Temporal Aggregation and Treatment of Zero Dependent Variables in the Estimation of Food Demand using Cross-Sectional Data

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Abstract

This study analyzes U.S. consumers' demand for eight food commodity groups: Cereal and Bakery goods, Meat and Eggs, Dairy, Fruits and Vegetables, Nonalcoholic Beverages, Fats and Oils, Sugar and Sweets, and Miscellaneous goods. The data used in this study is Nielsen Homescan data for the period 2002-2006. Two different levels of temporal aggregation, monthly and the average month within a year, referred to as "annual" were considered. We conclude that the models using monthly data closely approximate the underlying annual expenditure elasticities, but do a poor job of estimating own- and -cross price elasticities and marginal effects. This finding is true for both the uncensored model of Blundell and Meghir (1987), and the two-step censored model of Shonkwiler and Yen (1999). We also find that the more complex two-step censored model does not improve precision of the estimates over the simpler model.

Keywords: Censored demand models, EASI demand model.

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Previous literature suggests that biased elasticity estimates are not uncommon in the food demand field, in part due to the quality of empirical data available (Park et al. 1996; Raper, Wanazala & Nayga 2002; Andreyeva, Long and Brownell 2010). A potential source of biases in elasticity estimates are the data used in the analysis. For example, some datasets correspond to household surveys with short reference periods which in turn give rise to problems with reports of zero expenditure. These zeros may come from two sources: 1) genuine non-consumption, and 2) infrequency of purchases. Econometricians have developed models that attempt to account for both problems; however, as argued by Gibson & Kim (2011), there are very few studies that have evaluated these models, in part because of lack of suitable data. Therefore, one main objective of this article is to analyze the performance of econometric methods created to account for zero expenditures in demand analysis. A second objective of this article is to provide improved elasticity measures of US consumers' demand for food at home and the marginal effects of household characteristics on demand for food commodities.

The remainder of the article is organized as follows: first a brief review of literature focusing on previous studies analyzing the demand for food in the United States and the problem of zero expenditures in demand estimation. This is followed by a description of the Homescan dataset and an overview of the data management process. We next outline the modeling procedures and discuss the results of estimation. Finally, we provide conclusions.

Food Demand Analysis in the United States

Many of the food demand studies in the United States have focused on a specific food commodity or group (e.g., meats), examining the price and income effects between subsets of that food commodity or evaluating impacts of shocks on a particular commodity. Examples of this include Zhen et al.(2011); Brown, Behr, and Lee (1994);Yen, Kan, & Su (2002); Chouinard et al. (2005); Blisard & Blaylock (1993); Reed, Levedahl, & Clark (2003); and Gao, Wailes and Cramer (1994).[1] However, there are a limited number of studies that simultaneously consider multiple food commodity groups, including Raper, Wanazala, & Nayga (2002); Reed, Levedahl & Hallahan (2005); and Okrent & Alston (2010) though these differ in commodities analyzed and the composition of the commodities.

Demand analysts' choice of parametric demand model has been very diverse and no standard model has been accepted. The most commonly used parametric demand systems include the linear expenditure system first estimated by Stone (1954), the translog demand system of Christensen, Jorgenson and Lau (1975), and the Almost Ideal Demand System (AIDS) model of Deaton & Muellbauer (1980).

In a more comprehensive review of the literature, Andreyeva, Long and Brownell (2010) reviewed food price elasticity estimates from 160 studies to determine the mean elasticity estimates for various food commodity groups. They found considerable ranges in the estimates for each commodity group, owing to different datasets used, different time periods studied, different lengths of observation, and different modeling methods. The differences among published elasticity estimates highlight the need for more work and consistency in this area.

Censoring in Food Expenditures

One of the barriers to accurate consumer demand estimation using cross-sectional survey data, in particular as it relates to food products, is how to interpret a zero expenditure value. Over the survey period, it is possible for households to consume from "stocks" of previous purchases and not record purchases in the survey period. In these cases, zero food expenditures are present due to infrequency of purchases. A zero expenditure can also represent a true corner solution, due to the household selection of only one or several but not all brands or types of a food product. Zero corner solutions at higher levels of product aggregation can also occur if the price of the product is too high, or if consumers abstain for religious, moral, or preference reasons (Gibson and Kim 2011).

Econometricians have developed models that attempt to account for both problems: infrequency of purchases and corner solutions. Infrequency of purchase models (IPMs), introduced in the 1980's by Deaton and Irish (1984) and later Keen (1986) are a statistical "fix" to the infrequency of purchases problem. However, treating zero observations that truly represent corner solutions as infrequent purchases can lead to biased estimates of income elasticities (Gibson & Kim 2011; Raper, Wanazala, and Nayga 2002).

An alternative means to overcome the zero observations problem is to use a longer time horizon where remaining zeros are truly corner solutions. Econometricians have turned to infrequency of purchase models rather than longer time horizons due to data availability. Much of the disaggregate data needed for detailed food demand analysis are from diary surveys with short durations. Changing survey time frames would involve a long, complex and costly process and has thus far been rejected in favor of the econometric models.

By using Homescan data, which tracks a household's consumption over an extended period of time, the second approach is feasible and the infrequency of purchase problem is practically eliminated.[2] The results of the analysis using the entire period can then be used to benchmark the performance of econometric models proposed to account for the zero expenditures problem estimated using data from a randomly selected sample of monthly expenditures for each household.

Data

The Nielsen Homescan program provides households from across the continental United States with a handheld scanner to record all food purchases made from all outlets as they occur. Each record in the data set contains detailed product information down to the Universal Product Code (UPC) level including price, store purchased, weight, product characteristics (such as container type, brand, and flavor), and store location. A number of household self-identified demographic variables are also captured and matched to the purchases. We restrict this analysis to only the subset of households that also recorded non-UPC items such as fresh fruits or vegetables and in-store packaged breads and meats.: the "Fresh Foods Panel." Failure to account for additional non-UPC purchases would bias the total expenditure of a household downwards. Since there is a sizeable time burden on participating households, the retention rate for households within the Homescan panel varies.[3] Thus, data are treated as cross-sectional rather than panel due to participation differences in the dataset across time.

Food Commodity Groups

Using established USDA nutrition-based guidelines from the Quarterly Food At Home Price Database (QFAHPD) we consider 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. Each commodity group is itself composed of subgroups, identified in table 1.

To make data comparable across product sizes (e.g., ounces, pounds, etc.) all product sizes were converted to grams following the method used by the QFAHPD and price per 100g of product reported (Todd et al. 2010). Products with similar descriptions and characteristics were aggregated using unit values into “aggregate products” following the nutritional guideline-based methods of the QFAHPD. We further distinguished “aggregate products” by brand type as a control for quality.[4] The aggregate products were identified as belonging to subgroups and then to one of the eight commodity groups. A list of the commodity groups and subgroups is provided in table 1 along with the number of aggregate products identified within that group. Using yogurt as an example: Dannon fat free blueberry individual size yogurt and Dannon reduced fat strawberry quart-size yogurt are treated as the same aggregate product: “Dannon-branded reduced fat yogurt,” within the subgroup “Low fat yogurt and other dairy”, within the “Dairy” group.

Prices

To approximate a representative composite commodity price, researchers have adopted a number of indexing methods. The index number represents the deviation of the price paid by a household relative to the average household. Construction of a single price index to represent a composite commodity is a multi-stage process involving: 1) Determination of the price per unit for the aggregate food products, and 2) Construction of price indices for the commodity groups.

The first stage involves the determination of a single price for a relatively homogeneous-in-quality product. Following Diewert (1998) we use the unit value as the elementary price at the aggregate food product level. The unit value for aggregate product g in food commodity group j for household i (UV^{i}_{gj}) is calculated as:

$$UV^{i}_{gj} = \frac{\sum_{m=1}^{M} p^{i}_{mgj} q^{i}_{mgj}}{\sum_{m=1}^{M} q^{i}_{mgj}} \tag{1}$$

Where p^{i}_{mgj} is household *i's* price of the *m* brand in aggregate product g within the commodity group j, and q^{i}_{mgj} is household *i's* quantity purchased of the *m* brand in aggregate product g within the commodity group j. For some of the brand product categories where prices p^{i}_{mgj} are missing, prices were predicted following the methods proposed by Meghir and Robin (1992) and Zhen et al. (2011) (see Leffler, 2004 for more details). This required one regression over all households for each of the aggregate commodities (1,784 regressions).

In the second stage, unit values UV^{i}_{gj} are combined into an index representing the commodity group price. The Fisher price index for household *i's* commodity group j is:

$$P^{i}_{Fj} = \sqrt{P^{i}_{Pj} P^{i}_{Lj}}, \tag{2}$$

where P^{i}_{Fj} and P^{i}_{Lj} are household i's Laspeyres and Paasche price indices for commodity j, respectively. The Laspeyres index represents the differential in price household i pays for an average quantity of commodity j relative to the average household. The Paasche index on the other hand represents the price differential household *i* pays for its own consumption of commodity *j* relative to the price the average household would pay for the same quantity of commodity *j*.[5] The Fisher price index formula is widely viewed as "ideal" as it is a geometric mean of the Laspeyres and Paasche indexes. The Fisher index also satisfies all 20 of Diewert's axiomatic tests of index numbers and is deemed "superlative" for its ability to "approximate homothetic preferences" (Diewert 1998). It is also consistent with revealed preference theory (Diewert 1976, p.137).

Temporal Aggregation - Annual and Monthly Data

The static panel Homescan data in its native format contains one record for each product purchased for each household trip to the store, provided that the household records at least one trip per week for ten consecutive months. To provide a more manageable data set, we aggregate household purchases to a monthly level. This resulted in 1,341,685 records of year- and household-specific monthly purchases. Further sample reduction occurred as a result of limiting the analysis to only those households in the "Fresh Foods Panel" and focusing only on households in urban and suburban locations with purchases in at least one commodity group.

We also aggregated household purchases to an annual level. To make data comparable between households and with the monthly data, we construct average months.[6] Aggregating to an annual level leaves a data set with 35,421 year-specific average monthly household observations. The annual data is taken as a true measure of the demand for the food commodities, owing to the longer period of observation. One month from each household-specific year is randomly selected to comprise the monthly data set. This resulted in two data sets: one with a record of a household's average monthly consumption for a year, and one with a record of a randomly selected month of consumption for the same household in the same year. The proportion of zero budget share observations in the randomly selected month ranged from 3% to 22% for the eight commodity groups under consideration. The comparable percentages for the average month in the "annual" dataset ranged from 0.01% to 0.55%. These findings lend support to the underlying assumption that a year is a sufficiently long period of observation to observe even infrequently purchased commodities.

Summary Statistics

Summary statistics of the variables used in this article are presented in tables 2a-c. To assess the representativeness of the Homescan sample, the summary statistics of the participating households' socio-demographic characteristics are compared to the summary statistics from the US Census Bureau Current Population Survey in table 3. The Current Population Survey data is only available beginning in 2003, so 2003-2006 summary statistics are used for comparison. As a result, though some of these household head variables differ from the comparable US Census estimates, it is not a cause for concern due to the differences in the construction of the variables and the time period differences.[7]

Model Specification and Estimation

Preferences are assumed to be weakly separable, allowing models of household food at home to be constructed independently of households' other consumption choices (Meghir and Robin 1992; Alfonso and Peterson 2006). Expenditures on the eight food commodity groups identified previously are conditional on the broad food-at-home allocation (Gorman 1959). The demand systems are estimated using the Exact Affine Stone Index (EASI) demand system proposed by Lewbel and Pendakur (2009). This model specification was chosen over the AIDS model for its treatment of the error terms as unobserved preference heterogeneity. In addition, the model is linear in log-prices but allows for nonlinearity in demographic characteristics and real expenditures which facilitates estimation and interpretation while accommodating nonlinear Engel curves. Since Lewbel and Pendakur (2009) found that estimates from the linear approximation differed little from nonlinear exact estimates empirically, we use the linear approximation which can be expressed for this model as:

$$w_j^i = \sum_{r=0}^{5} b_{rj}(y^i)^r + \sum_{h=1}^{15}\left(C_{hj}z_h^i + D_{hj}z_h^i y^i\right) + \sum_{k=1}^{8} A_{kj} \ln P_{Fk}^i + \sum_{k=1}^{8} B_{kj} \ln P_{Fk}^i\, y^i + e_j^i, \qquad (3)$$

where w^i_j is household *i's* budget share on commodity *j*; y^i is a measure of real total expenditure and is calculated as $y^i = log(total\ expenditures\ for\ household\ i) - \sum^J_{k=1} w^i_k \ln P^i_{Fk}$; z^i_h are the *h* demographic characteristics of household *i*; $\ln P^i_{Fk}$ is the natural log of the Fisher price index for household *i* on each commodity *k*; b_{rj}, C_{hj}, D_{hj}, A_{kj}, and B_{kj} are the parameters; and e^i_j is an random error term with unknown distribution.

Estimation of the Annual Model

Since the annual data contains few zero observations on the dependent variables, the linear approximation of the EASI demand system in equation (3) is estimated using Seemingly Unrelated Regression (SUR) in SAS using Proc model. We impose symmetry ($\boldsymbol{A}_{kj}=\boldsymbol{A}_{jk}$, $\boldsymbol{B}_{kj}=\boldsymbol{B}_{jk}$ $\forall k,j$) and homogeneity ($\sum^8_{k=1} \mathbf{A}_{kj} = \sum^8_{k=1} \mathbf{B}_{kj} = 0\ \forall j$) restrictions.

Following convention, the last equation is dropped from the system and its parameters are recovered from the adding up constraint. (Barten 1969 as cited in Barnett and Serletis 2008 p. 219; Lewbel and Pendakur 2009; and Zhen et al. 2011)

Estimation of Monthly Models

We consider two procedures for the estimation of the monthly data models. The first procedure involves the use of simple linear regression and is therefore identical to the procedure used for the annual data model. As shown in Blundell and Meghir (1987, equation 9), if the expected value of the quantity consumed equals the expected value of the quantity purchased, then the parameters of the demand model can be consistently estimated by using linear regression. This approach has also been recommended by Angrist (1991) and Deaton (1997) as a sensible approximation to the model.

The second procedure used for the estimation of the monthly data models is the two-step econometric method of Shonkwiler and Yen (1999). Under the model assumptions, this method provides consistent parameter estimates, accounts for zeros due to corner solutions and infrequency of purchases, and is probably the most commonly used method to account for zero expenditures in demand model estimation (e.g., Alfonzo and Peterson, 2006; Carpio and Wohlgenant 2010; Yen and Lin 2006). The procedure works as follows. Consider the two equation system:

$$w_j^{i*} = f\left(\boldsymbol{y}^i \boldsymbol{z}^i \boldsymbol{P}_F^i; \boldsymbol{\theta}_j\right) + e_j^i, \qquad d_j^{i*} = \boldsymbol{\alpha}_j{}' \boldsymbol{x}^i + v_j^i \ , \tag{4}$$

$$\text{where } d_j^i = \begin{cases} 1 \text{ if } d_j^{i*} > 0 \\ 0 \text{ if } d_j^{i*} \leq 0 \end{cases} \quad \text{and} \qquad w_j^i = d_j^i * w_j^{i*}.$$

In the above system the index i corresponds to household and the index j to commodity. The variable $w^{i}_{j}{}^{*}$ is the latent (unobserved) budget share and $d^{i}_{j}{}^{*}$ is the latent variable defining the discrete choice decision of a household whether to buy a commodity. The function $f(\boldsymbol{y}^{i}\boldsymbol{z}^{i}\boldsymbol{P}^{i}{}_{F};\boldsymbol{\theta}_{j})$ is the EASI model as specified in equation (3), $\boldsymbol{z}^{i}$ represents the vector of 15 socio-demographic characteristics, $\boldsymbol{P}^{i}{}_{F}$ the vector of log Fisher price indexes, and $\boldsymbol{\theta}_{j}$ the vector of parameters. In the sample selection model, $\boldsymbol{\alpha}_{j}'$ is a vector of parameters corresponding to the vector $\boldsymbol{x}^{i}$ of socio-demographic characteristics and $v^{i}{}_{j}$ is an error term. The vector of demographic variables in the sample selection equation $\boldsymbol{x}^{i}$ differs from the vector $\boldsymbol{z}^{i}$ specified in the EASI model by the addition of 8 additional household variables (table 2c) modeled after those used by Zhen et al. (2009).

The first step of the Shonkwiler and Yen (1999) method involves the estimation of a probit model describing the sample selection. Estimates of $\boldsymbol{\alpha}_{\mathrm{j}}$ from the probit are used to calculate $\Phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i})$ and $\phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i})$. In the second step, estimates of $\boldsymbol{\theta}_{j}$ are obtained by SUR using a modified version of the EASI demand model incorporating $\Phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i})$ and $\phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i})$. The modified EASI demand model is:

$$w_{j}^{i} = \Phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i})\left(\sum_{r=0}^{5} b_{rj}(y^{i})^{r} + \sum_{h=1}^{15}(C_{hj}z_{h}^{i} + D_{hj}z_{h}^{i}y^{i}) + \sum_{k=1}^{8} A_{kj}\ln P_{Fk}^{i} + \sum_{k=1}^{8} B_{kj}\ln P_{Fk}^{i}\, y^{i}\right) + S_{j}\phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i}) + \xi_{j}, \quad (5)$$

where s_{j} is an additional parameter for the probability density function and $\xi^{i}{}_{j}$ is the random error term again with unknown distribution. Estimation of the parameters in the modified EASI demand system incorporating $\Phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i})$ and $\phi(\widehat{\boldsymbol{\alpha}}_{j}'\boldsymbol{x}^{i})$ uses the full system of eight commodities imposing the symmetry ($\boldsymbol{A}_{\mathrm{kj}}=\boldsymbol{A}_{\mathrm{jk}}$, $\boldsymbol{B}_{\mathrm{kj}}=\boldsymbol{B}_{\mathrm{jk}}$ $\forall k,j$) and adding up restrictions[8] ($\sum^{8}{}_{j=1}\boldsymbol{b}_{rj} = 1$ when r=1; $\sum^{8}{}_{j=1}\boldsymbol{b}_{rj} = 0$, $\forall\, r\neq1,0$; $\sum^{8}{}_{j=1}\boldsymbol{A}_{kj}=\sum^{8}{}_{j=1}\boldsymbol{B}_{kj} = 0$ $\forall j, k;$

$\sum^{8}_{j=1}\boldsymbol{C}_{hj}=\sum^{8}_{j=1}\boldsymbol{D}_{hj}=0\ \forall j,h)$. Heteroskedastic-robust standard errors of parameters and elasticities in all models were calculated using bootstrapping resampling procedures with 599 iterations.[9] Traditional instrumental variable techniques using two-stage least squares are inconsistent when applied to non-linear models such as the EASI model. As a result, a two stage residual inclusion (2SRI) procedure is employed as suggested by Terza, Basu and Rathouz (2007) and Blundell and Robin (2000).

Elasticities and Marginal Effects: Calculation and Comparison

Elasticities and marginal effects for the annual and monthly models are calculated from the parameters and shares as in Lewbel and Pendakur (2009). The compensated elasticities are recovered by taking the partial derivative of the share-form demand equations in (3) and (5) respectively for each commodity *j* with respect to the variable(s) of interest evaluated at mean values. The interested reader can find the parameters from the three models in Leffler (2012).

To compare elasticities and marginal effects between models, first, we calculated the percent error of the elasticities obtained from the monthly models, relative to the elasticities from the annual models. Then to more formally analyze the differences in elasticities between models, we also used bootstrapping procedures. For each bootstrapping sample we estimated annual and monthly models, their corresponding elasticities and marginal effects and the differences between estimates (n=599). This method has the advantage of providing standard errors which are used to evaluate statistical significance of the differences.

Results

Results in all models show the expected signs for the expenditure and own-price elasticities. Price elasticities of demand and expenditure (income) elasticities for the annual model as well as the marginal effects of the socio-demographic variables are provided in tables 5 through 7. The expenditure and uncompensated price elasticities for the monthly models are provided in tables 8 and 9. The interested reader can find compensated elasticities and marginal effects for the monthly models in Leffler (2012). Statistical significance of all estimates is evaluated at the 5% level.

Comparison of Annual and Monthly Models

Despite a shorter observation window, the monthly model results closely approximated the annual expenditure elasticities. The mean absolute percent error between the annual and monthly uncensored models was 6.54%.[10] The mean absolute percent error between the annual and censored monthly model was 10.96%. The individual commodity errors are shown in table 4. Six out of the eight expenditure elasticity percent errors are higher (absolute value) for the censored model than the uncensored model; however, the magnitudes of the differences are quite small in practice. Hence, the censored demand model does not seem to produce more precise estimates of expenditure elasticities.

Greater variation in percentage errors, between the uncensored monthly and annual data (mean absolute percent error 19.15%), and between the censored monthly and annual data (mean absolute percent error 17.12%) was evident for uncompensated own-price elasticities suggesting that the monthly data models do a poor job of approximating own-price elasticities of demand (table 4). Both monthly models overestimate own-price elasticities for the Cereal and Bakery, Meat and Eggs, Dairy, and Fruit and Vegetables commodities while underestimating the remaining four.

To compare performances of the two monthly models to the annual model in estimating uncompensated cross-price elasticities and marginal effects, we plot the monthly own and cross price values on the x-axis versus the counterparts from the annual model on the y-axis in figures 1 and 2. From the plot is it clear that both the censored and uncensored models exhibit some degree of bias in the uncompensated cross price elasticities. There did not appear to be an overall pattern to the bias. The variation in marginal effects between the censored monthly and annual models was more uneven, but no pattern emerged.

The results of the bootstrapping procedure confirm the results of the analysis using percentage errors. For the uncensored model, 7 of the 8 own-price uncompensated elasticities are significantly different from the elasticities of the annual model and an additional 30 cross-price elasticities are significantly different at the 5% level. For the censored model, all 8 own-price and 29 additional cross-price elasticities are significantly different. Moreover, even the differences in expenditure elasticities are found to be statistically significant (different) although they are not practically different. The performance of the models is notably different when marginal effects are considered. For the uncensored model, 12 of the 120 marginal effects are significantly different while the comparable figure for the censored model is 30. Complete results of the bootstrapping analysis are available in Leffler (2012).

Annual Model Elasticity Estimates

Most food products studied were normal, but Meat and Fruits and Vegetables were luxury goods with expenditure elasticities over one. Of our estimates, demand for the Fruits and Vegetables commodity is most own price elastic (-1.495). This finding suggests that commodity is most sensitive to price incentives such as sales, but also most sensitive to price fluctuations resulting from supply side shocks such as drought, crop disease, or infestation.

We also find cross-price elasticities that are consistent with economic theory and nutritional expectations. Dairy and Meat are substitutes, suggesting that consumers will shift a portion of their consumption from Meat to Dairy when the price of Meat increases. The shift is not symmetric, however. The Fruit and Vegetable commodity is found to be a substitute with Sweets and other Sugars. Households will substitute fruit for some sweets (0.127) when the price of Sugar and Other Sweets increases, though at a slower rate than when the directionality of the relative prices is reversed (0.415). Most of the cross-price elasticities are very inelastic. Since most households purchase some quantity of each composite commodity, fluctuations in the prices of other commodities don't greatly affect purchase decisions of households.

The marginal effects of this model provide some interesting conclusions. In accordance with the literature, those households in which the head of the household does not have a college degree consume less Dairy and fewer Fruits and Vegetables. Households in the Northeast region consume the most Meat and Nonalcoholic Beverages while consuming the fewest Miscellaneous food items. Larger families consume more of every food commodity except Fruits and Vegetables and Meats. The youngest age cohort, with a household head under 25 years of age, consumes the most prepared and snack foods (within Miscellaneous). This trend continues for all household head age categories. This finding corroborates that of Kinsey and Senauer (1996) who concluded that the socio-demographic composition of the labor force was changing the American consumer's overall demand for convenience and prepared food items.

Summary and Conclusions

This article modeled a system of demand for eight food commodity groups using the EASI demand model of Lewbel and Pendakur (2009) and five years of data (2002-2006) from the Nielsen Homescan program. Two different levels of temporal aggregation, monthly and the average month within a year were considered. Using the monthly data, we evaluated the performance of econometric methods, namely those of Shonkwiler and Yen (1999) and Blundell and Meghir (1987), to account for zero expenditures in food demand analysis. Elasticity measures of US consumers' average monthly demand for food at home as well as marginal effects of selected demographic variables on consumption were also provided.

We conclude that the models using monthly data closely approximate the underlying annual expenditure elasticities, but do a poor job estimating own- and –cross price elasticities and marginal effects. This finding is true for both the uncensored model and the censored model attempting to account for the cause of the zero expenditure. As a result, we conclude that the simplicity principle applies, at least when using Homescan data: the more complex model does not provide a significant improvement in precision.

While the own- and cross price elasticities estimated from this demand model differ from previous demand system estimates, there are not consistent patterns to the differences and the order of magnitude is not such that the broad conclusions drawn from previous studies are nullified. The household demands for Meat, Dairy, Fruits and Vegetables, and Sugar and Other Sweets are elastic while the demand for Cereal and Bakery goods, Nonalcoholic Beverages, Fats and Oils and Miscellaneous goods are slightly inelastic. The marginal effects bear out many of the long-held assumptions about food demand and the consumption patterns of different population sub-segments as well as provide evidence of a generational shift toward pre-processed and prepared foods.

One avenue for related future research includes modeling at lower levels of aggregation to construct comprehensive cross-price elasticities within commodities. Another interesting research idea related to consumer demand of branded goods is the impact of socio-demographic characteristics on branded purchase patterns and how coupons or promotional pricing, indicated in the Homescan panel, drive that behavior. The examples provided above are samples of the research questions that were discarded by this researcher as out of the defined scope of this project.

Table 1 – Commodities, subgroups, and aggregate products

Commodity Group	Subgroups	Number of aggregate products
Cereal and Bakery Goods	1.) Whole grain Bread, rolls, rice, pasta, cereal 2.) Whole grain flour and mixes 3.) Whole grain frozen/ready to cook 4.) Refined grain Bread, rolls, rice, pasta, cereal 5.) Refined grain flour and mixes 6.) Refined grain frozen/ready to cook 7.) Baked good mixes 8.) Bakery items, ready to eat 9.) Packaged baked goods 10.) Frozen desserts	263
Meat & Eggs	1.) Fresh/Frozen low fat meat 2.) Fresh/Frozen regular fat meat 3.) Canned meat 4.) Fresh/frozen poultry 5.) Canned poultry 6.) Fresh/frozen fish 7.) Canned fish 8.) Eggs	209
Dairy	1.) Low fat milk 2.) Low fat cheese 3.) Low fat yogurt and other dairy 4.) Regular fat milk 5.) Regular fat cheese 6.) Regular fat yogurt and other dairy 7.) Ice cream and frozen novelties	137
Fruits & Vegetables	1.) Fresh/Frozen Fruit 2.) Canned & Dried fruit 3.) Fresh/Frozen dark green vegetables 4.) Canned dark green vegetables 5.) Fresh/Frozen orange vegetables 6.) Canned orange vegetables 7.) Fresh/Frozen starchy vegetables 8.) Frozen/dried legumes 9.) Canned starchy vegetables 10.) Canned legumes 11.) Fresh/Frozen other vegetables 12.) Canned other vegetables 13.) Fresh/Frozen select nutrient vegetables 14.) Canned Select nutrient vegetables 15.) Other mixed vegetables	414
Nonalcoholic Beverages	1.)Non-alcoholic carbonated beverages 2.) Non-carbonated caloric beverages 3.) Water 4.) Fruit juice 5.) Coffee and Tea	141
Fats & Oils	1.) Oils 2.) Solid Fats 3.) Nut butters 4.) Salad Dressings and Spreads	74
Sugars and other Sweets	1.) Raw sugars 2.) Packaged sweet goods (candy) 3.) Jams, jellies, preserves and other sweets	88
Miscellaneous	1.) Raw & processed nuts & seeds 2.) Frozen entrees and sides 3.) Canned soups and sauces 4.) Packaged snacks 5.) Packaged/Ready to cook meals and sides 6.) Ready to eat deli items (hot & cold) 7.) Baby food 8.) Spices, seasonings, condiments, olives, pickles, relishes	458

Table 2a – Summary Statistics - Annual

Variable	Description	Mean	Std Dev
†aP_{F1}	Fisher Price index for Cereal and Bakery Goods	0.945	0.153
† aP_{F2}	Fisher Price index for Meat & Eggs	0.952	0.170
† aP_{F3}	Fisher Price index for Dairy	0.966	0.152
† aP_{F4}	Fisher Price index for Fruits & Vegetables	0.953	0.123
†aP_{F5}	Fisher Price index for Nonalcoholic Beverages	0.907	0.176
† aP_{F6}	Fisher Price index for Fats & Oils	0.946	0.150
† aP_{F7}	Fisher Price index for Sugar and Other Sweets	0.939	0.238
†aP_{F8}	Fisher Price index for Miscellaneous Goods	0.938	0.131
ay	Measure of Real Household Expenditures in an average month for a year	5.241	0.567
ayw1	Share of budget allocated to for Cereal and Bakery Goods for an average month	0.137	0.055
ayw2	Share of budget allocated to for Meat & Eggs for an average month	0.182	0.092
ayw3	Share of budget allocated to for Dairy for an average month	0.110	0.050
ayw4	Share of budget allocated to for Fruits & Vegetables for an average month	0.126	0.068
ayw5	Share of budget allocated to for Nonalcoholic Beverages for an average month	0.117	0.060
ayw6	Share of budget allocated to for Fats & Oils for an average month	0.033	0.019
ayw7	Share of budget allocated to for Sugar and Other Sweets for an average month	0.047	0.034
ayw8	Share of budget allocated to for Miscellaneous Goods for an average month	0.249	0.101
aytotalexp	Total household expenditures on food at home for an average month	203.595	110.399

Note: sample consists of 35,421 observations for each variable.
†Price Index variables enter the regressions as Natural Logs, but are presented here for ease of interpretation.

Table 2b – Summary Statistics - Monthly

Variable	Description	Mean	Std Dev
†P_{F1}	Fisher Price index for Cereal and Bakery Goods	0.949	0.170
† P_{F2}	Fisher Price index for Meat & Eggs	0.949	0.176
† P_{F3}	Fisher Price index for Dairy	0.971	0.158
† P_{F4}	Fisher Price index for Fruits & Vegetables	0.948	0.134
† P_{F5}	Fisher Price index for Nonalcoholic Beverages	0.921	0.194
† P_{F6}	Fisher Price index for Fats & Oils	0.963	0.172
† P_{F7}	Fisher Price index for Sugar and Other Sweets	0.956	0.289
† P_{F8}	Fisher Price index for Miscellaneous Goods	0.937	0.145
y	Measure of Real Household Expenditures in an average month for a year	5.143	0.796
w1	Share of budget allocated to for Cereal and Bakery Goods for a selected month	0.138	0.088
w2	Share of budget allocated to for Meat & Eggs for a selected month	0.175	0.127
w3	Share of budget allocated to for Dairy for a selected month	0.113	0.079
w4	Share of budget allocated to for Fruits & Vegetables for a selected month	0.126	0.095
w5	Share of budget allocated to for Nonalcoholic Beverages for a selected month	0.120	0.098
w6	Share of budget allocated to for Fats & Oils for a selected month	0.033	0.036
w7	Share of budget allocated to for Sugar and Other Sweets for a selected month	0.048	0.068
w8	Share of budget allocated to for Miscellaneous Goods for a selected month	0.247	0.141
totalexp	Measure of Real Household Expenditures in a selected month for a year	203.781	133.874

Note: sample consists of 35,421 observations for each variable.
†Price Index variables enter the regressions as Natural Logs, but are presented as raw measurements here for ease of interpretation

Table 2c – Summary Statistics – Socio-demographic Variables

Demographic Characteristic	Variable	Description	Mean	Standard Deviation
Education	LowEd	1 if head of household does not have high school diploma, 0 otherwise	0.035	0.184
	MidEd	1 if head of household is a high school graduate, but does not have a college degree, 0 otherwise	0.518	0.500
	HiEd[a]	1 if head of household is a college graduate or holds an advanced degree	0.447	0.497
Region	NE	1 if household resides in Northeast Region, 0 otherwise	0.238	0.426
	MW	1 if household resides in Midwest Region, 0 otherwise	0.144	0.351
	SO	1 if household resides in South Region, 0 otherwise	0.395	0.489
	WT[a]	1 if household resides in West Region, 0 otherwise	0.223	0.416
Age	Age_ref1	1 if head of household < 25 yrs, 0 otherwise	0.003	0.050
	Age_ref2	1 if head of household ≥ 25 and <30 yrs, 0 otherwise	0.020	0.141
	Age_ref3	1 if head of household ≥ 30 and <40 yrs, 0 otherwise	0.146	0.353
	Age_ref4	1 if head of household ≥ 40 and <50 yrs, 0 otherwise	0.245	0.430
	Age_ref5	1 if head of household ≥ 50 and <65 yrs, 0 otherwise	0.372	0.483
	Age_ref6[a]	1 if head of household ≥ 65 yrs, 0 otherwise	0.214	0.410
Race	RefWhite	1 if Household self-identifies as white, 0 otherwise	0.753	0.431
	RefBlack	1 if Household self-identifies as black, 0 otherwise	0.145	0.352
	RefOrient	1 if Household self-identifies as "oriental", 0 otherwise	0.037	0.188
	RefOther[a]	1 if Household self-identifies as "other", 0 otherwise	0.065	0.247
Family Size	FamilySize	categorical variable indicating number of members 1-9 with 9 being 9 or greater.	2.412	1.356
Hispanic	Hispanic	1 if Household self-identifies as Hispanic, 0 otherwise	0.081	0.274
	nonHispanic[a]	1 if Household does not self-identify as Hispanic, 0 otherwise	0.919	0.274
†Children in Household	dperslt18	1 if household includes children under age 18, 0 otherwise	0.255	0.436
	dpersgt18[a]	1 if household does not include children under age 18, 0 otherwise	0.745	0.436
†Year	d2002	1 if year of purchase is 2002, 0 otherwise	0.208	0.406
	d2003	1 if year of purchase is 2003, 0 otherwise	0.212	0.409
	d2004	1 if year of purchase is 2004, 0 otherwise	0.203	0.402
	d2005	1 if year of purchase is 2005, 0 otherwise	0.196	0.397
	d2006[a]	1 if year of purchase is 2006, 0 otherwise	0.180	0.384
†Presence of female adult**	dfadult	1 if female head of household, 0 otherwise	0.500	0.500
	dmadult[a]	1 if male head of household, 0 otherwise	0.500	0.500
†Age of female adult**	dfadult35	1 if female head of household is less than 35 years old, 0 otherwise	0.046	0.209
	dfadult36[a]	1 if female head of household is at least 35 years old, 0 otherwise	0.454	0.498
†Female Adult unemployment**	dfadultun	1 if female head is not employed for pay, 0 otherwise	0.247	0.431
	dfadultemp[a]	1 if female head is employed for pay, 0 otherwise	0.253	0.435

Note: sample consists of 35,421 observations for each variable.
† used only in Probit model for censored monthly demand
[a] dropped (reference household is in the West region, identifies race as "other" and not Hispanic, with a college-graduate head over 65 yrs.)

Table 3 - Representativeness of Socio-demographic Variables

Variable	Percent of Homescan Sample 2002-2006	Percent of Current Population Survey 2003-2006
LowEd	3.5%	14.9%
MidEd	51.8%	57.4%
HiEd	44.7%	27.7%
NE	23.8%	18.7%
MW	14.4%	23.0%
SO	39.5%	36.3%
WT	22.3%	22.0%
Age_ref1	0.3%	5.9%
Age_ref2	2.0%	7.9%
Age_ref3	14.6%	19.0%
Age_ref4	24.5%	21.8%
Age_ref5	37.2%	25.0%
Age_ref6	21.4%	20.5%
RefWhite	75.3%	82.1%
RefBlack	14.5%	12.2%
RefOrient	3.7%	3.6%
RefOther	6.5%	2.2%
FamilySize (persons)	2.412	2.416
Hispanic	8.1%	10.6%
nonHispanic	91.9%	89.4%
dperslt18	25.5%	34.6%
dpersgt18	74.5%	65.3%
d2002	20.8%	N/A**
d2003	21.2%	24.7%
d2004	20.3%	24.8%
d2005	19.6%	25.1%
d2006	18.0%	25.4%
dfadult	50.0%	N/A*
dmadult	50.0%	N/A*
dfadult35	4.6%	N/A*
dfadult36	45.4%	N/A*
dfadultun	24.7%	N/A*
dfadultemp	25.3%	N/A*

Source: US Census Bureau Current Population Survey, Annual Social and Economic Supplement, 2003 through 2006
*The current population does not attempt to determine head of household in married households as this article does
**The current population does not provide data for 2002, so 2003-2006 averages were used

Table 4– Summary Comparison of Percent Errors in Elasticities

Variable	Uncensored Monthly vs. Uncensored Annual		Censored Monthly vs. Uncensored Annual	
	Expenditure	Uncompensated Own-price	Expenditure	Uncompensated Own-price
Cereal & Bakery	-1.80%	12.03%	-8.82%	11.87%
Meat & Eggs	-1.00%	10.16%	4.71%	13.53%
Dairy	-3.15%	8.09%	-7.88%	9.43%
Fruits & Vegetables	-0.99%	12.86%	10.94%	15.75%
Non-alcoholic Beverages	13.84%	-10.05%	10.40%	-8.75%
Fats & Oils	-16.26%	-67.46%	-18.33%	-47.63%
Sugar & Other Sweets	-15.19%	-27.96%	12.90%	-13.86%
Miscellaneous	-0.13%	-4.59%	-13.71%	-16.13%

Table 5 – Estimated Compensated Elasticity Measures for Annual Model

Quantity Demanded	Prices							
	Cereal & Bakery	**Meats & Eggs**	**Dairy**	**Fruit & Vegetables**	**Nonalcoholic Beverages**	**Fats & Oils**	**Sugar & other Sweets**	**Miscellaneous Goods**
Cereal & Bakery	-0.750	0.222	0.030	0.306	-0.013	0.108	-0.018	0.114
	(0.024)	***(0.018)***	***(0.015)***	***(0.019)***	*(0.013)*	***(0.007)***	*(0.009)*	***(0.023)***
Meats & Eggs	0.167	-0.880	0.192	0.198	0.015	-0.030	0.083	0.255
	(0.014)	***(0.028)***	***(0.013)***	***(0.016)***	*(0.012)*	***(0.005)***	***(0.008)***	***(0.021)***
Dairy	0.038	0.318	-0.950	0.137	0.145	0.049	0.047	0.217
	(0.018)	***(0.021)***	***(0.025)***	***(0.022)***	***(0.014)***	***(0.009)***	***(0.011)***	***(0.026)***
Fruit & Vegetables	0.332	0.286	0.120	-1.335	0.328	0.024	0.186	0.059
	(0.021)	***(0.023)***	***(0.019)***	***(0.036)***	***(0.017)***	***(0.010)***	***(0.012)***	*(0.032)*
Nonalcoholic Beverages	-0.015	0.023	0.136	0.352	-0.619	0.031	0.059	0.033
	(0.015)	*(0.019)*	***(0.014)***	***(0.018)***	***(0.020)***	***(0.006)***	***(0.009)***	*(0.024)*
Fats & Oils	0.442	-0.163	0.160	0.089	0.109	-0.692	0.051	0.005
	(0.030)	***(0.027)***	***(0.031)***	***(0.037)***	***(0.021)***	***(0.033)***	***(0.016)***	*(0.035)*
Sugar & other Sweets	-0.053	0.324	0.110	0.502	0.148	0.036	-1.164	0.097
	(0.027)	***(0.031)***	***(0.025)***	***(0.032)***	***(0.022)***	***(0.011)***	***(0.022)***	***(0.037)***
Miscellaneous Goods	0.063	0.187	0.096	0.030	0.015	0.001	0.018	-0.410
	(0.013)	***(0.016)***	***(0.012)***	*(0.016)*	*(0.011)*	*(0.005)*	***(0.007)***	***(0.031)***

Standard Errors in Parentheses
Note: Bolded standard errors indicate elasticity or Marginal effect is different from zero at the 0.05level

Table 6 – Estimated Uncompensated and Expenditure Elasticity Measures for Annual Model

Quantity Demanded	Prices								
	Cereal & Bakery	**Meats & Eggs**	**Dairy**	**Fruit & Vegetables**	**Nonalcoholic Beverages**	**Fats & Oils**	**Sugar & other Sweets**	**Miscellaneous Goods**	**Expenditure**
Cereal & Bakery	-0.861	0.074	-0.059	0.203	-0.108	0.081	-0.056	-0.088	0.814
	(0.025)	***(0.020)***	***(0.015)***	***(0.020)***	***(0.012)***	***(0.007)***	***(0.009)***	***(0.023)***	***(0.024)***
Meats & Eggs	-0.034	-1.148	0.030	0.013	-0.158	-0.079	0.014	-0.111	1.473
	(0.014)	***(0.030)***	***(0.013)***	*(0.017)*	***(0.012)***	***(0.005)***	*(0.008)*	***(0.022)***	***(0.031)***
Dairy	-0.078	0.165	-1.042	0.031	0.046	0.020	0.008	0.008	0.843
	(0.019)	***(0.023)***	***(0.025)***	*(0.023)*	***(0.014)***	***(0.009)***	*(0.010)*	*(0.027)*	***(0.029)***
Fruit & Vegetables	0.158	0.055	-0.020	-1.495	0.179	-0.019	0.127	-0.257	1.272
	(0.022)	***(0.025)***	*(0.019)*	***(0.037)***	***(0.016)***	*(0.010)*	***(0.012)***	***(0.032)***	***(0.034)***
Nonalcoholic Beverages	-0.143	-0.148	0.033	0.233	-0.729	0.000	0.015	-0.201	0.941
	(0.016)	***(0.021)***	***(0.014)***	***(0.018)***	***(0.021)***	*(0.006)*	*(0.008)*	***(0.025)***	***(0.036)***
Fats & Oils	0.312	-0.335	0.056	-0.031	-0.002	-0.724	0.006	-0.230	0.948
	(0.031)	***(0.030)***	*(0.030)*	*(0.038)*	*(0.021)*	***(0.033)***	*(0.016)*	***(0.036)***	***(0.037)***
Sugar & other Sweets	-0.148	0.197	0.034	0.415	0.066	0.013	-1.197	-0.076	0.695
	(0.028)	***(0.035)***	*(0.025)*	***(0.034)***	***(0.021)***	*(0.011)*	***(0.022)***	*(0.038)*	***(0.050)***
Miscellaneous Goods	-0.044	0.045	0.010	-0.068	-0.076	-0.025	-0.018	-0.604	0.780
	(0.013)	***(0.017)***	*(0.012)*	***(0.017)***	***(0.011)***	***(0.005)***	***(0.007)***	***(0.032)***	***(0.023)***

Standard Errors in Parentheses

Note: Bolded standard errors indicate elasticity or Marginal effect is different from zero at the 0.05 level

Table 7- Estimated Sociodemographic Marginal Effects for Annual Model

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	"Oriental"		
Cereal & Bakery	0.242	0.528	1.819	1.504	0.023	-4.062	-3.159	-3.589	-3.212	-2.782	1.234	-1.267	-1.539	1.814	0.788
	(0.330)	***(0.125)***	***(0.185)***	***(0.192)***	*(0.167)*	***(0.993)***	***(0.436)***	***(0.238)***	***(0.192)***	***(0.156)***	***(0.288)***	***(0.337)***	***(0.435)***	***(0.143)***	***(0.268)***
Meats & Eggs	6.807	2.966	2.187	1.458	1.882	-5.624	-4.208	-3.253	-2.147	0.664	-2.735	9.205	5.505	-1.935	2.241
	(0.549)	***(0.200)***	***(0.282)***	***(0.311)***	***(0.244)***	***(1.584)***	***(0.688)***	***(0.380)***	***(0.315)***	***(0.267)***	***(0.494)***	***(0.601)***	***(0.716)***	***(0.257)***	***(0.421)***
Dairy	-1.908	-1.250	0.138	-0.901	-0.429	-1.884	0.604	-0.107	-0.493	-1.295	2.618	-4.885	-3.004	0.923	0.140
	(0.286)	***(0.104)***	*(0.172)*	***(0.190)***	***(0.150)***	***(0.789)***	*(0.430)*	*(0.213)*	***(0.170)***	***(0.142)***	***(0.294)***	***(0.316)***	***(0.409)***	***(0.142)***	*(0.260)*
Fruit & Vegetables	-5.826	-3.875	-0.708	-1.001	0.306	-9.034	-7.536	-8.349	-8.583	-5.472	-0.485	-0.815	4.539	-2.242	0.231
	(0.342)	***(0.143)***	***(0.232)***	***(0.244)***	*(0.202)*	***(1.248)***	***(0.520)***	***(0.288)***	***(0.230)***	***(0.209)***	*(0.354)*	***(0.399)***	***(0.543)***	***(0.181)***	*(0.311)*
Nonalcoholic Beverages	1.430	0.350	1.184	-0.752	-0.692	5.584	3.439	3.830	4.587	3.033	-1.775	0.432	-3.056	0.214	0.085
	(0.351)	***(0.140)***	***(0.211)***	***(0.202)***	***(0.179)***	***(1.426)***	***(0.488)***	***(0.266)***	***(0.202)***	***(0.156)***	***(0.370)***	*(0.406)*	***(0.511)***	*(0.185)*	*(0.307)*
Fats & Oils	0.155	0.150	0.380	-0.087	0.078	-1.415	-1.824	-1.536	-1.097	-0.478	0.183	-0.184	-1.191	0.110	-0.530
	(0.114)	***(0.045)***	***(0.065)***	*(0.069)*	*(0.060)*	***(0.407)***	***(0.132)***	***(0.082)***	***(0.067)***	***(0.059)***	*(0.107)*	*(0.119)*	***(0.140)***	*(0.055)*	***(0.090)***
Sugar & other Sweets	0.747	0.938	-0.123	1.069	-0.100	-2.088	-1.508	-0.804	0.038	0.274	0.388	-0.823	-0.588	0.406	-0.476
	(0.214)	***(0.078)***	*(0.109)*	***(0.131)***	*(0.097)*	***(0.474)***	***(0.239)***	***(0.146)***	*(0.114)*	***(0.101)***	***(0.178)***	***(0.205)***	***(0.249)***	***(0.106)***	***(0.160)***
Miscellaneous Goods	-1.648	0.193	-4.877	-1.290	-1.067	18.524	14.192	13.807	10.906	6.056	0.573	-1.663	-0.665	0.710	-2.480
	(0.566)	*(0.220)*	***(0.325)***	***(0.354)***	***(0.287)***	***(2.051)***	***(0.895)***	***(0.427)***	***(0.345)***	***(0.290)***	*(0.576)*	***(0.675)***	*(0.882)*	***(0.261)***	***(0.528)***

Standard Errors in Parentheses

Note: Bolded standard errors indicate elasticity or Marginal effect is different from zero at the 0.05 level

Table 8 – Estimated Uncompensated and Expenditure Elasticity Measures for Uncensored Monthly Model

Quantity Demanded	Prices								
	Cereal & Bakery	**Meats & Eggs**	**Dairy**	**Fruit & Vegetables**	**Nonalcoholic Beverages**	**Fats & Oils**	**Sugar & other Sweets**	**Miscellaneous Goods**	**Expenditure**
Cereal & Bakery	-0.757	-0.007	-0.031	0.107	-0.074	0.042	-0.063	-0.045	0.829
	(0.027)	*(0.019)*	*(0.017)*	***(0.019)***	***(0.015)***	***(0.009)***	***(0.011)***	***(0.021)***	***(0.028)***
Meats & Eggs	-0.097	-1.031	-0.021	-0.095	-0.118	-0.046	0.125	-0.204	1.488
	(0.014)	***(0.029)***	***(0.013)***	***(0.016)***	***(0.013)***	***(0.007)***	***(0.010)***	***(0.020)***	***(0.031)***
Dairy	-0.043	0.075	-0.958	-0.002	0.033	0.021	0.005	0.000	0.869
	(0.021)	***(0.021)***	***(0.031)***	*(0.024)*	*(0.017)*	***(0.012)***	*(0.013)*	*(0.023)*	***(0.030)***
Fruit & Vegetables	0.054	-0.096	-0.048	-1.302	0.089	0.050	0.163	-0.192	1.284
	(0.020)	***(0.022)***	***(0.020)***	***(0.039)***	***(0.017)***	***(0.012)***	***(0.013)***	***(0.027)***	***(0.033)***
Nonalcoholic Beverages	-0.083	-0.055	0.038	0.154	-0.803	0.018	-0.009	-0.072	0.811
	(0.018)	***(0.021)***	*(0.018)*	***(0.020)***	***(0.025)***	***(0.009)***	***(0.012)***	***(0.025)***	***(0.042)***
Fats & Oils	0.139	-0.176	0.044	0.212	0.032	-1.212	0.058	-0.198	1.102
	(0.039)	***(0.039)***	***(0.042)***	***(0.047)***	*(0.030)*	***(0.049)***	***(0.023)***	***(0.048)***	***(0.047)***
Sugar & other Sweets	-0.175	0.573	0.019	0.484	-0.020	0.049	-1.531	-0.200	0.801
	(0.037)	***(0.042)***	*(0.033)*	***(0.038)***	***(0.029)***	***(0.016)***	***(0.042)***	***(0.044)***	***(0.094)***
Miscellaneous Goods	-0.019	-0.021	0.010	-0.034	-0.031	-0.016	-0.038	-0.631	0.781
	(0.012)	***(0.015)***	*(0.011)*	*(0.014)*	***(0.012)***	*(0.006)*	***(0.008)***	***(0.026)***	***(0.025)***

Standard Errors in Parentheses

Note: Bolded standard errors indicate elasticity or Marginal effect is different from zero at the 0.05 level

Table 9 – Estimated Uncompensated and Expenditure Elasticity Measures for Censored Monthly Model

Quantities Demanded	Prices								
	Cereal & Bakery	**Meats & Eggs**	**Dairy**	**Fruit & Vegetables**	**Nonalcoholic Beverages**	**Fats & Oils**	**Sugar & other Sweets**	**Miscellaneous Goods**	**Expenditure**
Cereal & Bakery	-0.759	-0.018	-0.032	0.094	-0.077	0.032	-0.033	-0.093	0.886
	(0.026)	*(0.019)*	***(0.018)***	***(0.020)***	***(0.015)***	***(0.010)***	***(0.011)***	***(0.024)***	***(0.035)***
Meats & Eggs	-0.085	-0.992	-0.027	-0.076	-0.109	-0.054	0.061	-0.122	1.404
	(0.015)	***(0.028)***	*(0.014)*	***(0.017)***	***(0.014)***	***(0.008)***	***(0.011)***	***(0.021)***	***(0.039)***
Dairy	-0.041	0.044	-0.944	-0.008	0.023	0.029	0.016	-0.029	0.909
	(0.021)	***(0.022)***	***(0.030)***	*(0.024)*	*(0.017)*	***(0.013)***	*(0.013)*	*(0.027)*	***(0.033)***
Fruit & Vegetables	0.067	-0.058	-0.032	-1.259	0.089	0.015	0.134	-0.088	1.133
	(0.022)	***(0.024)***	*(0.021)*	***(0.038)***	***(0.017)***	*(0.014)*	***(0.014)***	***(0.028)***	***(0.041)***
Nonalcoholic Beverages	-0.080	-0.062	0.029	0.129	-0.793	0.017	0.013	-0.096	0.844
	(0.018)	***(0.022)***	*(0.016)*	***(0.020)***	***(0.025)***	*(0.010)*	*(0.013)*	***(0.025)***	***(0.041)***
Fats & Oils	0.079	-0.201	0.060	0.047	0.021	-1.069	0.081	-0.140	1.121
	(0.037)	***(0.039)***	*(0.039)*	*(0.047)*	*(0.030)*	***(0.042)***	***(0.027)***	***(0.047)***	***(0.073)***
Sugar & other Sweets	-0.038	0.324	0.067	0.363	0.058	0.075	-1.362	-0.092	0.606
	(0.030)	***(0.037)***	***(0.028)***	***(0.034)***	***(0.028)***	***(0.019)***	***(0.041)***	***(0.043)***	***(0.077)***
Miscellaneous Goods	-0.053	0.003	-0.011	-0.015	-0.055	-0.015	-0.039	-0.701	0.887
	(0.014)	*(0.016)*	*(0.013)*	*(0.015)*	***(0.012)***	***(0.007)***	***(0.009)***	***(0.027)***	***(0.038)***

Standard Errors in Parentheses

Note: Bolded standard errors indicate elasticity or Marginal effect is different from zero at the 0.05 level

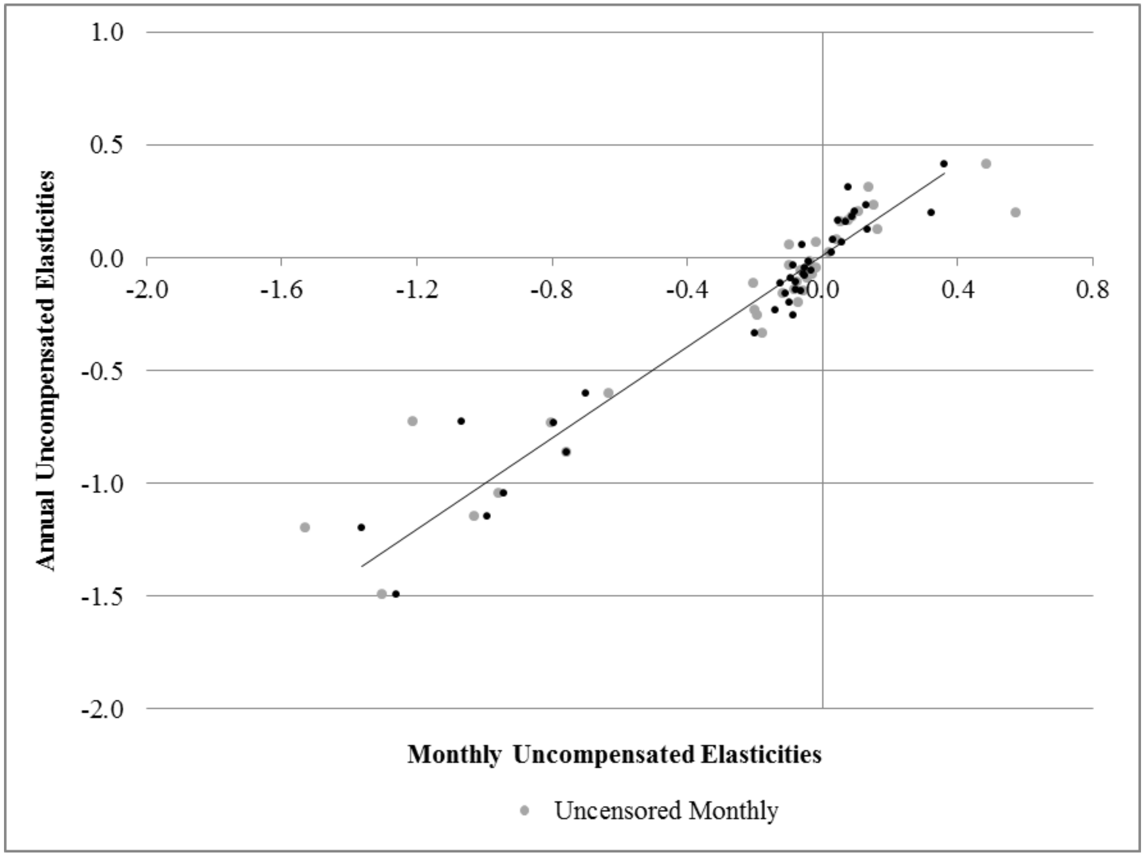

Figure 1 – Plot of significant annual vs. monthly uncompensated elasticities

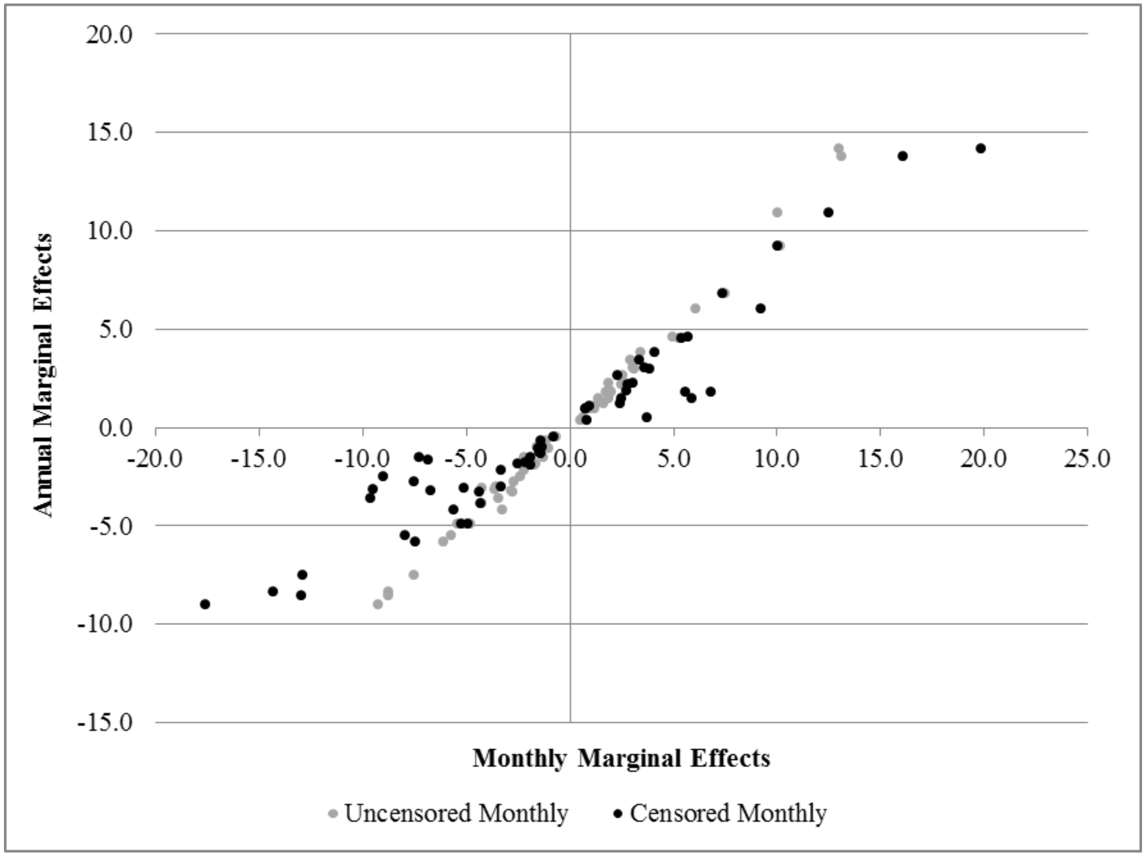

Figure 2 – Plot of Significant Annual vs. Monthly Marginal Effect Estimates

Footnotes to text

1. For additional examples, see Table A – 1a and 1b in Okrent and Alston (2011)
2. Proportion of observations with zero expenditures were 0.55% or less over a year-long period
3. In the final dataset with 11,980 households (35,421 year-specific household records) 25% of households were included for all five years followed by 17%, 14%, 17%, and 27% for 4 years, 3 years, 2 years, and 1 year, respectively. Also notable is that while the inclusion years are consecutive, years are not necessarily the same years for all households.
4. Similar to the method used by Zhen et al. (2011), brands composing a five percent or greater market share of their respective aggregate product were identified individually. For other methodologies used in the branded food literature specifically using Homescan data, see Zhen et al. 2011; Arnade, Gopinsth & Pick 2008; and Martinez 2008. To address degrees of freedom concerns in the price regressions explained in the next section, where these brand-specific aggregate products contained fewer than 3,200 observations, brand-specific aggregate products were added to the "other brands" aggregate product. In the event an entire aggregate product (all brands and non/store brand combined) contained fewer than 3,200 observations, that aggregate product was combined with another aggregate product considered similar by product characteristics within the same subgroup.
5. In the Paasche index, both the numerator and denominator contain household *i*'s quantity term. For disaggregated products, this term may be zero. It is possible that a

household may not purchase one or more of the components (aggregate products) of a commodity. While it is unlikely that an entire commodity over which this index is used would have zero values, leading to an undefined fraction, the treatment of any individual zero quantity will have implications for the index value. To prevent any complications arising from zero values, where the recorded quantity was zero we used the unit value ratio, omitting the quantity term. This implicitly raises a zero quantity to a quantity of one. We recognize that this may bias the index upward, but believe this problem is negligible when the Paasche index is used as a factor in the Fisher index formula.

6. 1,110 households or 3% recorded purchases for 10 months, 3,229 households, or 9% recorded purchases for 11 months, and the remaining 31,082 (88%) recorded purchases for all 12 months in a given year.

7. Household head in this article was first determined by household composition. For married households, the working member was deemed the head. If both members are employed, the partner with the longer time spent outside the home was deemed the "head." In the case where both partners spent equal time outside the home, the partner with the higher education level was deemed the "head." On the other hand, the U.S. Census Bureau defines the reference person or household head as "the person (or one of the people) in whose name the housing unit is owned or rented (maintained) or, if there is no such person, any adult member, excluding roomers, boarders, or paid employees. If the house is owned or rented jointly by a married

couple, the householder may be either the husband or the wife.” (U.S. Department of Commerce, U.S. Bureau of the Census)

8. Homogeneity restriction is automatically satisfied (Yen, Kan & Su 2002, p. 1800)
9. Bootstrapping was performed using 199, 399, and 599 iterations. There were not material differences between the 399 iteration results and the 599 iteration results, so higher iterations were not needed.
10. This comparison and the ones that follow in this section include only those elasticities and marginal effects that are statistically significant at the 5% level.

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