sum_{j \varepsilon \Omega} w_j^*}$$, if $w_i^* > 0$ and Ω corresponds to the positive latent share space.

$$w_i = 0, \qquad \text{if } w_i^* \le 0$$

In this mapping rule, we find that not only is the adding-up condition for latent and observed shares satisfied but because the rule addressed the two constraints imposed on the latent share, non-negative expenditure shares are expected. As for the estimation procedure, the error structure of the respective share equation assumes a multivariate normal distribution, thus the method of maximum simulated likelihood was used to evaluate the integrals inherent in this multivariate distribution.

Generalized Maximum Entropy Procedure[1] (GME)

The method of maximum entropy is an information theoretic approach that does not impose parametric distributional assumptions (Golan, Judge and Miller 1996, Golan, Perloff and Shen 2001). Following the SAS ETS 9.2 ENTROPY Procedure guide (SAS ETS 9.2 User Guide, 2008), the procedure selects the parameter estimates consistent with the maximization of the entropy distribution. Thus, the entropy metric for a given distribution is given as:

(15) $$\max \; -\sum_{i=1}^{n} p_i \ln(p_i) \;\text{ s.t. } \sum_{i=1}^{n} p_i = 1,$$

where p_i is the probability of the ith support point.

In a regression framework, since this method assumes no parametric assumptions, reparameterizations are used to identify the respective β_i parameters and the error terms. In a simple two support point example, the expression for the reparameterized coefficients can be written as $\beta_i = p_{h1}s_{h1} + p_{h2}s_{h2}$ where p_{h1} and p_{h2} represent the probabilities and s_{h1} and s_{h2} are the upper and lower bounds values based on prior information on β_i. Likeweise, the reparametrized error term can be written as $\varepsilon = r_{z1}e_{z1} + r_{z2}e_{z2}$ where r_{z1} and r_{z2} are associated weights of the error term's upper and lower bound values of e_{z1} and e_{z2} (SAS ETS 9.2 User Guide, 2008). From this reparameterization, the GME maximization problem can be notationally written as:

(16) $$\max \;\; G(p,r) = -p'\ln(p) - r'\ln(r)$$

[1] The SAS ETS 9.2 Entropy procedure guide provides excellent discussion on how to use the SAS experimental procedure, The ENTROPY Procedure. The ensuing discussion follows theoretical exposition of the general maximum entropy estimation principle given in the SAS procedure.

$$\text{s.t.} \quad q = X\,S\,p + E\,r$$

$$1_H = (\mathrm{I_H} \Theta 1'_L)\,p$$

$$1_Z = (\mathrm{I_Z} \Theta 1'_L)\,r$$

where q is the vector of response variable, X is the matrix of independent covariate observations. *S* and *p* denote the vectors of support points and their associated probabilities, while *r* is a weight vector associated with the support points contained in *E*. And finally $\mathrm{I_H}$ and $\mathrm{I_Z}$ are identity matrices. The symbol Θ is the Kronecker product.

However for this exercise, we deal with censored shares in a demand system. As such that we make modifications in solving the primal problem of the entropy procedure found in equation (16). For example, given that q = w_i is the share in the AIDS model, $w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{M}{a(p)}\right] + \varepsilon$, we apply the following conditions:

$$w_i^* = \begin{matrix} \alpha_i + \sum_{j=1}^{6} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{a(p)}\right) + \varepsilon_i : w_i > 0 \\ lowerbound : w_i \leq 0 \end{matrix}$$

Thus for this case, the primal optimization problem can be written as

(17) $$\max \quad G(p,r) = -p'\ln(p) - r'\ln(r)$$

$$\text{s.t} \quad w_i = \left[\alpha_i + \sum_{i=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{a(p)}\right)\right] Sp + Er$$

$$w_i^{LB} \leq \left[\alpha_i + \sum_{i=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{a(p)}\right)\right]^{LB} S^{LB} p + E^{LB} r^{LB}$$

$$1_H = (\mathrm{I_H} \Theta 1'_L)\,p$$

$$1_Z = (I_Z \Theta 1'_L)\, r$$

A similar construction can be done in the QUAIDS model.

Estimation Issues

The estimation of the AIDS and QUAIDS specification using the maximum entropy technique was done using the experimental SAS procedure called PROC ENTROPY. However, this experimental procedure at present is only limited to estimation of systems of linear relationships. Thus, attempts were made to linearize the demand system by using the starting values generated from the ITSUR specification and simplifying through the use of mean values of the non-linear components such as the nonlinear price index *ln(a(p))* and Cobb–Douglas price aggregator *b(p)* into constants in both the AIDS and QUAIDS model. Thus, in this case, the linearized AIDS and QUAIDS model can be represented as:

(18) $$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \Delta_i + \varepsilon_i$$, for the AIDS model

where $\Delta_i = \ln\left(\frac{M}{C}\right)$ and ln C is a calculated constant of ln *a(p)*

(19) $$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \Delta + \lambda_i \Gamma^2 + \varepsilon$$, for the QUAIDS model

where $\Gamma^2 = \frac{\left[\ln\left(\frac{M}{C}\right)\right]^2}{D}$ with lnC as the calculated constant of ln *a(p)* and D is the constant representing the Cobb-Douglas price aggregator *b(p)*.

The imposition of classical restrictions of symmetry and homogeneity was not done in the maximum entropy estimation of the demand system. Difficulties were encountered in identifying the values of support points of those coefficients being restricted. And with so many restrictions being imposed, the identification of problematic constraints was a major problem. Thus, in using the maximum entropy estimation procedure, the estimation of the AIDS and QUAIDS models were done without the usual imposition of the classical theoretical constraints.

The use of the Dong, Gould and Kaiser (2004) technique was only performed in the AIDS model. We did not attempt to use this procedure in the QUAIDS model specification. Again this action was necessary due primarily to the highly non-linear nature of the QUAIDS model. Convergence associated with this procedure was difficult to achieve.

Data

The data used in the study is the 1999 AC Nielsen HomeScan Panel where the data set is a compilation of household purchase transactions of this calendar year. In this data set, the transaction records of each household relate to total expenditures and quantities of commodities purchased primarily in retail groceries, including the use of discounts coupons. The number of households in the sample is 7, 195 and because quarterly observations are used for each household, the total sample size comes to 28,780. This sample size can be thought of a nationally representative sample of the purchases made by U.S. households from retail grocery stores or mass merchandisers for the calendar year 1999.

Insert Table 1

In this study, the selected socio-demographic variables used were household income, household size, race, region and seasonality. From Table 1, we find the mean household income is $51,740 and the dominant household size for the sample is those with two members (38%). As for race, approximately 94 percent are white and black households and for regions, 34 percent come from the South while the rest has the following breakdown: East (20%), Central (25%) and West (20%).

Another feature of the data set is that commodity prices are not readily available. Instead one uses the derivation of expenditures over quantities of the purchased item, called unit values and these unit values serve as proxies for the price variables. If both the expenditures and quantities were zero, then this study utilized a simple price imputation procedure resting on the use of income, race and regional dummy variables. If $p_i = 0$ for a particular household, then

Pfruitjuice = 4.53912 + (*hinc**0.00000345) + (*white**-0.0885) + (*black**-0.24972) + (*oriental**0.01158) + (*central**-0.07377) + (*south**-0.02857) + (*west**0.60825);

Ptea = 2.07429 + (*hinc**0.00000716) + (*white**-0.39710) + (*black**-0.08642) + (*oriental**-0.13340) + (*central**0.03567) + (*south**-0.29073) + (*west**0.24558);

Pcoffee = 1.26359 + (*hinc**0.00000539) + (*white**-0.26017) + (*black**-0.18400) + (*oriental**0.86170)+ (*central**0.10697) + (*south**0.00532) + (*west**0.33853);

Pcsd = 2.29327 + (*hinc**0.0000006510327) + (*white**0.02942) + (*black**0.03566) + (*oriental**0.14496) + (*central**0.07624) + (*south**0.16520)+ (*west**0.21459);

Pwater = 1.98661 + (*hinc**0.00000218) + (*white**0.04082) + (*black**-0.06763) + (*oriental**0.01389) + (*central**-0.00548) + (*south**-0.06986) + (*west**-0.20992);

Pmilk = 3.21833 + (*hinc**-0.000000112181) + (*white**-0.13875) + (*black**0.28677) + (*oriental**0.22932) + (*central**-0.24758) + (*south**-0.05396) + (*west**0.17670);

Insert Tables 2, 3 and 4

The coefficients were derived by regressing the price of each non-alcoholic beverage item with household income (*hinc*), race (*white,black* and *oriental*) and regions (*central, south* and *west*). Tables 2, 3 and 4 present the mean total expenditures, quantity purchased and prices for the six non-alcoholic beverages considered. In this case we find that the top household purchases with respect to non-alcoholic beverages were carbonated soft drinks, fruit juices, milk and coffee. The mean prices are as follows: fruit juices ($4.71/gal), tea ($2.06/gal), coffee ($1.41/gal), carbonated soft drinks ($2.48/gal), bottled water ($2.06/gal) and milk ($3.08/gal). On the other hand, Table 5 presents the mean budget shares of the beverage items. For the period 1999, approximately 81 percent of total expenditures for non alcoholic beverages are captured by carbonated soft drinks, fruit juices and milk. The remaining 19 percent are devoted to tea (4.7 %), coffee (11%) and bottled water (3.8 %).

Insert Table 5

Table 6 describes the degree of censoring associated with each type of non-alcoholic beverages for each household on a quarterly basis. From the table, items with minimal to medium censoring are milk (6.77%), carbonated soft drinks (8.84 %) and fruit juices (23.09 %). On the other hand, the remaining highly censored non-alcoholic beverage items are tea (54.88 %), coffee (42.77 %) and bottled water (60.65 %).

Insert Table 6

Empirical Results

Estimated Demand Parameters[2]

Almost all of the socio-demographic coefficients in both specifications and across all estimation techniques are statistically significant. Also, almost all of the parameters in both AIDS and QUAIDS and across estimation techniques are relatively close to one another and the same can be said for the AIDS and QUAIDS unrestricted cases. Thus it can be postulated that because of a relatively large sample size, the various estimation procedures converged to yielding relatively close parameter estimates. Also, the parameters associated with the quadratic term in the QUAIDS specification are highly significant, suggesting in part a bias towards the QUAIDS specification over the AIDS model across the various estimation procedures, with or without incorporating demand restrictions. In Table 7, we find that the symmetry, homogeneity and the combination of both restrictions are rejected in both the AIDS and QUAIDS models.

Insert Table 7

Expenditure and Compensated Elasticities

In Tables 8 to 15, we present the calculated expenditure and compensated elasticities of non-alcoholic beverages across model specifications, estimation techniques and imposition of theoretical restrictions. From the tables, we find that both expenditure elasticities and own-price elasticities were generally similar across model specifications, estimation techniques and whether or not the theoretical restrictions were imposed. All of

[2] Due to space constraints, the estimated parameters are not included in the text, but are available upon request.

the expenditure elasticities are positive indicating that all non-alcoholic beverages are normal goods. Also, if we look at the compensated cross-price elasticities across model specifications, estimation techniques and with or without theoretical restrictions, we find that almost all of them are positive indicating that the set of non-alcoholic beverages are net substitutes. Similarly, the major substitutes for fruit juice and tea are coffee, carbonated soft drink and milk. On the other hand the major substitutes for coffee are fruit juice, carbonated soft drinks and milk. For carbonated soft drinks the major substitutes are coffee and milk. Coffee, carbonated soft drinks and milk represent the major non-alcoholic beverage substitutes for bottled water. Finally, the major commodity substitutes for milk are fruit juice, coffee and carbonated soft drinks.

Insert Tables 8 to 15

Elasticity Comparisons across Censored Estimation Techniques of Non-Alcoholic Beverages

In Table 9, we present the AIDS compensated or Hicksian price elasticity matrix of non-alcoholic beverages. We note more variability of cross-price elasticities estimates of non-alcoholic beverage that are highly censored, that is for tea, coffee and bottled water. On the other hand, relatively less variable cross-price elasticity estimates were observed for commodities with relatively fewer censoring issues. For example, in milk, the cross-price elasticity estimates of milk with respect to fruit juice ranged from 0.152 to 0.275. The cross-price elasticity values for bottled water with respect to fruit juice ranged from 0.011 to 0.492. Also note that associated p-values for all price elasticities are mostly significant. For the QUAIDS specification, we note the same claim that the greater number of censored observations the commodity, the more variable the respective own- and cross-price elasticities are. For milk the compensated price elasticities with respect to fruit juice ranged from 0.153 to 0.283, while for the bottled water, the compensated price elasticities ranged from -0.033 to 0.451 (Table 11). On the other hand, the same observation can be made for the AIDS and QUAIDS unrestricted cases. For example the cross-price elasticity of milk with respect fruit juice ranged from 0.122 to 0.152 for AIDS (Table 13) and 0.121 to 0.153 for QUAIDS (Table 15), while the cross-price elasticity of bottled water with respect to fruit juice ranged from 0.372 to 0.675 for the AIDS specification and 0.378 to 0.666 for the QUAIDS model.

Elasticity Comparisons across Model Specifications (AIDS vs. QUAIDS)

The compensated own- and cross-price elasticity matrices of non-alcoholic beverages of both the AIDS and QUAIDS models are presented in Tables 9 and 11. We note relatively similar price elasticity estimates especially with respect to the own-price elasticity values of both models. For milk, the range of the AIDS own price elasticities were from -0.951 to -1.211, whereas for the QUAIDS model, the values ranged from -1.015 to -1.215. Also if we look at a highly censored commodity such as bottled water, the cross-price elasticity of bottled water with respect to tea ranged from 0.002 to 0.380 for the AIDS model and 0.004 to 0.428 in the QUAIDS specification. The same findings also were observed for the unrestricted cases of AIDS and QUAIDS where the calculated compensated price elasticities were remarkably similar.

Elasticity Comparisons across Imposition of Theoretical Restrictions

In Tables 9 and 13, we show the compensated own- and cross-price elasticity matrices of the AIDS restricted and unrestricted cases. Two notable results were observed; own-price elasticity estimates (absolute values) were larger in the restricted case vis-à-vis the unrestricted case. On the other hand compensated cross-price elasticities were generally larger in absolute terms in the unrestricted case relative to the values generated in the restricted case. The same result also was observed for the QUAIDS restricted and unrestricted models (Tables 11 & 15).

Fit Comparisons across Econometric Techniques

Table 16 present the R-square values of the budget share equations from different censoring econometric techniques across demand system specification and imposition of theoretical restrictions. From the estimates, we find that across model specifications and theoretical restrictions, the Heien and Wessells approach had the highest R-square values in its budget share equations. On the other hand, R-square values generated by the Shonkwiler and Yen technique registered second if theoretical restrictions are relaxed. Likewise, the ITSUR technique placed last across demand model specifications and theoretical impositions in terms of goodness of fit.

Insert Table 16

Conclusions

We find that the price elasticities especially the compensated price elasticities were robust and relatively similar and statistically significant across model specifications, estimation techniques and restriction impositions. The signs of the compensated cross-price elasticities across the board were generally positive indicating that the respective non-alcoholic beverages are net substitutes. Comparative analysis show that across estimation techniques, greater variability of compensated cross-price elasticity estimates were observed in highly censored non-alcoholic beverages such as tea, coffee and bottled water. As for the comparison between model specifications (AIDS versus QUAIDS), the compensated price estimates were remarkably similar especially for the own-price elasticity values. Finally, the estimates for unrestricted compensated cross-price elasticities were generally greater vis-à-vis the restricted cases. The reverse is generally true with regard to the compensated own-price elasticity estimates. The robustness of both the parameter estimates and the calculated expenditure and price elasticities may be explained in part to the availability of high number of observations (n~30,000). However, since most censored data sets do not usually have this particular characteristic, then studies that simulate the effect of sample size will be beneficial on determining whether robustness will still be observed for parameter estimates and price and expenditures elasticities in the presence of differing sample sizes.

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Table 1. Descriptive Statistics of Relevant Household Demographic Variables.

Variables	Mean	Std. Deviation	Min	Max
Household Income($)	51,740	26,254	5,000	100,000
Household Size (%)				
One member	22	41	0	1
Two members	38	48	0	1
Three members	16	37	0	1
Four members	15	36	0	1
Five members	10	29	0	1
Race (%)				
White	84	37	0	1
Black	10	30	0	1
Oriental	1	11	0	1
Other	5	22	0	1
Region (%)				
East	20	40	0	1
Central	25	43	0	1
South	34	47	0	1
West	20	40	0	1
Observations	28,780			

Table 2. Descriptive Statistics for Total Expenditure for Each Non- Alcoholic Beverage Item (n=28,780).

	Mean ($)	Std. Deviation ($)	Min ($)	Max ($)
Fruit Juices	14.19	19.15	0	268.82
Tea	3.42	7.36	0	177.26
Coffee	8.45	13.21	0	230.59
Carbonated Soft Drinks	31.14	41.24	0	1814.93
Bottled Water	3.02	8.34	0	206.96
Milk	22.86	23.87	0	304.05

Table 3. Descriptive Statistics for Quantities for Each Non Alcoholic Beverage Item (n=28,780).

	Mean (gallons)	Std. Deviation (gallons)	Min (gallons)	Max (gallons)
Fruit Juices	3.17	4.25	0	63.31
Tea	2.76	6.03	0	137.50
Coffee	8.27	13.73	0	305.51
Carbonated Soft Drinks	13.27	16.83	0	681.75
Bottled Water	2.44	7.51	0	151.45
Milk	8.30	9.22	0	98.00

Table 4. Descriptive Statistics for Prices[1] for Each Non-Alcoholic Beverage Item (n=28,780).

	Mean ($/gallon)	Std. Deviation ($/gallon)	Min ($/gallon)	Max ($/gallon)
Fruit Juices	4.71	1.31	0.99	15.09
Tea	2.06	1.24	0.08	16.08
Coffee	1.41	1.32	0.13	16.03
Carbonated Soft Drinks	2.48	0.85	0.30	11.44
Bottled Water	2.06	1.04	0.05	12.83
Milk	3.08	0.89	0.88	15.56

[1] When expenditure and quantities are equal to zero, price imputation was used P_i=f (income, race and region).

Table 5. Descriptive Statistics for Budget Shares for Each Beverage Item for Calendar Year 1999.

Beverage Product	Average Budget Share	Std. Deviation	Min	Max
Fruit Juices	0.175	0.188	0	1
Tea	0.047	0.096	0.	1
Coffee	0.109	0.153	0	1
Carbonated Soft Drinks	0.343	0.247	0	1
Bottled Water	0.038	0.094	0.	1
Milk	0.288	0.210	0.	1

Table 6. Number of Censored Responses for Each Beverage Item.

	Number of Observations	Percentage
Fruit Juices	6,646	23.09
Tea	15,795	54.88
Coffee	12,310	42.77
Carbonated Soft Drinks	2,544	8.84
Bottled Water	17,454	60.65
Milk	1,949	6.77

Table 7. Tests of Symmetry, Homogeneity and Combination of Symmetry and Homogeneity Restriction Based on Wald Tests.

	Symmetry		Homogeneity		Symmetry and Homogeneity	
	χ^2-Statistic	p-value	χ^2-Statistic	p-value	χ^2-Statistic	p-value
A. AIDS model						
ITSUR	671.32	<.0001	367.24	<.0001	755.93	<.0001
Heien & Wessells	610.79	<.0001	201.58	<.0001	730.66	<.0001
Shonkwiler & Yen	561.91	<.0001	177.43	<.0001	624.23	<.0001
B. QUAIDS model						
ITSUR	664.31	<.0001	351.10	<.0001	726.78	<.0001
Heien & Wessells	623.55	<.0001	745.17	<.0001	1027.90	<.0001
Shonkwiler & Yen	594.46	<.0001	392.83	<.0001	1019.80	<.0001

Table 8. Expenditure Elasticities[1] of Non-Alcoholic Beverages Using the AIDS System and 1999 ACNielsen Homescan Data

Item	ITSUR Estimate	Heien & Wessells Estimate	Shonkwiler & Yen Estimate	GME Estimate	Dong et al. Actual Estimates	Dong et al. Latent Estimates	Mean	Standard Deviation
Fruit Juice	1.023	0.960	1.021	1.042	1.008	1.027	1.013	0.028
	(0.000)	(0.000)	(0.000)		(0.000)	(0.005)		
Tea	0.733	1.733	0.684	0.741	0.889	0.728	0.918	0.405
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)		
Coffee	0.991	0.857	1.004	0.968	1.005	1.021	0.974	0.060
	(0.000)	(0.000)	(0.000)		(0.000)	(0.089)		
Carbonated Soft drinks	1.141	1.122	1.154	1.158	1.112	1.156	1.140	0.019
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)		
Bottled Water	0.934	0.752	0.924	0.958	1.128	1.397	1.016	0.222
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)		
Milk	0.873	0.847	0.864	0.847	0.864	0.790	0.848	0.030
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)		

Note: p-values are in brackets
[1]Calculated using sample means
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Table 9. Compensated Own- and Cross-Price Elasticity Matrix[1] of Non-Alcoholic Beverages Using the AIDS and the 1999 ACNielsen Homescan Data

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Fruit Juice	ITSUR	**-0.827**	[.0001]	0.050	[.0001]	0.193	[.0001]	0.139	[.0001]	0.020	[.0108]	0.425	[.0001]
	Heien &Wessells	**-0.777**	[.0001]	0.040	[.0001]	0.173	[.0001]	0.139	[.0001]	0.018	[.0149]	0.407	[.0001]
	Shonkwiler & Yen	**-0.812**	[.0001]	0.022	[.0245]	0.231	[.0001]	0.114	[.0001]	0.001	[.9528]	0.445	[.0001]
	Dong et. al (actual)	**-0.877**	[.0001]	0.064	[0.0001]	0.189	[.0001]	0.202	[.0001]	-0.006	[.1923]	0.428	[.0001]
	Dong e.t al (latent)	**-0.913**		0.091		0.265		0.065		-0.006		0.498	
	GME(unrestricted)	**-0.730**		0.057		0.255		0.257		-0.142		0.474	
	Mean	**-0.823**		**0.054**		**0.218**		**0.153**		**-0.019**		**0.446**	
	Std. Deviation	**0.066**		**0.023**		**0.038**		**0.068**		**0.061**		**0.034**	
Tea	ITSUR	0.199	[.0001]	**-1.244**	[.0001]	0.153	[.0001]	0.399	[.0001]	0.103	[.0001]	0.390	[.0001]
	Heien &Wessells	0.115	[.0001]	**-1.224**	[.0001]	0.011	[.5905]	0.530	[.0001]	-0.016	[.2609]	0.585	[.0001]
	Shonkwiler & Yen	0.101	[.0073]	**-1.496**	[.0001]	0.587	[.0001]	0.373	[.0001]	0.296	[.0001]	0.139	[.0001]
	Dong et al (actual)	0.190	[.0001]	**-1.256**	[0.0001]	0.147	[.0001]	0.425	[.0001]	0.051	[.0001]	0.442	[.0001]
	Dong et al (latent)	0.210		**-1.725**		0.216		0.519		0.135		0.645	
	GME (unrestricted)	0.361		**-1.207**		0.206		0.257		-0.142		0.474	
	Mean	**0.196**		**-1.359**		**0.220**		**0.417**		**0.071**		**0.446**	
	Std. Deviation	**0.093**		**0.209**		**0.194**		**0.101**		**0.148**		**0.177**	
Coffee	ITSUR	0.310	[0.0001]	0.066	[.0001]	**-1.483**	[.0001]	0.437	[.0001]	0.109	[.0001]	0.560	[.0001]
	Heien &Wessells	0.284	[0.0001]	0.008	[.3918]	**-1.270**	[.0001]	0.393	[.0001]	0.090	[.0001]	0.495	[.0001]
	Shonkwiler & Yen	0.376	[0.0001]	0.231	[.0001]	**-1.764**	[.0001]	0.442	[.0001]	0.193	[.0001]	0.522	[.0001]
	Dong et. al (actual)	0.289	[.0001]	0.061	[.0001]	**-1.337**	[.0001]	0.437	[.0001]	0.092	[.0001]	0.459	[.0001]
	Dong et. al (latent)	0.409		0.090		**-1.785**		0.500		0.192		0.594	
	GME (unrestricted)	0.189		0.050		**-1.522**		0.343		0.081		0.462	
	Mean	**0.310**		**0.084**		**-1.527**		**0.425**		**0.126**		**0.515**	
	Std. Deviation	**0.077**		**0.077**		**0.213**		**0.053**		**0.052**		**0.054**	

Table 9. Continued

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Carbonated Soft drinks	ITSUR	0.064	[.0001]	0.054	[.0001]	0.139	[.0001]	**-0.645**	[.0001]	0.068	[.0001]	0.320	[.0001]
	Heien &Wessells	0.066	[.0001]	0.069	[.0001]	0.125	[.0001]	**-0.642**	[.0001]	0.053	[.0001]	0.329	[.0001]
	Shonkwiler & Yen	0.049	[.0001]	0.054	[.0001]	0.115	[.0001]	**-0.637**	[.0001]	0.067	[.0001]	0.352	[.0001]
	Dong et al (actual)	0.112	[.0001]	0.067	[.0001]	0.137	[.0001]	**-0.676**	[.0001]	0.084	[.0001]	0.276	[.0001]
	Dong et al (latent)	0.096		0.093		0.181	[.0001]	**-0.708**		0.132		0.207	
	GME (unrestricted)	0.080		0.071		0.160		**-0.603**		0.091		0.377	
	Mean	**0.078**		**0.068**		**0.143**		**-0.652**		**0.083**		**0.310**	
	Std. Deviation	**0.023**		**0.014**		**0.024**		**0.036**		**0.028**		**0.061**	
Bottled Water	ITSUR	0.097	[.0089]	0.125	[.0001]	0.314	[.0001]	0.628	[.0001]	**-1.977**	[.0001]	0.814	[.0001]
	Heien &Wessells	0.088	[.0090]	0.002	[.8978]	0.250	[.0001]	0.493	[.0001]	**-1.527**	[.0001]	0.694	[.0001]
	Shonkwiler & Yen	0.011	[.8326]	0.351	[.0001]	0.566	[.0001]	0.651	[.0001]	**-2.541**	[.0001]	0.962	[.0001]
	Dong et al (actual)	0.139	[.0001]	0.146	[.0001]	0.278	[.0001]	0.512	[.0001]	**-1.807**	[.0001]	0.732	[.0001]
	Dong et al (latent)	0.068		0.380		0.670		0.811		**-3.455**		1.525	
	GME (unrestricted)	0.492		0.225		0.389		0.791		**-1.908**		0.853	
	Mean	**0.149**		**0.205**		**0.411**		**0.648**		**-2.203**		**0.930**	
	Std. Deviation	**0.173**		**0.144**		**0.170**		**0.134**		**0.698**		**0.307**	
Milk	ITSUR	0.264	[.0001]	0.067	[.0001]	0.213	[.0001]	0.370	[.0001]	0.109	[.0001]	**-1.023**	[.0001]
	Heien &Wessells	0.256	[.0001]	0.090	[.0001]	0.192	[.0001]	0.380	[.0001]	0.097	[.0001]	**-1.014**	[.0001]
	Shonkwiler & Yen	0.275	[.0001]	0.032	[.0001]	0.219	[.0001]	0.375	[.0001]	0.134	[.0001]	**-1.036**	[.0001]
	Dong et al (actual)	0.235	[.0001]	0.052	[.0001]	0.195	[.0001]	0.381	[.0001]	0.088	[.0001]	**-0.951**	[.0001]
	Dong et al (latent)	0.272		0.074		0.281		0.383		0.152		**-1.162**	
	GME (unrestricted)	0.152		0.040		0.148		0.251		0.102		**-1.211**	
	Mean	**0.242**		**0.059**		**0.208**		**0.357**		**0.114**		**-1.066**	
	Std. Deviation	**0.046**		**0.022**		**0.044**		**0.052**		**0.024**		**0.099**	

Note: p-values are in brackets

[1]Calculated using sample means.

Table 10. Expenditure Elasticities[1] of Non-Alcoholic Beverages Using the QUAIDS System and 1999 ACNielsen Homescan Data

Item	ITSUR Estimate	Heien & Wessells Estimate	Shonkwiler & Yen Estimate	GME Estimate	Mean	Standard Deviation
Fruit Juice	0.982	0.932	0.964	1.010	0.972	0.033
	(0.000)	(0.000)	(0.000)			
Tea	0.767	1.601	0.841	0.776	0.996	0.404
	(0.000)	(0.000)	(0.000)			
Coffee	0.879	0.757	0.844	0.872	0.838	0.056
	(0.000)	(0.000)	(0.000)			
Carbonated Soft drinks	1.184	1.171	1.189	1.201	1.186	0.012
	(0.000)	(0.000)	(0.000)			
Bottled Water	1.033	0.828	1.127	1.054	1.011	0.128
	(0.000)	(0.000)	(0.000)			
Milk	0.870	0.855	0.864	0.833	0.856	0.016
	(0.000)	(0.000)	(0.000)			

Note: p-values are in brackets
[1]Calculated using sample means

Table 11. Compensated Own- and Cross-Price Elasticity Matrix[1] of Non-Alcoholic Beverages Using the QUAIDS and the 1999 ACNielsen Homescan Data

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Fruit Juice	ITSUR	**-0.826**	[.0001]	0.050	[.0001]	0.191	[.0001]	0.140	[.0001]	0.020	[.0108]	0.426	[.0001]
	Heien &Wessells	**-0.776**	[.0001]	0.040	[.0001]	0.172	[.0001]	0.139	[.0001]	0.018	[.0214]	0.408	[.0001]
	Shonkwiler & Yen	**-0.805**	[.0001]	0.013	[.2032]	0.247	[.0001]	0.117	[.0001]	-0.009	[.4151]	0.438	[.0001]
	GME (unrestricted)	**-0.716**		0.043		0.270		0.251		-0.172		0.469	
	Mean	**-0.781**		**0.036**		**0.220**		**0.162**		**-0.036**		**0.435**	
	Std. Deviation	**0.048**		**0.016**		**0.046**		**0.060**		**0.092**		**0.026**	
Tea	ITSUR	0.197	[.0001]	**-1.243**	[.0001]	0.154	[.0001]	0.399	[.0001]	0.103	[.0001]	0.391	[.0001]
	Heien &Wessells	0.115	[.0001]	**-1.228**	[.0001]	-0.002	[.9184]	0.544	[.0001]	-0.011	[.4564]	0.581	[.0001]
	Shonkwiler & Yen	0.067	[.0772]	**-1.422**	[.0001]	0.480	[.0001]	0.365	[.0001]	0.321	[.0001]	0.189	[.0001]
	GME (unrestricted)	0.337		**-1.199**		0.175		0.482		0.078		0.737	
	Mean	**0.179**		**-1.273**		**0.202**		**0.447**		**0.123**		**0.475**	
	Std. Deviation	**0.118**		**0.101**		**0.202**		**0.081**		**0.141**		**0.237**	
Coffee	ITSUR	0.313	[0.0001]	0.066	[.0001]	**-1.490**	[.0001]	0.442	[.0001]	0.111	[.0001]	0.558	[.0001]
	Heien &Wessells	0.286	[0.0001]	0.006	[.5303]	**-1.275**	[.0001]	0.397	[.0001]	0.091	[.0001]	0.495	[.0001]
	Shonkwiler & Yen	0.396	[0.0001]	0.182	[.0001]	**-1.700**	[.0001]	0.487	[.0001]	0.164	[.0001]	0.471	[.0001]
	GME (unrestricted)	0.228		0.039		**-1.484**		0.336		0.068		0.452	
	Mean	**0.306**		**0.073**		**-1.487**		**0.415**		**0.108**		**0.494**	
	Std. Deviation	**0.070**		**0.077**		**0.174**		**0.065**		**0.041**		**0.046**	
Carbonated Soft drinks	ITSUR	0.062	[.0001]	0.054	[.0001]	0.139	[.0001]	**-0.644**	[.0001]	0.068	[.0001]	0.321	[.0001]
	Heien &Wessells	0.064	[.0001]	0.069	[.0001]	0.126	[.0001]	**-0.642**	[.0001]	0.052	[.0001]	0.331	[.0001]
	Shonkwiler & Yen	0.042	[.0001]	0.057	[.0001]	0.103	[.0001]	**-0.638**	[.0001]	0.084	[.0001]	0.352	[.0001]
	GME (unrestricted)	0.067		0.073		0.152		**-0.611**		0.094		0.384	
	Mean	**0.059**		**0.064**		**0.130**		**-0.634**		**0.075**		**0.347**	
	Std. Deviation	**0.011**		**0.009**		**0.021**		**0.016**		**0.019**		**0.028**	

Table 11. Continued

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Bottled Water	ITSUR	0.092	[.0693]	0.125	[.0001]	0.317	[.0001]	0.628	[.0001]	**-1.976**	[.0001]	0.814	[.0001]
	Heien &Wessells	0.083	[.0140]	0.004	[.8310]	0.249	[.0001]	0.494	[.0001]	**-1.525**	[.0001]	0.695	[.0001]
	Shonkwiler & Yen	-0.033	[.5349]	0.428	[.0001]	0.495	[.0001]	0.530	[.0001]	**-2.496**	[.0001]	1.076	[.0001]
	GME (unrestricted)	0.451		0.236		0.347		0.818		**-1.892**		0.862	
	Mean	**0.148**		**0.198**		**0.352**		**0.618**		**-1.972**		**0.862**	
	Std. Deviation	**0.210**		**0.180**		**0.104**		**0.145**		**0.400**		**0.159**	
Milk	ITSUR	0.266	[.0001]	0.067	[.0001]	0.215	[.0001]	0.367	[.0001]	0.108	[.0001]	**-1.024**	[.0001]
	Heien &Wessells	0.257	[.0001]	0.091	[.0001]	0.195	[.0001]	0.377	[.0001]	0.096	[.0001]	**-1.015**	[.0001]
	Shonkwiler & Yen	0.283	[.0001]	0.031	[.0001]	0.227	[.0001]	0.375	[.0001]	0.120	[.0001]	**-1.036**	[.0001]
	GME (unrestricted)	0.153		0.039		0.145		0.261		0.103		**-1.215**	
	Mean	**0.240**		**0.057**		**0.195**		**0.345**		**0.107**		**-1.072**	
	Std. Deviation	**0.059**		**0.027**		**0.036**		**0.056**		**0.010**		**0.095**	

Note: p-values are in brackets

[1]Calculated using sample means.

Table 12. Expenditure Elasticities[1] of Non-Alcoholic Beverages Using the AIDS System and 1999 ACNielsen Homesan Data (Unrestricted)

Item	ITSUR Estimate	Heien & Wessells Estimate	Shonkwiler & Yen Estimate	GME Estimate	Mean	Standard Deviation
Fruit Juice	1.039	0.976	1.040	1.042	1.024	0.032
	(0.000)	(0.000)	(0.000)			
Tea	0.745	1.770	0.715	0.741	0.993	0.519
	(0.000)	(0.000)	(0.000)			
Coffee	0.976	0.841	0.965	0.968	0.937	0.065
	(0.000)	(0.000)	(0.000)			
Carbonated Soft Drinks	1.155	1.135	1.171	1.158	1.155	0.015
	(0.000)	(0.000)	(0.000)			
Bottled Water	0.963	0.762	0.963	0.958	0.911	0.100
	(0.000)	(0.000)	(0.000)			
Milk	0.847	0.820	0.836	0.847	0.838	0.013
	(0.000)	(0.000)	(0.000)			

p-values are in parenthesis
[1]Calculated using sample means

Table 13. Compensated Own- and Cross-Price Elasticity Matrix[1] of Non-Alcoholic Beverages Using the AIDS and 1999 ACNielsen Homescan Data (Unrestricted)

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Fruit Juice	ITSUR	**-0.723**	[.0001]	0.059	[.0001]	0.259	[.0001]	0.264	[.0001]	0.002	[.9024]	0.600	[.0001]
	Heien &Wessells	**-0.682**	[.0001]	0.061	[.0001]	0.239	[.0001]	0.251	[.0001]	0.003	[.7842]	0.539	[.0001]
	Shonkwiler & Yen	**-0.690**	[.0001]	0.048	[.0002]	0.283	[.0001]	0.271	[.0001]	-0.019	[.2473]	0.683	[.0001]
	GME	**-0.730**		0.057		0.255		0.257		-0.142		0.474	
	Mean	**-0.706**		**0.057**		**0.259**		**0.261**		**-0.039**		**0.574**	
	Std. Deviation	**0.024**		**0.006**		**0.018**		**0.009**		**0.069**		**0.089**	
Tea	ITSUR	0.327	[.0001]	**-1.219**	[.1954]	0.177	[.0001]	0.415	[.0001]	0.065	[.0001]	0.631	[.0001]
	Heien &Wessells	0.292	[.0001]	**-1.347**	[.4191]	-0.084	[.0001]	0.626	[.0001]	-0.239	[.0001]	1.501	[.0001]
	Shonkwiler & Yen	0.102	[.0001]	**-1.342**	[.1649]	0.853	[.0001]	0.259	[.0001]	0.443	[.0001]	-0.139	[.0001]
	GME	0.361		**-1.207**		0.206		0.257		-0.142		0.474	
	Mean	**0.270**		**-1.279**		**0.288**		**0.389**		**0.032**		**0.617**	
	Std. Deviation	**0.116**		**0.076**		**0.398**		**0.174**		**0.302**		**0.677**	
Coffee	ITSUR	0.185	[0.0001]	0.049	[.0003]	**-1.526**	[.0001]	0.338	[.0001]	0.081	[.0001]	0.045	[.0001]
	Heien &Wessells	0.165	[0.0001]	0.092	[.0001]	**-1.324**	[.0001]	0.320	[.0001]	0.066	[.0001]	0.335	[.0001]
	Shonkwiler & Yen	0.187	[0.0002]	0.062	[.0001]	**-1.930**	[.0001]	0.312	[.0001]	0.125	[.0001]	0.575	[.0001]
	GME	0.189		0.050		**-1.522**		0.343		0.081		0.462	
	Mean	**0.181**		**0.063**		**-1.575**		**0.328**		**0.088**		**0.354**	
	Std. Deviation	**0.011**		**0.020**		**0.255**		**0.014**		**0.026**		**0.228**	

Table 13. Continued

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Carbonated Soft drinks	ITSUR	0.107	[.0001]	0.076	[.0001]	0.179	[.0001]	**-0.572**	[.0001]	0.097	[.0001]	0.436	[.0001]
	Heien &Wessells	0.109	[.0001]	0.050	[.0001]	0.182	[.0001]	**-0.593**	[.0001]	0.099	[.0001]	0.449	[.0001]
	Shonkwiler & Yen	0.102	[.0001]	0.082	[.0001]	0.175	[.0001]	**-0.552**	[.0001]	0.096	[.0001]	0.450	[.0001]
	GME	0.080		0.071		0.160		**-0.603**		0.091		0.377	
	Mean	**0.099**		**0.070**		**0.174**		**-0.580**		**0.096**		**0.428**	
	Std. Deviation	**0.013**		**0.014**		**0.010**		**0.023**		**0.004**		**0.034**	
Bottled Water	ITSUR	0.486	[.0001]	0.223	[.0001]	0.384	[.0001]	0.789	[.0001]	**-1.910**	[.0001]	0.838	[.0001]
	Heien &Wessells	0.372	[.0001]	0.213	[.0001]	0.246	[.0001]	0.605	[.0001]	**-1.474**	[.0001]	0.570	[.0001]
	Shonkwiler & Yen	0.675	[.0001]	0.347	[.0001]	0.576	[.0001]	0.651	[.0001]	**-2.461**	[.0001]	1.016	[.0001]
	GME	0.492		0.225		0.389		0.791		**-1.908**		0.853	
	Mean	**0.506**		**0.252**		**0.399**		**0.709**		**-1.938**		**0.819**	
	Std. Deviation	**0.125**		**0.064**		**0.135**		**0.095**		**0.404**		**0.185**	
Milk	ITSUR	0.127	[.0001]	0.024	[.0009]	0.129	[.0001]	0.222	[.0001]	0.096	[.0001]	**-1.269**	[.0001]
	Heien &Wessells	0.125	[.0001]	0.060	[.0001]	0.120	[.0001]	0.250	[.0001]	0.088	[.0001]	**-1.309**	[.0001]
	Shonkwiler & Yen	0.122	[.0001]	0.023	[.0001]	0.135	[.0001]	0.199	[.0001]	0.102	[.0001]	**-1.303**	[.0001]
	GME	0.152		0.040		0.148		0.251		0.102		**-1.211**	
	Mean	**0.131**		**0.037**		**0.133**		**0.230**		**0.097**		**-1.273**	
	Std. Deviation	**0.014**		**0.018**		**0.012**		**0.025**		**0.007**		**0.045**	

Note: p-values are in brackets
[1]Calculated using sample means

Table 14. Expenditure Elasticities[1] of Non-Alcoholic Beverages Using the QUAIDS System and 1999 ACNielsen Homescan Data (Unrestricted)

Item	ITSUR Estimate	Heien & Wessells Estimate	Shonkwiler & Yen Estimate	GME Estimate	Mean	Standard Deviation
Fruit Juice	1.054	0.956	1.079	1.010	1.025	0.054
	(0.000)	(0.000)	(0.000)			
Tea	0.586	1.547	0.929	0.776	0.959	0.416
	(0.000)	(0.000)	(0.000)			
Coffee	0.988	0.734	0.661	0.872	0.814	0.145
	(0.000)	(0.000)	(0.000)			
Carbonated Soft Drinks	1.162	1.198	1.199	1.201	1.190	0.019
	(0.000)	(0.000)	(0.000)			
Bottled Water	0.943	0.862	0.995	1.054	0.963	0.081
	(0.000)	(0.000)	(0.000)			
Milk	0.854	0.820	0.856	0.833	0.841	0.017
	(0.000)	(0.000)	(0.000)			

Note: p-values are in brackets
[1]Calculated using sample means

Table 15. Compensated Own- and Cross-Price Elasticity Matrix[1] of Non-Alcoholic Beverages Using the QUAIDS and the 1999 ACNielsen Homescan Data (Unrestricted)

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Fruit Juice	ITSUR	**-0.723**	[.0001]	0.100	[.0001]	0.258	[.0001]	0.268	[.0001]	0.003	[.8061]	0.600	[.0001]
	Heien &Wessells	**-0.683**	[.0001]	0.017	[.3264]	0.238	[.0001]	0.246	[.0001]	0.003	[.8260]	0.539	[.0001]
	Shonkwiler & Yen	**-0.698**	[.0001]	0.071	[.0001]	0.502	[.0001]	0.275	[.0001]	0.003	[.8804]	0.687	[.0001]
	GME	**-0.716**		0.043		0.270		0.251		-0.172		0.469	
	Mean	**-0.705**		**0.058**		**0.317**		**0.260**		**-0.041**		**0.574**	
	Std. Deviation	**0.018**		**0.036**		**0.124**		**0.014**		**0.087**		**0.093**	
Tea	ITSUR	0.312	[.0001]	**-1.658**	[.0001]	0.179	[.0001]	0.361	[.0001]	0.037	[.0001]	0.622	[.0001]
	Heien &Wessells	0.276	[.0001]	**-1.207**	[.0001]	-0.119	[.0001]	0.671	[.0001]	-0.254	[.0001]	1.424	[.0001]
	Shonkwiler & Yen	0.089	[.0001]	**-1.383**	[.0001]	2.085	[.0001]	0.390	[.0001]	0.555	[.0001]	-0.184	[.0001]
	GME	0.337		**-1.199**		0.175		0.482		0.078		0.737	
	Mean	**0.254**		**-1.362**		**0.580**		**0.476**		**0.104**		**0.650**	
	Std. Deviation	**0.113**		**0.215**		**1.013**		**0.140**		**0.335**		**0.659**	
Coffee	ITSUR	0.185	[0.0001]	0.081	[.0001]	**-1.527**	[.0001]	0.342	[.0001]	0.083	[.0001]	0.454	[.0001]
	Heien &Wessells	0.163	[0.0001]	-0.163	[.0001]	**-1.330**	[.0001]	0.304	[.0001]	0.070	[.0001]	0.351	[.0001]
	Shonkwiler & Yen	0.240	[0.0001]	-0.052	[.1667]	**-3.728**	[.0001]	0.227	[.0001]	-0.042	[.2921]	0.580	[.0001]
	GME	0.228		0.039		**-1.484**		0.336		0.068		0.452	
	Mean	**0.204**		**-0.024**		**-2.017**		**0.302**		**0.044**		**0.459**	
	Std. Deviation	**0.036**		**0.108**		**1.144**		**0.053**		**0.058**		**0.094**	
Carbonated Soft drinks	ITSUR	0.106	[.0001]	0.096	[.0001]	0.178	[.0001]	**-0.572**	[.0001]	0.098	[.0001]	0.438	[.0001]
	Heien &Wessells	0.110	[.0001]	0.214	[.0001]	0.184	[.0001]	**-0.578**	[.0001]	0.097	[.0001]	0.435	[.0001]
	Shonkwiler & Yen	0.093	[.0001]	0.108	[.0001]	0.348	[.0001]	**-0.561**	[.0001]	0.112	[.0001]	0.461	[.0001]
	GME	0.067		0.073		0.152		**-0.611**		0.094		0.384	
	Mean	**0.094**		**0.123**		**0.216**		**-0.580**		**0.100**		**0.429**	
	Std. Deviation	**0.019**		**0.062**		**0.089**		**0.021**		**0.008**		**0.033**	

Table 15. Continued

		Fruit Juice		Tea		Coffee		Carbonated Soft Drinks		Bottled Water		Milk	
Bottled Water	ITSUR	0.486	[.0001]	0.167	[.0001]	0.385	[.0001]	0.783	[.0001]	**-1.912**	[.0001]	0.837	[.0001]
	Heien &Wessells	0.378	[.0001]	0.358	[.0001]	0.261	[.0001]	0.593	[.0001]	**-1.467**	[.0001]	0.602	[.0001]
	Shonkwiler & Yen	0.666	[.0001]	0.354	[.0001]	0.819	[.0001]	1.029	[.0001]	**-2.440**	[.0001]	1.180	[.0001]
	GME	0.451		0.236		0.347		0.818		**-1.892**		0.862	
	Mean	**0.495**		**0.279**		**0.453**		**0.806**		**-1.928**		**0.870**	
	Std. Deviation	**0.122**		**0.093**		**0.250**		**0.179**		**0.399**		**0.237**	
Milk	ITSUR	0.128	[.0001]	0.043	[.0001]	0.129	[.0001]	0.227	[.0001]	0.096	[.0001]	**-1.270**	[.0001]
	Heien &Wessells	0.127	[.0001]	0.022	[.0594]	0.124	[.0001]	0.236	[.0001]	0.091	[.0001]	**-1.290**	[.0001]
	Shonkwiler & Yen	0.121	[.0001]	0.026	[.0001]	0.243	[.0001]	0.216	[.0001]	0.112	[.0001]	**-1.311**	[.0001]
	GME	0.153		0.039		0.145		0.261		0.103		**-1.215**	
	Mean	**0.132**		**0.033**		**0.160**		**0.235**		**0.101**		**-1.271**	
	Std. Deviation	**0.014**		**0.010**		**0.056**		**0.019**		**0.009**		**0.041**	

Note: p-values are in brackets
[1]Calculated using sample means

Table 16. R-squared Values of Budget Share Equations from Different Censoring Econometric Techniques.

Micro-Demand System Model	Econometric Techniques	Fruit Juice w_f	Coffee w_c	Soft Drink w_s	Bottled Water w_w	Milk w_m	Tea w_t
AIDS	ITSUR	0.0622	0.0673	0.0484	0.0764	0.0734	0.0184
	Heien & Wessells	0.1937	0.3202	0.0966	0.2593	0.1441	0.0038
	Shonkwiler & Yen	0.0629	0.0641	0.0479	0.0720	0.0744	0.0133
	GME (unrestricted)	0.0673	0.0695	0.0537	0.0801	0.0937	0.0145
	Dong et. al	0.0139	0.0484	0.0016	0.0676	0.0253	0.0101
QUAIDS	ITSUR	0.0636	0.0732	0.0517	0.0779	0.0734	0.0189
	Heien & Wessells	0.1956	0.3259	0.1054	0.2602	0.1463	0.0037
	Shonkwiler & Yen	0.0643	0.0702	0.0511	0.0740	0.0742	0.0155
	GME (unrestricted)	0.0681	0.0742	0.0571	0.0816	0.0940	0.0150
AIDS (unrestricted)	ITSUR	0.0672	0.0694	0.0532	0.0801	0.0940	0.0035
	Heien & Wessells	0.1981	0.3257	0.1008	0.2649	0.1699	0.0113
	Shonkwiler & Yen	0.0676	0.0697	0.0529	0.0766	0.0944	0.0005
	GME	0.0673	0.0695	0.0537	0.0801	0.0937	0.0145
QUAIDS (unrestricted)	ITSUR	0.0682	0.0697	0.0536	0.0804	0.0946	0.0030
	Heien & Wessells	0.1995	0.3299	0.1106	0.2656	0.1721	0.0001
	Shonkwiler & Yen	0.0696	0.1076	0.0562	0.0768	0.0958	0.0037
	GME	0.0681	0.0742	0.0571	0.0816	0.0940	0.0150