Demand System Estimation in the Absence of Price Data: an Application of Stone-Lewbel Price Indices

César E. Castellón
Graduate Research Assistant, The John E. Walker Department of Economics, Clemson University, Clemson, SC 29634-0313, ccastel@clemson.edu

Tullaya Boonsaeng
Research Assistant Professor, The John E. Walker Department of Economics, Clemson University, Clemson, SC 29634-0313, tboonsa@clemson.edu

Carlos E. Carpio
Assistant Professor, The John E. Walker Department of Economics, Clemson University, Clemson, SC 29634-0313, ccarpio@clemson.edu

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Abstract

Lewbel (1989) developed an approach for the construction of household level commodity price indices (Stone-Lewbel prices) using only budget shares and CPIs of the goods comprising the commodity groups. In this study, we consider three alternative CPIs for the construction of SL prices and the estimation of a demand system. The three CPIs consider are: monthly, quarterly and unity. Where the unity CPI is used to simulate a scenario where no price index information is available. Elasticities and marginal effect estimates from the demand models proved to be robust to the alternative CPIs considered in this study (even to the absence of one).

Keywords: Stone-Lewbel price index, censored demand models, EASI demand model.

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Estimation of demand systems allows economists to compute demand elasticities for composite or individual commodities. These estimates find applications in analyzing market changes, tax incidence, consumption patterns, international trade, etc. Demand systems' parameter estimates can also be used for policy analysis, as most systems of equation allow for indirect utility and cost functions to be recovered.

A significant share of the demand analysis literature uses cross-sectional data from micro-level household surveys, due to higher availability and lower collection cost in comparison with panel data. A common limitation with cross-sectional data is the lack of price information, an important variable in estimating demand systems[1]. For example, in the U.S. the Bureau of Labor Statistics (BLS) conducts an annual survey of consumer expenditures (Consumer Expenditure Survey (CEX)); however, the survey does not collect data on prices paid for goods and services purchased.

There are several approaches used in the literature to overcome the lack of prices problem. In some cases, consumer expenditure surveys also collect data on quantities purchased and unit values (expenditure divided by quantities) are used as proxies for prices (e.g., Cox and Wohlgenant, 1986; Deaton, 1988). Another common approach in the literature is to incorporate external sources of price variability, such as Consumer Price Indices (CPIs), to account for missing prices (e.g., Seale Jr *et al*., 2003; Kastens and Brester, 1996). However, studies conducted by Slesnick (2005) and Hoderlein and Mihaleva (2008) have found this approach to be problematic as it does not account for spatial and household variability.

[1] Though this problem is characteristic to cross-sectional data, is not endemic to it, Carliner (1973) experienced the same limitation when working with panel data.

In this paper we empirically evaluate the approach proposed by Lewbel (1989) that allows for the construction of household level price indices (Stone-Lewbel (SL) prices) for commodity groups using as inputs CPIs and the budget shares of sub-groups of the commodities of interest. Hoderlein and Mihaleva (2008) found that relative to the use of CPIs only, the use of SL prices results in demand models' parameters and functions that are more precise and economically plausible. Nevertheless, a question remains about the selection of the CPIs for the construction of SL prices.

The time period for which a CPI is measured might range from a month to a year, and can be regionally or demographic specific. Therefore, the question of how dependent the demand estimation results are to the selected CPIs for the construction of SL prices becomes relevant in practical settings. In this study we consider three alternative CPIs for the construction of SL prices which are in turn utilized to estimate a demand system for eight food commodities using household level data for the United States. Elasticities, marginal effects and parameter estimates are compared for each of the price series to derive conclusions regarding the effect of using alternative CPIs.

The paper is organized as follows. In the next section we provide a brief review on SL prices and the selected parametric demand system, followed by a brief description of our survey data. Next, we discuss estimations procedures and results. Finally, we make some concluding remarks.

Conceptual framework

SL Price Indices

Lewbel (1989) derives the SL price indices by generalizing Barten's (1964) equivalence scales.[2] The generalized equivalence scales are defined as

$$M_{li}(q_{li}, a) = u_i(q_i, z^*)/u_{li}(q_{li}, z_l) \quad (1)$$

where M_{li} is the equivalence scale for commodity group i, household *l*; q_i is a vector of quantities for the goods comprising commodity group i; and z^* and z_l are vectors of demographic characteristics for a reference household[3] (*) and a given household (*l*), respectively.

By assuming that the utility function is homothetically separable it follows that there exist commodity group price indices (v_{li}) for each household, which are functions of the demographic characteristics for a reference household (z^*) and a vector of within-group prices (p_i). Hence, Lewbel (1989) shows that equation (1) can be rewritten as

$$M_{li}(q_{li}, z_l) = v_{li}(p_i, z_l)/v_i(p_i, z^*), \quad (2)$$

thus the equivalence scale M_{li} depends only on relative prices and demographic characteristics. Furthermore, because of the weak homotheticity property, the commodity group price indices (v_{li}) are the cost function for the goods comprising the commodity, such that

$$w_{lik} = \partial \log v_{li} / \partial \log p_{ik} \quad (3)$$

where w_{lik} and p_{ik} are the budget share and price for a particular good *k* within commodity group *i* for a given household *l*. Equation (3) implies that upon observing sub-group budget shares for individual commodities, we can integrate back these estimates and recover the commodity group price index, that is

[2] For a detailed explanation on equivalent scales see Muellbauer (1974).
[3] We choose the average household as the reference household.

$$\log\big(v_{li}(p_i, z_l)\big) = p_{ik} \int h_{lik}(p_i, z_l)\, dp_{ik} \tag{4}$$

where $h_{lik}(p_i, z_l)$ is defined to be the functional form for w_{lik}, and v_{li} is the SL price index for commodity group *i*, household *l*. Hence, the variation in the composition of expenditures within commodity groups allows for the identification of household level commodity price indices. In particular, if the within-group utility functions are assumed to be of the Cobb-Douglas form, say

$$u_{li}(q_{li}, z_l) = k_i \prod_{j=1}^{n_i} q_{lij}{}^{w_{lij}}, \tag{5}$$

where k_i is a scaling factor for commodity group *i* constructed using the sub-group budget shares of the reference household ($k_i = \prod_{j=1}^{n_i} \bar{w}_{ij}{}^{-\bar{w}_{ij}}$), then SL prices take the form (Lewbel, 1989)

$$v_{li} = \frac{1}{k_i} \prod_{j=1}^{n_i} \left(\frac{p_{ij}}{w_{lij}}\right)^{w_{lij}} \tag{6}$$

where p_{ij} are within commodity group price estimates. Equation (6) implies that household level price indices can be calculated using sub-groups budget shares (w_{lij}) and price indices (p_{ij}).

The LA/EASI Demand System

In this study we use the Exact Affine Stone Index (EASI) demand system recently proposed by Lewbel and Pendakur (2009). This demand system has several advantages relative to traditional demand systems such as the AIDS and Rotterdam models. The EASI demand system allows for nonlinear Engel curves and can be integrated back to the original cost function. Also, the budget share error terms can be rationalized as unobserved preference heterogeneity and demographic effects can be easily incorporated into the model. Like the AIDS model, the EASI demand system possesses a convenient linear approximation (LA) that uses the stone price index[4] to circumvent its nonlinear specification for real expenditures.

The LA/EASI demand budget share equations are defined as

[4] Lewbel and Pendakur (2009) conduct an empirical comparison between the actual model and its linear approximation without finding any major differences.

$$w_{it} = \sum_{r=0}^{5} b_{ri} y_t^r + \sum_{m=1}^{M} (C_{mi} z_{mt} + D_{mi} z_{mt} y_t) + \sum_{k=1}^{N} A_{ki} \log p_{kt} + \sum_{k=1}^{N} B_{ki} \log p_{kt} y_t + \varepsilon_{it} \qquad (7)$$

where index *i* correspond to commodity and index *t* correspond to household, y_t is total real expenditures ($y_t = \ln x_t - \sum_{i=1}^{N} w_{it} \log p_i$), x_t is total nominal expenditures, p_k is the price index for commodity group k, w_{it} is the demand budget share, the z_{mt}'s are demographic characteristics; and the $C_{mi}'s$, $D_{mi}'s$, $A_{ki}'s$, $B_{ki}'s$, and $b_{ri}'s$ are parameters to be estimated.

Equation (7) is a reduced form of Lewbel and Pendakur's (2009) original demand equation as we have omitted an interaction term between socio-demographic characteristics and prices to reduce the number of parameters to estimate [5].The system of *N* equations of the form in (7) satisfies adding-up and homogeneity restrictions if

$\sum_{i=1}^{N} b_{0i} = 1$, $\sum_{i=1}^{N} b_{ri} = 0$ for $r \neq 0$,

and $\sum_{i=1}^{N} A_{ki} = \sum_{i=1}^{N} C_{mi} = \sum_{i=1}^{N} D_{mi} = \sum_{i=1}^{N} B_{ki} = 0 \ \forall\ i.$ (8)

where symmetry of the Slutsky matrix is ensured by symmetry of the *nxn* matrices **A** and **B** which are composed of parameters A_{ki} and B_{ki}.

In short, the LA/EASI model possesses a set of desirable properties while retaining the familiar features that popularized the AIDS model. Nevertheless, the model does not yield traditional Marshallian demand functions, but what Lewbel and Pendakur (2009) describe as implicit Marshallian demand equations.

Implicit Marshallian demand equations of the form in (7) are Hicksian demands were the utility term has been approximated using total real expenditures. As a consequence, Marshallian demand elasticities cannot be directly derived from equation (7). We follow Lewbel and Pendakur's (2009) suggestion and estimate compensated (Hicksian) demand and expenditure

[5] To analyze the sensitivity of the results to the exclusion of this interaction, we estimated a LA/EASI model with the interaction terms between prices and socio-demographic variables, but the results were similar to those using the reduced model in (7).

elasticities to later recover uncompensated (Marshallian) demand elasticities using the Slutsky equation[6].

Data

From the Bureau of Labor and Statistics (BLS) we obtained Consumer Expenditure Survey (CEX) data in addition to monthly and quarterly Consumer Price Indices (CPIs). We constructed pooled cross-sectional data by grouping CEX and CPIs data from years 2002 to 2006.

Our pooled cross-sectional dataset included initially 36,364 households. Those observations with values of income and total expenditures below or equal to zero were discarded. Also, observations with missing values for socio demographic variables as well as outliers in commodity group expenditures were deleted. The final data set contains 30,768 households.

Using established USDA nutrition-based guidelines from the Quarterly Food At Home Price Database (QFAHPD) we consider the following eight commodity groups: 1) Cereal and Bakery products, 2) Meats and Eggs, 3) Dairy, 4) Fruits and Vegetables, 5) Nonalcoholic Beverages, 6) Fats and Oils, 7) Sugar and Other Sweets, and 8) Miscellaneous foods. Thirty sub-group commodities where allocated in the above categories. The allocation matched the existent composition for commodity groups for CPIs from the BLS.

Summary statistics and commodity groups' composition are presented in Table 1. The degree of purchase censoring (at two-week frequencies) ranged from 6% for Cereal and Bakery products to 35% for Fats and Oils. Also, those groups with the highest percentage of purchase censoring are associated with the smallest budget shares.

To produce consistent monthly and quarterly CPIs series over time, we used the average CPI from 2002 to 2006 as the base period (2002-2006=100). Also, since the BLS does not

[6] See Lewbel and Pendakur (2009) page 836 and Appendix 5.10

estimate regional CPI series, we constructed regional CPIs by deflating the national level CPIs using regional CPIs for all items (Slesnick, 2005; Raper, *et al*., 2002).

Descriptions and summary statistics of demographic variables employed to account for household heterogeneity are detailed in Table 2. We observe that for most of the cases the reference person in the household is at least 30 years old, while the predominant racial group is Caucasian. Also, 86% of the households have at least one adult female and 11% of the reference persons self-identify as Hispanics. Moreover, to assess the representativeness of the CEX data, the statistics presented in Table 2 were compared with summary statistics for the same variables, from the United States Census Bureau Current Population Survey (CPS) for the 2003 to 2006 period. We found the results from both surveys to be remarkably similar.

Estimation Procedures

SL Price Indices for Censored Observations

Three series of SL prices are constructed using alternative regional CPIs (monthly, quarterly, and unity) in place of the input prices (p_{ij}) described in equation (6). By a unity CPI we mean that all households face a unique price, which for convenience is chosen to be 100. The idea behind this approach is to simulate a scenario were no price information is available, such that SL price indices are derived entirely from the subgroup budget shares. Although intuitively a more disaggregated CPI would always be preferred; there might be situations in which this is not possible[7].

Summary statistics for monthly, quarterly and unity CPI based SL price indices for the uncensored observations are provided in Table 3. Notice that the mean, standard deviation,

[7]To assess the relevance of SL prices for our data, we estimated a complete demand system using only monthly CPIs as proxy for prices. Results obtained for this system included positive compensated own-price elasticity for one of the commodity groups.

maximum and minimum values for the monthly, quarterly and unity based SL price indices are about the same for all the categories.

As evidenced by equation (6) the SL price index is undefined if one or more of the sub-group commodity shares w_{lij} equals zero. Hoderlein and Mihaleva (2008) avoided the problem by dropping observations with zero $w_{lij}{}'$s. This solution, though plausible for lower levels of censoring, results quite restrictive for data sets with higher levels of censoring. Therefore, we adopted the regression imputation approach employed in demand studies of cross-sectional data (with censored expenditures) that uses unit values to proxy for prices (see Cox and Wohlgenant, 1986; Alfonzo and Peterson, 2006; and Lopez, 2011). Hence, we use the estimates of SL price indices for uncensored observations obtained from equation (6) and regress the log of these indices on a set of demographic characteristics. Ordinary Least Square (OLS) parameters estimates are then use to recover log SL prices for households with censored expenditure information[8].

Censored Approximated LA/EASI Demand Model

The high proportion of individuals reporting zero expenditure for some of the food groups requires the use of procedures that account for the censored distribution of these responses. Several methods are available for the estimation of a system of censored demand equations. In this study, we use the two-step procedure of Shonkwiler and Yen (1999).

The procedure is formalized as follows. Consider the system of equations:

$$w_{it}^{*} = f(\boldsymbol{p}, \boldsymbol{z}_t, y_t;\ \boldsymbol{\theta}_i) + \varepsilon_{it}, \qquad d_{it}^{*} = \boldsymbol{s}_t'\boldsymbol{\rho}_i + \mu_{it} \tag{9}$$

$$d_{it} = \begin{cases} 1\ if\ d_{it}^{*} > 0 \\ 0\ if\ d_{it}^{*} \leq 0 \end{cases} \qquad w_{it} = d_{it} w_{it}^{*} \tag{10}$$

[8] To test the sensitivity of our results to the presence of censored observations, we run a full system of equations using only the uncensored observations. We found our estimates to be robust even when using only households with positive expenditures.

$(i = 1, 2, \ldots, N; t = 1, 2, \ldots, T)$

where, for the i^{th} commodity group and t^{th} observation, w_{it}^{*} is the latent variable for demand budget share, d_{it}^{*} is a latent variable defining the sample selection in (9), w_{it} and d_{it} are the observed dependent variables; $f(\boldsymbol{p}, \boldsymbol{z}_t, y_t;\ \boldsymbol{\theta}_i)$ represents a demand equation of the form in (7), where $\boldsymbol{\theta}_i$ is a vector of parameter estimates, $\boldsymbol{p}$ is a vector of prices, $\boldsymbol{z}_t$ is a vector of socio-demographic characteristics, and y represents real expenditures; $\boldsymbol{s}_t$ is a vector of household characteristics explaining the sample selection process, and $\boldsymbol{\rho}_i$is the vector of parameters for the sample selection equation.

The procedure continues as: 1) Maximum Likelihood (ML) probit estimates are obtained for $\boldsymbol{\rho}_i$; 2) the vector of parameter estimates $\widehat{\boldsymbol{\rho}}_i$is used to calculate $\widehat{\Phi}_{it}$ and $\widehat{\phi}_{it}$, which represent estimates for the cdf and pdf of μ_{it}; and 3) estimates for the parameters in $\boldsymbol{\theta}_i$ are obtained using equations of the form:

$$w_{it} = \widehat{\Phi}_{it} \left(\sum_{r=0}^{5} b_{ri} y_t^r + \sum_{m=1}^{M} (C_{mi} z_{mt} + D_{mi} z_{mt} y_t) + \sum_{k=1}^{N} A_{ki} \log p_{kt} + \sum_{k=1}^{N} B_{ki} \log p_{kt} y_t \right) + \sigma_i \widehat{\phi}_{it} + \varepsilon_{it}, \quad (11)$$

which is the censored LA/EASI demand equation for commodity group *i*.

Elasticities and demographic effects can be derived from equation (11) (Yen *et al.*, 2002; Yen and Lin, 2006). It is straightforward to show that compensated (Hicksian) price elasticities (e_{ij}^{*}) in the censored LA/EASI demand systems are given by

$$e_{ij}^{*} = \frac{1}{w_i} \widehat{\Phi}_i \left(A_{ji} + B_{ji} y\right) + w_j - \delta_{ji} \quad (12)$$

where δ_{ji} is the kronecker delta. In the case of *N* goods we have N^2 simultaneous equations for expenditure elasticities (η_{ix}) of the form

$$\eta_{ix} = \frac{1}{w_i} \Phi_i \left(1 - \sum_{k=1}^{N} w_k \log p_k (\eta_{kx} - 1)\right) \left(\sum_{r=1}^{5} r b_{ri} y^{r-1} + \sum_{m=1}^{M} D_{mi} z_m + \sum_{k=1}^{N} B_{ki} \log p_k \right) + 1 \quad (13)$$

where η_{ix} is the expenditure elasticity of commodity group *i* with respect to nominal expenditures *x*. The system of simultaneous equations in equation (13) can be solved for η_{ix}[9].

Marginal effects of socio-demographic characteristics can also be derived from equation (11); however the formula is dependent upon the presence of the socio-demographic characteristic in the share equation or probit model only, or in both equations.

The MODEL procedure from SAS was used to estimate the Seemingly Unrelated Regression (SUR) estimators of the parameters in (11) using all *N* equations. The use of the *N* equations is possible since the system of censored demand equations (11) does not have a singular variance-covariance matrix of residuals (Yen *et al*., 2002; Drichoutis *et al*., 2008).

Given the likely correlation between the error terms in each equation and total real expenditures (*y*) (Lewbel and Pendakur, 2009; p.834; LaFrance, 1991), we used the approach suggested by Blundell and Robin (2000) where each equation in (11) is augmented with the error term v from a reduced form of *y*. As a result, the error term ε_i in (11) is rewritten as the orthogonal decomposition $\varepsilon_i = \omega_i v + u_i$ where $E(u_i | lnx, z_1, \ldots, z_m, \log p_1, \ldots, \log p_n) = 0$. Our reduced form of y follows Blundell and Robin's (2000) specification and is defined as a function of a linear trend, log prices, demographic variables, interaction terms between socio-demographic characteristics and log income, and linear and higher order terms of log income. The hypothesis that the ω_i parameters are different from zero is used to test the endogeneity of y (Blundell and Robin, 2000; Boonsaeng *et al*., 2008)

To account for the use of two-step estimation procedures and the heteroskedasticity of the disturbances in the system of equations of the form in (11) (Shonkwiler and Yen, 2001), we

9 Solution of this simultaneous system of equations is available from the authors upon request.

estimated standard errors for parameter, elasticities, and marginal effect estimates using the non-parametric bootstrapping procedure outlined in Wooldridge (2002: 379) using 900 replications.

Comparison of Elasticities and Marginal Effects

Compensated (Hicksian) elasticities and expenditure elasticities are estimated for the reference household using the equations (12) and (13). Uncompensated (Marshallian elasticities) are recovered using the Slutsky equation. Marginal effects are also estimated for the reference household.

Two procedures were used to assess differences across our demand systems' estimates. First, we compare the percent error of the elasticities obtained when using monthly CPI based SL prices relative to those obtained when using quarterly and unity CPI based SL prices. To more formally analyze the statistical difference between parameter estimates and functions we use bootstrapping procedures. The selection of bootstrapping procedures is due to the fact that the samples used to estimate the parameters and functions are not drawn from independent populations but in fact the same population, hence statistical methods of comparison of means such as the student's t-test result inappropriate.

The comparison suing bootstrapping procedures involved the following three steps: 1) we used the parameter estimates from the bootstrapping samples to obtained elasticities and marginal effect estimates for each sample; 2) for each bootstrap sample we calculated the difference between the systems using quarterly and unity CPI based SL prices and the estimates of the system with monthly CPI based SL prices (i.e., these estimates are used as benchmark) ,and3) using the distributions of differences, we constructed 95% confidence intervals for all parameter, elasticity and marginal effect estimates.

Results

We start the results section reporting and discussing the tests of endogeneity of expenditures as well as the tests of the homogeneity and symmetry demand system restrictions. Next we compare the estimation results from demand models estimated using the three alternative CPIs. Finally, we discuss elasticities and marginal effects values.

The null hypothesis that real expenditure is exogenous is rejected (5% level) in five of the eight demand equations for the systems using monthly and quarterly CPI based SL prices, and in six of the eight demand equations for the system using unity CPI based SL prices. However, the bias caused by endogeneity seems to be small as the parameter, elasticity and marginal effect estimates of the models where robust to the correction for endogeneity.

Symmetry and adding-up conditions were tested and imposed in our censored LA/EASI demand systems. Homogeneity is not tested nor imposed, as it is implicitly satisfied if the symmetry and adding-up conditions hold. Table 4 summarizes the results for the tests from the theory. The Wald test rejects both null hypotheses for symmetry and adding-up conditions for all demand systems. Parameter estimates from the restricted systems of equations were then used for estimation of elasticities and marginal effects.

Comparison of Models

Percent errors of expenditure and own-price elasticities obtained when using monthly CPI based SL prices relative to those obtained when using quarterly and unity CPI based SL prices are presented in Table 5. Elasticities obtained using the three specifications are shown in Tables 7, 8 and 9. The percentage error for expenditure elasticities ranged (in absolute terms) from 0.002% to 0.05% for the quarterly CPI based SL prices, and from 0.02% to 0.86% for the unity CPI based SL prices. For own-price elasticities, percentage error (from absolute differences) ranged from 0.004% to 0.20% for the quarterly CPI based SL prices, and from 0.09% to 2.09% for the unity based SL prices, respectively.

Similarly, we estimated percent errors for cross-price elasticities and marginal effect estimates. Mean percentage errors (from absolute differences) for cross-price elasticities were of 1.36% and 10.36% for the quarterly and the unity CPI based SL prices. Similarly, marginal effects' mean percentage errors were of 5.91% and 12.57% for quarterly CPI and unity based SL prices[10]. The high mean percentage errors for cross-price elasticities and marginal effects relative to own-price and expenditure elasticities, is explained by the presence of estimates that were not statistically different from zero (5% level).

In short, differences in elasticity estimates and marginal effects obtained using the three alternative CPIs are relatively small. Elasticity estimates using quarterly CPI based SL prices are closer to the estimates obtained using monthly CPI based SL prices than those estimates obtained from using unity CPI based SL prices. From a practical point of view, the elasticity estimates obtained using the three alternative specifications are the same.

Even though from a practical stand point elasticities obtained using the alternative specifications are equal, the tests of the differences using bootstrapping procedures revealed statistically significant differences (at a 5% level) across models. Specifically, 7 out of 8 own-price and expenditure elasticities from the model using quarterly CPI based SL prices were statistically different than those obtained from the models using monthly CPI based SL prices. All the own-price elasticities and 4 out of 8 expenditure elasticities obtained from a demand model using the unity CPI based SL prices are statistically different than those obtained from a model using monthly CPIs. Regarding statistical differences between cross-price elasticities, we

[10] We also estimated percentage errors for parameter estimates. Mean percentage errors for quarterly and unity CPI based SL prices were of 1.08% and 415%, respectively. The high mean percentage error for unity based SL prices is explained by the presence of parameter estimates not statistically different from zero.

found that 22 out of 56 were statistically different between the systems using quarterly and monthly CPI based SL prices. Similarly, 20 of the 56 cross-price elasticities were statistically different between the models employing monthly CPI and unity based SL prices.

Estimates for marginal effects from systems using monthly, quarterly and unity CPI based SL prices are provided in Tables 10, 11 and 12, respectively. Results from the bootstrapping procedure indicated (at a 5% level) that 102 out of 120 marginal effects were not statistically different between the systems using quarterly and monthly CPI based SL prices. In a similar fashion, 94 of the 120 marginal effect estimates were not statistically different between the models using monthly CPI and unity based SL prices.

Another concern was whether the use of different CPIs had any effect in the precision of parameter, elasticity and marginal effect estimates. Empirical evidence discarded this possibility as estimates for standard errors for elasticities and marginal effects in Tables 7 to 12 were particularly close. Moreover, a comparison of the number of significant (5% level) parameter, elasticity and marginal effect estimates is presented in Table 6. Though the number of significant parameters is smaller for the system using unity based SL prices, differences in the number of significant elasticities and marginal effect are found to be small across the three systems.

The similarity between the empirical results from the models using unity and quarterly CPI based SL prices and the ones obtained from the model with monthly CPI based SL prices are very likely a consequence of the remarkable similarity in the CPIs, as evidenced in Table 3.

Elasticities and marginal effects

In this section our discussion focuses on elasticities and marginal effects obtained from the system using monthly CPI based SL prices, since this was the model used as benchmark.

Moreover, as shown above, the elasticity values and marginal effects across the three alternative specifications are not different for practical purposes.

Consistent with the theory, we observe all own-price uncompensated elasticities to be negative and statistically significant (5% level). From the expenditure elasticities we observe that none of the commodity groups falls in the category of inferior goods, an expected result given the broad level of aggregation. Relations indicated by cross-price elasticities were found to be consistent with nutritional expectations. For instance, the groups of Meats and Dairy were found to be substitutes, as well as the groups of Cereals and Sweets which is explained by the inclusion of bakery products within cereals. Moreover, most cross-price elasticities were found to be inelastic and to indicate complementary relations across goods. Again, this can be seen as a consequence of the high level of aggregation.

Results from marginal effects are found, for most of the cases, to be consistent with general expectations. Households with a less educated reference person tend to spend less in fruits and vegetables and more in sweets. Larger households consume more of all commodity groups with exception of the Fats & Oils group. White households consume the most dairy and sweets, Asian households consume the most from the Fruit and Vegetables commodity, while Black households consume the most Meat. Also, a consumption pattern might be identified from the age group of the reference person. Households with a younger reference person are found to consume the most from the miscellaneous group; this is associated with a higher consumption level of ready-to-eat food and snacks. Moreover, those household with an older reference person seem to spend more in most of the categories, this can be associated with a larger household or/and a higher income.

Also, our estimated own-price elasticities for the groups of Cereals, Meats, Dairy, Fruits & vegetables, and Fats& oils are more inelastic than those found in the literature (see Raper *et al*., 2002). Differences are also noticed in the estimates for expenditure elasticities. In particular, our expenditure elasticity for the group of Meats is more inelastic than the presented by Raper *et al*. (2002). We believe these results to be a consequence of differences in the chosen commodity groups included in the system, as well as of the within-group aggregation. Moreover, estimates of *per capita* income from the BLS show that this statistic has almost doubled from $20.8 in 1992, when Raper *et al*. (2002) conducted their study, to an average of $34.17 for 2002 to 2006. This increment in income might explain why our own-price elasticities are found to be more inelastic.

Summary and Conclusions

Lewbel (1989) developed an approach for the construction of household level commodity price indices (SL prices) using only budget shares and CPIs of the goods comprising the commodity groups. In this study, we consider three alternative CPIs for the construction of SL prices and the estimation of a demand system. The three CPIs consider are: monthly, quarterly and unity. Where the unity CPI is used to simulate a scenario where no price index information is available. The evaluation of the performance of the three SL prices is carried out by comparing elasticities, marginal effects and parameters obtained from demand models using household level data for the United States.

Our results suggest that current estimates of CPIs from the BLS posses to low variability, such that their influence in the performance of SL price indices is rather small. Elasticities and marginal effect estimates from the demand models proved to be robust to the alternative CPIs considered in this study (even to the absence of one).

We conclude that the incorporation of CPI data in the calculation of SL prices plays a limited role, thereby making possible the estimation of demand systems in the absence of price information. However, more research is needed to evaluate the performance of unity based SL prices with other datasets.

Table 1
Commodity groups' composition and summary statistics

Commodity groups	Group composition	Mean budget share	Level of censoring
Cereals & Bakery	1) Cereals 2) Bakery products	15%	6%
Meats & Eggs	1) Beef 2) Pork 3) Poultry 4) Fish & sea food 5) Eggs 6) Other meats	23%	9%
Dairy	1) Milk 2) Cheese 3) Ice cream 4) Other dairy products	12%	8%
Fruit & Vegetables	1) Fresh fruit 2) Fresh vegetables 3) Processed fruit and vegetables	15%	9%
Nonalcoholic Beverages	1) Juice & soda 2) Coffee & tea	12%	11%
Fats & Oils	1) Butter & margarine 2) Salad dressing 3) Fats & oils 4) Other fats	3%	35%
Sugar & other Sweets	1) Sugar 2) Candies 3) Other sweets	4%	33%
Miscellaneous Goods	1) Soups 2) Prepared foods 3) Snacks 4) Seasoning 5) Baby food 6) Other foods	16%	11%

Table 2
Descriptive statistics of household composition and household characteristics

Category	Variable	Definition	Mean	Std. Dev.	Min	Max
Continuous Variables						
	Family Size[*†•]	N of members living in the household	2.56	1.460	1	9
	Proportion of persons below 18[†•]		0.36	0.481	0	1
	Annual Income[•]	Annual family income before taxes	57007.23	53222.170	1	694723
Dummy Variables (yes=1, no=0)						
Education level of the reference person	No College[*†•]	Reference person has less than college education	0.14	0.345	0	1
	Some College[*†•]	Reference person has some college education	0.56	0.496	0	1
	College	Reference person has at least college education	0.30	0.457	0	1
Region of Residence	North Region[*†•]	Household is located in the north region of the country	0.18	0.385	0	1
	Mid West Region[*†•]	Household is located in the mid west region of the country	0.26	0.436	0	1
	South Region[*†•]	Household is located in the south region of the country	0.33	0.472	0	1
	West Region	Household is located in the west region of the country	0.23	0.421	0	1
Age of the reference person	< 25[*†•]	Reference person is younger than 25	0.06	0.243	0	1
	≥25-30 [*†•]	Reference person is at least 25 but younger than 30	0.07	0.263	0	1
	≥30-40 [*†•]	Reference person is at least 30 but younger than 40	0.20	0.398	0	1
	≥40-50 [*†•]	Reference person is at least 40 but younger than 50	0.22	0.413	0	1
	≥50-65 [*†•]	Reference person is at least 50 but younger than 65	0.24	0.429	0	1
	>65	Reference person is older than 65	0.20	0.402	0	1
Racial group of the reference person	White[*†•]	Reference person self-identifies as white	0.84	0.368	0	1
	Black[*†•]	Reference person self-identifies as black	0.11	0.309	0	1
	Asian[*†•]	Reference person self-identifies as asian	0.04	0.192	0	1
	Other	Reference person self-identifies as neither white, black or asian	0.02	0.125	0	1
Year in which the survey was collected	2002[†•]	Household was interview in year 2002	0.18	0.385	0	1
	2003[†•]	Household was interview in year 2003	0.19	0.394	0	1
	2004[†•]	Household was interview in year 2004	0.21	0.407	0	1
	2005[†•]	Household was interview in year 2005	0.21	0.409	0	1
	2006	Household was interview in year 2006	0.20	0.404	0	1
	Hispanic[†•]	Reference person self-identifies as hispanic	0.11	0.311	0	1
	Female adult unemployment[†•]	Reference person is female and unemployed	0.13	0.341	0	1
	Presence of a female adult[†•]	There is at least one female member older than 20 in the hh	0.86	0.351	0	1
	Age of female adult[†]	There is at least one female adult younger than 35 in the hh	0.26	0.439	0	1

*Refers to demographic variables used in the Censored LA/EASI model.
†Refers to demographic variables used in the PROBIT model.
•Refers to demographic variables used to regress SL prices.

Table 3
Summary statistics for the SL price index series for uncensored observations

Commodity groups	N	Monthly CPI based SL price indices				Quarterly CPI based SL price indices				Unity CPI based SL price indices			
		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Cereals & Bakery	29014	83.655	20.738	49.416	110.339	83.657	20.739	49.610	109.902	83.647	20.645	52.822	105.643
Meats & Eggs	27925	54.735	23.158	16.258	115.775	54.740	23.155	16.605	115.318	54.725	23.088	18.844	111.801
Dairy	28188	64.417	26.005	27.180	125.438	64.422	26.001	27.659	124.787	64.416	25.932	30.026	120.044
Fruit & Vegetables	27937	74.121	21.814	31.437	107.365	74.126	21.793	31.828	106.176	74.187	21.724	33.982	101.945
Nonalcoholic Beverages	27469	77.818	23.283	57.228	127.820	77.811	23.281	57.524	127.713	77.843	23.275	60.382	120.765
Fats & Oils	20015	52.896	25.078	27.808	128.602	52.900	25.085	28.341	129.163	52.881	24.974	30.875	123.412
Sugar & other Sweets	20701	57.815	23.421	37.433	123.093	57.816	23.416	37.886	122.139	57.826	23.376	39.677	118.986
Miscellaneous Goods	27392	55.527	24.432	19.396	130.660	55.535	24.430	19.592	130.590	55.611	24.442	20.974	125.688

Table 4
Tests of the demand restrictions

Price serie used to estimate de system	Restriction Tested	Test type	Value of the Statistic	Probability of rejecting the null hypothesis
Monthly CPI based SL prices	Symmetry	Wald	717.29	<0.0001
	Adding-up	Wald	2008.6	<0.0001
Quarterly CPI based SL prices	Symmetry	Wald	716.61	<0.0001
	Adding-up	Wald	2010.9	<0.0001
Unity CPI based SL prices	Symmetry	Wald	675.06	<0.0001
	Adding-up	Wald	2012.6	<0.0001

Table 5
Comparison of percent errors in elasticities

Commodity groups	Monthly vs. Quarterly CPI based SL prices		Monthly vs. Unity CPI based SL prices	
	Uncompensated Own-price	Expenditure	Uncompensated Own-price	Expenditure
Cereals & Bakery	0.004%	0.023%	-0.166%	0.362%
Meats & Eggs	0.068%	0.002%	0.294%	-0.198%
Dairy	-0.010%	0.022%	-0.431%	0.071%
Fruit & Vegetables	0.133%	-0.027%	0.897%	-0.261%
Nonalcoholic Beverages	-0.070%	-0.047%	-0.095%	-0.725%
Fats & Oils	-0.154%	0.035%	-2.093%	0.018%
Sugar & other Sweets	-0.203%	0.009%	0.142%	-0.694%
Miscellaneous Goods	0.053%	0.012%	1.387%	0.858%

Table 6
Summary of significant estimates for estimated demand systems[a]

Estimates	Monthly CPI based SL prices	Quarterly CPI based SL prices	Unity CPI based SL prices
Parameters	51%	51%	23%
Elasticities	78%	79%	83%
Marginal effects	70%	70%	67%

[a]Significance is tested at a 5% level

Table 7
Estimated uncompensated and expenditure elasticities when employing monthly CPI based SL price index

Quantity Demanded	Prices								Expenditure
	Cereal & Bakery	**Meats & Eggs**	**Dairy**	**Fruit & Vegetables**	**Nonalcoholic Beverages**	**Fats & Oils**	**Sugar & other Sweets**	**Miscellaneous Goods**	
Cereal & Bakery	-0.7208**	-0.1818**	-0.0563**	-0.1049**	-0.0408**	-0.0066	0.0254**	-0.0382**	1.1241**
	(0.0131)	(0.0119)	(0.0093)	(0.0097)	(0.0100)	(0.0059)	(0.0065)	(0.0100)	(0.0222)
Meats & Eggs	-0.0879**	-0.5287**	-0.0949**	-0.0548**	-0.042**	-0.0019	-0.0170**	-0.1198**	0.9471**
	(0.0056)	(0.0105)	(0.0055)	(0.0062)	(0.0057)	(0.0033)	(0.0038)	(0.0074)	(0.0152)
Dairy	-0.0178*	-0.1485**	-0.5789**	-0.0354**	0.0144	-0.0156**	0.0199**	-0.0055	0.7675**
	(0.0099)	(0.0124)	(0.0157)	(0.0103)	(0.0103)	(0.0060)	(0.0069)	(0.0104)	(0.0234)
Fruit & Vegetables	-0.1041**	-0.1301**	-0.0712**	-0.5971**	-0.1021**	-0.0148**	-0.0052	-0.1276**	1.1524**
	(0.0085)	(0.0110)	(0.0081)	(0.0134)	(0.0089)	(0.0051)	(0.0057)	(0.0095)	(0.0180)
Nonalcoholic Beverages	-0.0182	-0.0718**	-0.0050	-0.0886**	-0.7502**	-0.0069	0.0192**	-0.0077	0.9293**
	(0.0115)	(0.0130)	(0.0109)	(0.0115)	(0.0187)	(0.0070)	(0.0089)	(0.0119)	(0.0235)
Fats & Oils	-0.0397**	-0.0662**	-0.0846**	-0.0667**	-0.0525**	-0.7928**	0.0303	-0.1342**	1.2066**
	(0.0199)	(0.0213)	(0.0173)	(0.0186)	(0.0202)	(0.0397)	(0.0263)	(0.0176)	(0.0350)
Sugar & other Sweets	0.0919**	-0.0679**	0.0312**	0.0120	0.0477**	0.0335*	-1.1087**	0.0259	0.9343**
	(0.0177)	(0.0210)	(0.0168)	(0.0170)	(0.0205)	(0.0217)	(0.0350)	(0.0177)	(0.0367)
Miscellaneous Goods	-0.0172**	-0.1810**	-0.0311**	-0.0962**	-0.0159*	-0.0268**	0.0046	-0.6456**	1.0092**
	(0.0070)	(0.0111)	(0.0068)	(0.0081)	(0.0079)	(0.0040)	(0.0047)	(0.0124)	(0.0187)

Note: Standard errors in parentheses.
* Denotes significance at the 10% level.
** Denotes significance at the 5% level.

Table 8
Estimated uncompensated and expenditure elasticities when employing quarterly CPI based SL price index

Quantity Demanded	Prices: Cereal & Bakery	Meats & Eggs	Dairy	Fruit & Vegetables	Nonalcoholic Beverages	Fats & Oils	Sugar & other Sweets	Miscellaneous Goods	Expenditure
Cereal & Bakery	-0.7208**	-0.1813**	-0.0562**	-0.1054**	-0.0411**	-0.0064	0.0254**	-0.0381**	1.1238**
	(0.0132)	(0.0105)	(0.0088)	(0.0094)	(0.0101)	(0.0059)	(0.0065)	(0.0091)	(0.0122)
Meats & Eggs	-0.0876**	-0.5283**	-0.0950**	-0.0551**	-0.0422**	-0.0018	-0.0170**	-0.1199**	0.9471**
	(0.0055)	(0.0098)	(0.0052)	(0.0061)	(0.0057)	(0.0033)	(0.0038)	(0.0071)	(0.0083)
Dairy	-0.0176**	-0.1486**	-0.5790**	-0.0359**	0.0145	-0.0155**	0.0201**	-0.0052**	0.7673**
	(0.0099)	(0.0111)	(0.0152)	(0.0101)	(0.0107)	(0.0060)	(0.0069)	(0.0097)	(0.0138)
Fruit & Vegetables	-0.1047**	-0.1306**	-0.0717**	-0.5964**	-0.1012**	-0.0154**	-0.0049	-0.1279**	1.1527**
	(0.0085)	(0.0100)	(0.0078)	(0.0133)	(0.0090)	(0.0051)	(0.0057)	(0.0090)	(0.0100)
Nonalcoholic Beverages	-0.0186*	-0.0723**	-0.0049	-0.0875**	-0.7507**	-0.0068	0.0191**	-0.0081	0.9297**
	(0.0116)	(0.0123)	(0.0107)	(0.0114)	(0.0186)	(0.0070)	(0.0088)	(0.0154)	(0.0153)
Fats & Oils	-0.0392	-0.0657**	-0.0844**	-0.0686**	-0.0519*	-0.7941**	0.0317	-0.1340**	1.2061**
	(0.0197)	(0.0189)	(0.0164)	(0.0180)	(0.0203)	(0.0397)	(0.0265)	(0.0155)	(0.0185)
Sugar & other Sweets	0.0921**	-0.0681**	0.0316*	0.013	0.0476**	0.0346*	-1.1109**	0.0259	0.9343**
	(0.0175)	(0.0184)	(0.0159)	(0.0164)	(0.0205)	(0.0218)	(0.0352)	(0.0159)	(0.0193)
Miscellaneous Goods	-0.0171**	-0.1812**	-0.0309**	-0.0964**	-0.0161**	-0.0267**	0.0046**	-0.6453**	1.0091**
	(0.0088)	(0.0141)	(0.0078)	(0.0100)	(0.0099)	(0.0042)	(0.0139)	(0.0133)	(0.0363)

Note: Standard errors in parentheses.
* Denotes significance at the 10% level.
** Denotes significance at the 5% level.

Table 9
Estimated uncompensated and expenditure elasticities when employing unity CPI based SL price index

Quantity Demanded	Prices								Expenditure
	Cereal & Bakery	Meats & Eggs	Dairy	Fruit & Vegetables	Nonalcoholic Beverages	Fats & Oils	Sugar & other Sweets	Miscellaneous Goods	
Cereal & Bakery	-0.7220**	-0.1768**	-0.0519**	-0.1062**	-0.0452**	-0.0039	0.0246**	-0.0385**	1.1200**
	(0.0118)	(0.0048)	(0.0092)	(0.0106)	(0.0090)	(0.0051)	(0.0054)	(0.0103)	(0.0246)
Meats & Eggs	-0.0857**	-0.5271**	-0.0958**	-0.0547	-0.0435	-0.0027**	-0.0180	-0.1216**	0.9490**
	(0.0047)	(0.0053)	(0.0041)	(0.0046)	(0.0042)	(0.0017)	(0.0019)	(0.0057)	(0.0231)
Dairy	-0.0127**	-0.1497**	-0.5814**	-0.0361**	0.0136*	-0.0173**	0.0198	-0.0032**	0.7669**
	(0.0096)	(0.0056)	(0.0151)	(0.0108)	(0.0089)	(0.0063)	(0.0060)	(0.0108)	(0.0254)
Fruit & Vegetables	-0.1064**	-0.1301**	-0.0721**	-0.5918**	-0.0982**	-0.0151**	-0.0067**	-0.1349**	1.1554**
	(0.0084)	(0.0061)	(0.0089)	(0.0138)	(0.0084)	(0.0049)	(0.0051)	(0.0114)	(0.0271)
Nonalcoholic Beverages	-0.0247**	-0.0755**	-0.0066**	-0.0845**	-0.7509**	-0.0049**	0.0211	-0.0099**	0.9360**
	(0.0106)	(0.0074)	(0.0106)	(0.0122)	(0.0140)	(0.0061)	(0.0060)	(0.0134)	(0.0343)
Fats & Oils	-0.0314**	-0.0700	-0.0890**	-0.0675**	-0.046**	-0.8094**	0.0364**	-0.1295**	1.2064**
	(0.0179)	(0.0073)	(0.0187)	(0.0183)	(0.018)	(0.0280)	(0.0129)	(0.0181)	(0.0374)
Sugar & other Sweets	0.0883**	-0.0733	0.0302	0.0070	0.0520	0.0383**	-1.1071**	0.0238**	0.9408**
	(0.0152)	(0.0072)	(0.0152)	(0.0160)	(0.0134)	(0.0108)	(0.0139)	(0.0167)	(0.0362)
Miscellaneous Goods	-0.0168**	-0.1812**	-0.0285**	-0.1011**	-0.0156**	-0.0253**	0.0046**	-0.6367**	1.0006**
	(0.0074)	(0.0053)	(0.0068)	(0.0087)	(0.0093)	(0.0039)	(0.0043)	(0.0125)	(0.0198)

Note: Standard errors in parentheses.
* Denotes significance at the 10% level.
** Denotes significance at the 5% level.

Table 10
Estimated socio-demographic marginal effects when employing monthly CPI based SL price index

Quantities Demanded	Education		Region			Age of Household Head in years					Race			Family Size	Hispanic
	No college	Some college	Northeast	Midwest	South	<25	≥25 -30	≥30 -40	≥40 -50	≥50 -60	White	Black	Asian		
Cereal & Bakery	-1.480*	-0.920	4.140**	1.100	1.550*	-10.380**	-8.690**	-8.410**	-7.360**	-5.100**	1.840	-2.150	-2.970	2.780**	-2.970**
	(0.799)	(0.563)	(0.852)	(0.711)	(0.719)	(2.333)	(1.646)	(1.319)	(1.029)	(0.794)	(1.755)	(1.884)	(2.231)	(0.605)	(0.807)
Meats & Eggs	2.510**	1.940**	3.110**	0.990*	3.480**	-11.320**	-5.690**	-5.040**	-1.580**	0.300	-1.100	6.300**	1.150	3.220**	7.000**
	(0.724)	(0.485)	(0.681)	(0.618)	(0.583)	(1.831)	(1.216)	(0.969)	(0.754)	(0.670)	(1.677)	(1.837)	(2.110)	(0.427)	(0.922)
Dairy	-2.260**	-1.620**	0.940**	-0.370	-0.850**	-4.970**	-2.740**	-2.140**	-2.040**	-1.560**	2.580**	-4.680**	-5.690**	2.180**	-1.580**
	(0.539)	(0.362)	(0.472)	(0.409)	(0.379)	(1.281)	(0.844)	(0.664)	(0.565)	(0.466)	(1.081)	(1.194)	(1.448)	(0.343)	(0.523)
Fruit & Vegetables	-5.320**	-4.600**	-0.460	-1.710**	-1.990**	-13.380**	-10.330**	-9.440**	-8.050**	-4.560**	1.140	0.710	13.170**	1.000**	6.090**
	(0.587)	(0.410)	(0.491)	(0.436)	(0.425)	(1.255)	(0.913)	(0.754)	(0.610)	(0.501)	(1.273)	(1.326)	(1.669)	(0.260)	(0.580)
Nonalcoholic Beverages	1.370**	1.140**	0.990**	0.450	0.760**	6.110**	4.400**	5.320**	5.080**	4.170**	-1.460	-2.430**	-3.600**	0.680**	0.170
	(0.457)	(0.332)	(0.458)	(0.378)	(0.380)	(0.843)	(0.637)	(0.515)	(0.499)	(0.471)	(1.040)	(1.124)	(1.436)	(0.282)	(0.500)
Fats & Oils	0.950**	0.500**	-0.450**	-0.040	-0.160	0.920**	0.730**	0.610**	0.330	0.220	-0.250	0.650	-1.050**	-0.530**	-0.270*
	(0.168)	(0.121)	(0.170)	(0.157)	(0.159)	(0.369)	(0.287)	(0.209)	(0.162)	(0.149)	(0.361)	(0.384)	(0.479)	(0.087)	(0.196)
Sugar & other Sweets	0.570	0.580**	-1.440**	0.000	-0.480	-1.150**	-0.060	0.850*	1.310**	0.820**	0.310	0.230	-1.870*	0.040	-1.600**
	(0.337)	(0.237)	(0.324)	(0.293)	(0.295)	(0.557)	(0.457)	(0.369)	(0.341)	(0.337)	(0.754)	(0.818)	(0.968)	(0.158)	(0.385)
Miscellaneous Goods	-3.490**	-1.890**	-4.190**	-0.490	-1.230**	5.120**	4.590**	3.060**	2.960**	1.630**	0.300	-4.500**	-4.040**	0.550**	-4.020**
	(0.514)	(0.357)	(0.516)	(0.393)	(0.376)	(1.019)	(0.709)	(0.523)	(0.449)	(0.406)	(0.968)	(1.085)	(1.209)	(0.241)	(0.460)

Note: Standard errors in parentheses.
* Denotes significance at the 10% level.
** Denotes significance at the 5% level.

Table 11
Estimated socio-demographic marginal effects when employing quarterly CPI based SL price index

Quantities Demanded	Education		Region			Age of Household Head in years					Race			Family Size	Hispanic
	No college	Some college	Northeast	Midwest	South	<25	≥25 -30	≥30 -40	≥40 -50	≥50 -60	White	Black	Asian		
Cereal & Bakery	-1.480*	-0.930	4.140**	1.100	1.550*	-10.380**	-8.690**	-8.420**	-7.360**	-5.090**	1.840	-2.150	-2.970	2.780**	-2.970**
	(0.800)	(0.564)	(0.853)	(0.712)	(0.720)	(2.339)	(1.650)	(1.322)	(1.031)	(0.795)	(1.757)	(1.886)	(2.234)	(0.606)	(0.808)
Meats & Eggs	2.510**	1.950**	3.100**	0.990*	3.480**	-11.330**	-5.690**	-5.040**	-1.580**	0.300	-1.100	6.300**	1.140	3.220**	7.000**
	(0.724)	(0.485)	(0.681)	(0.618)	(0.583)	(1.834)	(1.217)	(0.970)	(0.754)	(0.669)	(1.676)	(1.836)	(2.110)	(0.428)	(0.922)
Dairy	-2.260**	-1.620**	0.940**	-0.380	-0.850**	-4.970**	-2.740**	-2.140**	-2.040**	-1.550**	2.580**	-4.680**	-5.680**	2.180**	-1.580**
	(0.539)	(0.362)	(0.472)	(0.408)	(0.379)	(1.285)	(0.845)	(0.665)	(0.566)	(0.466)	(1.080)	(1.193)	(1.447)	(0.343)	(0.523)
Fruit & Vegetables	-5.320**	-4.600**	-0.460	-1.710**	-1.990**	-13.380**	-10.330**	-9.440**	-8.050**	-4.570**	1.150	0.720	13.180**	1.000**	6.090**
	(0.587)	(0.410)	(0.492)	(0.436)	(0.425)	(1.258)	(0.914)	(0.756)	(0.611)	(0.502)	(1.274)	(1.328)	(1.671)	(0.261)	(0.580)
Nonalcoholic Beverages	1.380**	1.150**	0.990**	0.450	0.770**	6.120**	4.410**	5.330**	5.080**	4.170**	-1.460	-2.440**	-3.600**	0.670**	0.170
	(0.461)	(0.335)	(0.458)	(0.379)	(0.380)	(0.859)	(0.642)	(0.517)	(0.499)	(0.471)	(1.041)	(1.127)	(1.435)	(0.287)	(0.501)
Fats & Oils	0.950**	0.500**	-0.450**	-0.040	-0.160	0.920**	0.730**	0.610**	0.330	0.220	-0.250	0.650	-1.050**	-0.530**	-0.270*
	(0.169)	(0.121)	(0.170)	(0.157)	(0.159)	(0.370)	(0.287)	(0.210)	(0.163)	(0.149)	(0.362)	(0.385)	(0.480)	(0.087)	(0.197)
Sugar & other Sweets	0.570	0.580**	-1.440**	0.000	-0.480	-1.150**	-0.060	0.850*	1.310**	0.820**	0.300	0.220	-1.870*	0.040	-1.600**
	(0.338)	(0.238)	(0.325)	(0.293)	(0.296)	(0.559)	(0.458)	(0.370)	(0.343)	(0.338)	(0.756)	(0.820)	(0.970)	(0.159)	(0.386)
Miscellaneous Goods	-3.490**	-1.890**	-4.190**	-0.490	-1.230**	5.120**	4.590**	3.050**	2.960**	1.630**	0.290	-4.510**	-4.040**	0.550**	-4.020**
	(0.582)	(0.404)	(0.577)	(0.454)	(0.430)	(1.097)	(0.819)	(0.611)	(0.530)	(0.475)	(1.125)	(1.243)	(1.394)	(0.260)	(0.530)

Note: Standard errors in parentheses.
* Denotes significance at the 10% level.
** Denotes significance at the 5% level.

Table 12
Estimated socio-demographic marginal effects when employing unity CPI based SL price index

Quantities Demanded	Education		Region			Age of Household Head in years					Race			Family Size	Hispanic
	No college	Some college	Northeast	Midwest	South	<25	≥25 -30	≥30 -40	≥40 -50	≥50 -60	White	Black	Asian		
Cereal & Bakery	-1.502**	-0.938**	4.124**	1.086	1.535*	-10.370**	-8.693**	-8.411**	-7.361**	-5.100**	1.839	-2.165	-2.933	2.783**	-2.980**
	(0.803)	(0.564)	(0.815)	(0.678)	(0.679)	(2.330)	(1.630)	(1.272)	(0.946)	(0.752)	(1.574)	(1.804)	(2.050)	(0.569)	(0.720)
Meats & Eggs	2.497**	1.943**	3.110**	1.010*	3.490**	-11.222**	-5.613**	-4.985**	-1.552**	0.325	-1.134	6.222**	1.067	3.185**	7.002**
	(0.677)	(0.463)	(0.665)	(0.596)	(0.566)	(1.853)	(1.184)	(0.933)	(0.714)	(0.645)	(1.946)	(2.078)	(2.276)	(0.401)	(0.806)
Dairy	-2.275**	-1.635**	0.938*	-0.389	-0.858**	-5.055**	-2.781**	-2.164**	-2.065**	-1.569**	2.596**	-4.702**	-5.684**	2.196**	-1.57**
	(0.541)	(0.368)	(0.483)	(0.422)	(0.394)	(1.308)	(0.858)	(0.675)	(0.560)	(0.465)	(1.173)	(1.359)	(1.606)	(0.341)	(0.520)
Fruit & Vegetables	-5.354**	-4.621**	-0.438	-1.691**	-1.974**	-13.491**	-10.365**	-9.465**	-8.070**	-4.571**	1.157**	0.704*	13.180**	1.019**	6.101**
	(0.607)	(0.427)	(0.518)	(0.466)	(0.449)	(1.278)	(0.935)	(0.760)	(0.619)	(0.528)	(1.520)	(1.581)	(1.821)	(0.256)	(0.580)
Nonalcoholic Beverages	1.414**	1.170**	1.000	0.456	0.767	6.294**	4.465**	5.371**	5.102**	4.168**	-1.455**	-2.388**	-3.591**	0.650	0.164
	(0.448)	(0.331)	(0.464)	(0.387)	(0.387)	(0.896)	(0.656)	(0.523)	(0.488)	(0.463)	(1.41)	(1.463)	(1.796)	(0.285)	(0.479)
Fats & Oils	0.958**	0.505**	-0.455	-0.031	-0.155	0.935	0.748*	0.620	0.339	0.224	-0.253	0.651	-1.057**	-0.531**	-0.268
	(0.172)	(0.123)	(0.181)	(0.164)	(0.168)	(0.425)	(0.311)	(0.234)	(0.170)	(0.152)	(0.371)	(0.397)	(0.503)	(0.102)	(0.196)
Sugar & other Sweets	0.593*	0.597**	-1.456**	0.010	-0.472	-1.163*	-0.058	0.858**	1.323**	0.830**	0.296	0.237	-1.912**	0.042	-1.614**
	(0.354)	(0.246)	(0.351)	(0.309)	(0.320)	(0.619)	(0.484)	(0.396)	(0.365)	(0.358)	(0.801)	(0.876)	(1.013)	(0.172)	(0.387)
Miscellaneous Goods	-3.498**	-1.902**	-4.185**	-0.523	-1.256**	5.007**	4.495**	2.979**	2.915**	1.605**	0.305	-4.457**	-3.939**	0.588	-4.006**
	(0.508)	(0.356)	(0.505)	(0.396)	(0.376)	(1.051)	(0.722)	(0.531)	(0.450)	(0.409)	(0.929)	(1.060)	(1.213)	(0.240)	(0.446)

Note: Standard errors in parentheses.
* Denotes significance at the 10% level.
** Denotes significance at the 5% level.

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