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ABSTRACT

A system of nine censored Engel curve equations was estimated for Hispanic households in the U.S.: grains, vegetables, fruits, milk, meat, legumes, fats, sugar, and beverages. Income and household size elasticities, with their respective confidence intervals, are reported and the results compared with other ethnic groups in the U.S.

Key words: Engel curves, food demand, Hispanic population, censored equations

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A Censored System Estimation of Hispanic Household Food Consumption Patterns

Abstract
A system of nine censored Engel curve equations was estimated for Hispanic households in the U.S.: grains, vegetables, fruits, milk, meat, legumes, fats, sugar, and beverages. Income and household size elasticities, with their respective confidence intervals, are reported and the results compared with other ethnic groups in the U.S.

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Introduction

Recent studies suggested that Hispanics have different consumption patterns than the rest of the U.S. population. In the case of food consumption, this has important implications for producers, food processors and retailers. In recent years there has been a dramatic growth in the Hispanic population in the U.S. due to high birth and immigration rates. In 1997, 29.7 million persons of Hispanic origin resided in the United States, representing 11.1% of the total population (U.S. Census Bureau, *Current Population Report*, 1998). From this number, approximately 13.4 million were foreign-born (Camarota, 1999). According to U.S. Census Bureau projections, by 2010 the Hispanic community is expected to comprise 15.5% of the population. In addition, Hispanics buying power has been growing at a compound rate of 7.5% in the last decade, and today it has been estimated at $350 billion nationwide. These factors are the primary reason why the Hispanic market is considered the leading growth market in the United States (Fan and Zuiker, 1998).

With regard to their consumption patterns, Fan and Zuiker (1998) found that Hispanic Households allocate significantly more of their budget to food eaten at home, shelter, and apparel and significantly less to food consumed away from home, entertainment, education, health care, and tobacco, compared to non-Hispanic White households. Using data from the 1987-88

Nationwide Food Consumption Survey, Holcomb, Park, and Capps (1995) estimated that on average, U.S. households devoted approximately 15% of their income to total food expenditures, 9% of household income was devoted to food eaten at home, and 6% to food eaten away from home. In comparison, Lanfranco, Ames, and Huang (2000a) results showed that in the period 1994-1996, Hispanic households devoted a much higher proportion of their budget to total food (29.4%), when compared to the average American household, but the proportion spent in food consumed away from home is smaller (3.6%).

Income and household size elasticities of food expenditures reported in both studies also showed different response patterns between Hispanic and average U.S. households. For Hispanic households, Lanfranco, Ames, and Huang (2000b) reported income elasticities ranging from 0.29 to 0.34 for total food, 0.20 to 0.27 for food eaten at home, and from 0.22 to 1.04 for food eaten away from home. Household size elasticities ranged from 0.32 to 0.39 for total food, from 0.39 to 0.47 for food eaten at home, and from –0.18 to 0.13 for food away from home. The range of values of the income elasticities obtained by Holcomb, Park, and Capps (1995) for the whole U.S. population were 0.27 to 0.50 for total food, 0.11 to 0.24 for food consumed at home, and 0.30 to 0.64 for food consumed away from home. The range of values of household size elasticity for expenditures in the same three broad food categories were 0.24 to 0.57, 0.53 to 0.68, and 0.04 to 0.20, respectively (p. 8).

To allow broad comparisons between the two studies, Lanfranco, Ames, and Huang (2000b) used the same set of models and estimation procedures than Holcomb, Park, and Capps (1995), plus two additional econometric techniques for the estimations involving censored-response problems given by the food-away-from-home category. However, the origin of the data sets and the periods involved were different for each study. The general conclusions hold, although the magnitudes of the coefficients are slightly different.

With regard to comparisons with other ethnic groups in the United States, Fan and Lewis (1999) suggested that there are statistically significant differences in budget allocation between Hispanic Americans and African-Americans. According to their results, Hispanic households allocated a larger proportion of their budget to both food consumed at home and food consumed away from home than African Americans, at any level of total expenditure, but less than non-Hispanic Caucasians. On average, the difference in budget share for food away from home is about 15% between African-Americans and Hispanics.

In a more recent study about food consumption patterns of the Hispanic community in the U.S., Lanfranco, Ames, and Huang (2000b) estimated Engel curves for nine main food groups and three meat food groups. Their findings will be discussed in more detail later in this paper, when compared with results reported in the present article. However, it can be pointed out that Hispanic's demand for food was relatively income inelastic but more responsive to household size.

As a general conclusion, Lanfranco, Ames, and Huang (2000b) argued that the food industry should pay attention to some socioeconomic characteristics of the households, as well as to the effect of government income transfer programs when targeting Hispanic consumers with their products. More research in this field should be conducted to provide a good insight about food demand patterns of the Hispanic community.

Ethnic consumption behavior is an important goal of economic research. The increasing demand for ethnic food represents a challenge, as well as an opportunity for the food industry. The results of the present research are expected to complement these preliminary results, offering improved information to food processors, and retailers about food the consumption patterns of the Hispanic population in the U.S., and the role of socioeconomic factors and income transfer payments in the demand for the prime food groups.

Objectives

A primary objective of this paper is to provide more precise estimates of some of the socioeconomic factors determining food consumption patterns of the Hispanic community in the U.S., using a two-step estimation procedure for a system of censored equations. A secondary objective is to compare the results with other ethnic groups and the U.S. population as a whole.

Estimation of Equations with Limited-Dependent Variables

Traditionally, the estimation of food consumption elasticities from censored equations was limited to the use of single equations. The so-called Tobit models have been a common specification for censored and truncated regressions (Kennedy, 1998). An important assumption underlying the standard Tobit model is that the decision to consume and the decision about the amount to consume are the same. Regarding food consumption, it has been argued that the determinants of the decision whether to consume from a particular food group are often not the same as the determinants of how much to consume, in particular when we refer to highly specified food groups (Haines, Guilkey, and Popkin, 1988). In this case, ignoring the two-step decision process would miss the true behavioral patterns, leading to erroneous results in the estimation process. To address this problem, various estimation methods based on a two-step decision process have been utilized.

Models involving a two-stage process imply that two dependent variables are analyzed (Guilkey, Haines, and Popkin, 1990): (a) a dichotomous variable that indicates whether or not an individual consumes a nonzero amount from a particular food group, and (b) the actual quantity consumed for those who chose to consume. According to this idea, a two-stage decision process for consumption of the i^{th} person can be described by the following equations:

$$d_i^* = \mathbf{z}_i'\gamma + e_i^* \qquad \textit{Dichotomous or Decision Equation} \qquad (1)$$

$$q_i^* = \mathbf{x}_i'\beta + u_i^* \qquad \textit{Regression or Level Equation} \qquad (2)$$

The dependent variable d_i^* in equation (1) is a reservation value and it is unobserved. Instead, we observe the binary realization d_i, which takes the value $d_i = 1$ (yes) when $d_i^* > 0$, and $d_i = 0$ (no) when $d_{1i}^* \leq 0$. The dependent variable in equation (2) contains the consumption information of those individuals for which the realization variable $d_i = 1$ (yes), that is $q_i = q_i^*$ when $d_i^* > 0$, being otherwise their information unobservable ($q_i = 0$). The vectors $\mathbf{z}_i$ and $\mathbf{x}_i$ represent the regressors included in the decision and level equation, respectively, while β and γ are their associate parameters.

In their study, Lanfranco, Ames, and Huang (2000b) considered a semi-logarithmic model for the estimation of the individual Engel curves. Due to households reporting zero consumption during the time of the survey, a censored-response problem can commonly arise when dealing with cross-sectional microdata, a problem commonly known as selectivity bias (Davidson and MacKinnon, 1993). For this reason, the sample of U.S. Hispanic households was previously examined to determine the presence of this potential problem. The results, presented in a separate study, indicated that the presence of selectivity bias in this sample was found in eight of the ten groups analyzed (Lanfranco, Ames, and Huang (2000c).

Under the hypothesis of selectivity bias, the disturbances of equations (1) and (2) are assumed to be correlated through a correlation coefficient ρ (rho), and following a bivariate normal distribution. Dropping the subscripts for individual observations, and assuming $\sigma_e^2 = 1$ for identification purposes, we can rename $\sigma_u^2 = \sigma^2$ for simplicity, so that we can write:

$$\left(e^*, u^*\right) \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \sigma_{eu} \\ \sigma_{ue} & \sigma^2 \end{pmatrix}\right], \qquad (3)$$

To deal with this problem, Lanfranco, Ames, and Huang (2000b) estimated the Engel curve associated with each food category as a individual equation, using both the Heckman's two-step procedure (Heckman, 1976; 1979) and the Amemiya's type II Tobit method (Amemiya, 1985). These are two "sample selection" models derived from the Tobit model.

The extension provided by the sample selection models is precisely the separation of the decision and the level process into two different but related equations. Moreover, Leung and Yu (1996) pointed out that while censored equation models that do not account for selectivity bias assume that $E(u_i^* \mid d_i^* > 0) = 0$, sample selection models assume that $E(u_i^*) = 0$, so that $E(u_i^* \mid d_i^* > 0) = \rho\sigma.\lambda_i(\mathbf{z}_i'\gamma)$, where ρ (rho) and σ (sigma) are defined as before, and $\lambda_i(\mathbf{z}_i'\gamma)$, called "inverse Mills ratio" is computed from the probit model in (1) as:

$$\lambda_i = \lambda(\mathbf{z}_i'\gamma) = \frac{\phi(\mathbf{z}_i'\gamma/\sigma_e)}{\Phi(\mathbf{z}_i'\gamma/\sigma_e)}, \qquad (4)$$

Again, $\sigma_e = 1$ as noted before, ϕ is the standard normal probability distribution function (pdf) and Φ is the standard normal cumulative distribution function (cdf).

Two-Step Estimation of Systems of Censored Equations

Today, the advances in computing power allow the use of more sophisticated econometric procedures for estimating systems of equations with limited dependent variables. Examples of such methodologies are the two-step estimation procedures proposed by Heien and Wessells (1990) and by Shonkwiler and Yen (1999). More recently, Perali and Chavas (2000) developed a different approach for the estimation of censored demand equations from large cross-section data. In general, systems estimation procedures incorporate all the available information into their estimates, including potential relationships among equations. They have smaller asymptotic variance-covariance matrix, and so, more efficient estimates can be obtained than those obtained from single-equation estimation techniques (Kennedy, 1998).

Heien and Wessells (1990) proposed a two-step estimation procedure for systems of limited-dependent variable equations. In the first step, the maximum likelihood estimation of the set of probit equations defined in (1) provides an estimated selectivity regressor by which each of the level equations in (2) is augmented. This first step is identical to Heckman's procedure. In the second step of this multivariate version, the system of level equations augmented by the inverse Mills ratio defined in (4) is jointly estimated using the seemingly unrelated regression procedure (SUR).

Shonkwiler and Yen (1999) criticized the Heien-Wessells estimator arguing that, although appealing for its easy implementation, it gives inconsistent estimates. As an alternative, they proposed a consistent two-step (CTS) estimation method that, according with their results from Monte Carlo simulation, outperformed the procedure developed by Heien and Wessells.

Following Maddala (1983), given the model in (2)-(3) and the non-zero observations q_i,

$$E\left(q_i \mid d_i^* > 0\right) = \mathbf{x}_i^{'}\beta + E\left(u_i \mid e_i > -\mathbf{z}_i^{'}\gamma\right) = \mathbf{x}_i^{'}\beta + \delta\,\frac{\phi\left(\mathbf{z}_i^{'}\gamma\right)}{\Phi_i\left(\mathbf{z}_i^{'}\gamma\right)} \tag{5}$$

The last term is the inverse Mills ratio. For a demand system composed by m different commodities, we need to estimate m different equations. Thus, expression (5) represent a system of m augmented level equation that can be estimated by SUR (Heien and Wessells, 1990). Shonkwiler and Yen (1999) argued that this method is derived from a procedure that is based on nonlimit observations, such as Heckman's two-step. The conditional expectation in (5) then implies the unconditional expectation $E(q_i) = \mathbf{x}_i'\beta + 2\delta.\phi(\mathbf{z}_i'\gamma)$ that deviates from the unconditional mean expressions for the conventional censored dependent variable specification (Shonkwiler and Yen, 1999, pp. 972-73).

Shonkwiler and Yen (1999) suggested that estimation of a censored system require a procedure that uses the whole sample. Given equation (5), if instead of using only the nonzero observations we use all the observations, the unconditional mean of q_i is:

$$E(q_i) = \Pr(d_i^* > 0) \cdot E(q_i \mid d_i^* > 0) + \Pr(d_i^* \le 0) \cdot E(q_i \mid d_i^* \le 0)$$

$$= \Phi_i \cdot \left(\mathbf{x}_i^{'}\beta + \delta \frac{\phi_i}{\Phi_i} \right) + (1 - \Phi_i) \cdot 0$$

$$= \Phi_i \cdot \mathbf{x}_i^{'}\beta + \delta \cdot \phi_i \qquad (6)$$

The model proposed by Shonkwiler and Yen (1999) is a generalization of the linear model originally assumed by equation (2). The term $\mathbf{x}_i'\beta$ can be substituted by a general deterministic component $f(\mathbf{x}_i,\beta)$ that can be nonlinear in β. In addition, the censoring mechanism of each dependent variable is governed by a separate stochastic process. Shonkwiler and Yen (1999) define their procedure as a multi-equation generalization of Amemiya's Type II model. For m equations (commodities) and n observations (individuals), the level equation derived in (6) can be written now as,

$$q_{ik} = \Phi(\mathbf{z}_{ik}^{'}\gamma_k) \cdot f(\mathbf{x}_{ik}, \beta_k) + \delta_k \phi(\mathbf{z}_{ik}^{'}\gamma_k) + \xi_{ik} \qquad i = 1,\ldots,n;\ k = 1,\ldots,m \qquad (7)$$

The estimation of the system in (7) is carried out a two-step procedure using all the observations. The first step is the same than for Heckman's two-step and therefore, for the Heien-Wessells' procedure. The parameters γ_k of the probit equations introduced in (1) are estimated consistently by maximum likelihood (MLE). The estimates of γ are then used to compute ϕ and Φ, so that in the second step, the equations in (7) can be jointly estimated by MLE or SUR to obtain consistent estimates for the β_k and δ_k parameters.

Shonkwiler and Yen (1999, p. 974) noted that the error term ξ_{ik} in (7) is zero-meaned but also heteroscedastic. As a consequence, the MLE or SUR estimates from the second step are consistent but inefficient. To adjust the variance-covariance matrix of the estimated parameters, they recommended the procedure developed by Murphy and Topel (1985). For the case of nonindependent random components such as (3), the variance-covariance matrix of the parameters can be estimated consistently as stated by Theorem 2 in Murphy and Topel (1985, p. 376). As an alternative that avoids the correction of the variance covariance matrix, Shonkwiler and Yen (1999) pointed out that the first and second steps could be combined, allowing the estimation by MLE within one optimization algorithm, which avoids the necessity of the suggested correction.

In summary, the two-step procedure proposed by Shonkwiler and Yen (1999) for the estimation of systems of censored equations appears to be an interesting alternative when direct maximum likelihood estimation is not easy to implement due to complexities of the functional form chosen, or to the size of the system. Yen and Kan (2000) recently applied this methodology, estimating a three-equation translog demand system for fat and oils, using cross-sectional data. Although in our study we are dealing with a system of Engel curves that are linear in the parameters, the size and the cross section data set we are utilizing and the number of equations considered suggest that employing this method could be a plausible alternative.

Data Set and Methodology

The cross-sectional data set used in this research was constructed from USDA's 1994-96 *Continuing Survey of Food Intakes by Individuals* (CSFII 94-96). The total sample consisted of 6,984 U.S. households, categorized as follows: 643 households that identified themselves as of Hispanic origin (9% of the total sample), 834 households of African-American origin (12%), and

5,507 non-Hispanic white households (79% of the total).

The main focus of the present study was to improve the single-equation estimations of income and household size elasticities obtained by Lanfranco, Ames, and Huang (2000b), by using the same sample and with a systems approach. For this reason, the same broad nine food groups were considered in the analysis: grains, vegetables, fruits, milk, meats, fats, sugar, legumes, and beverages. By the same token, the same semi-logarithmic functional form was chosen to represent the Engel curve for each of the groups.

Demand for food was measured as the quantity consumed of each food group, in grams per week, per household. Household income was constructed from reported annual, before-tax household income for the previous calendar year. It was transformed into weekly income by dividing the annual amount by 52. Logarithm of household income was denoted by LINCWK.

In this study, we used the so-called Amsterdam scale as a variable that acts as a proxy for household size, due to its simplicity. This scale represents household members in relation the reference unit, an adult male, 18 years old and over. Each adult female is represented by 0.90 equivalent adult males; males and females from 14-17 years represent 0.98 and 0.90 equivalent adult males, respectively, and individuals under 14 years old from both sexes are valued as 0.52 equivalent adult males, in terms of the Amsterdam Scale (Deaton and Muellbauer, 1980). The variable LHHSIZE correspond to its logarithm.

Other demographic and socio-economic variables that were hypothesized to influence food demand were also included in the analysis. The logarithm of the age of the household head was represented by variable LAGE, whereas sex was represented by the binary variable SEX (1-Female; 0-Male). To represent the education level of the household head we used two dummy variables. Variable EDU1 (1-Yes; 0-No) represents individuals that completed at least one year of high school or received a General Education Degree (GED), and variable EDU2 (1-Yes; 0-

No) represents individuals that attended at least one year of college. The default accounts for individuals that at most completed elementary school.

The tenure status of the household dwelling was considered through the binary OWNER (1-Owner; 0-Other). Finally, binary variables for two income transfer payments for low-income households were also included; the variables considered were WIC for participation in the Women, Infant, and Children program (1-Yes; 0-No), and FSTAMP for participation in the Food Stamp program (1-Yes; 0-No).

The model for each ethnic group was estimated separately. The decision and level stages of the consumption process were modeled using the formulations specified in (2) and (9), respectively. Following the methodology of Shonkwiler and Yen (1999), in the first step the probit equations for each food category were estimated using MLE.

The system of nine semi-logarithmic equations was jointly estimated by MLE in the second step separately for each ethnic group. Using this method instead of plain SUR, the estimation proceeds iterating simultaneously on the parameters and the residual covariance matrix, so that even linear models may take more than one iteration to converge (Hall and Cummins, 1999). Consistent starting values for the parameters β_k and δ_k were provided by initial estimation of each level equation using Heckman's two-step procedure. A separate stochastic process governs the censoring mechanism of each dependent variable, so the model is not invariant to the dropped equation when restrictions such as adding-up have to be maintained. In this study we were limited in working with physical quantities, not expenditures, therefore we do not have to observe any restriction of this kind because the data matrix is not singular. So, there is no need to drop any equation.

As expected, a simple Lagrange Multiplier test described in Greene (1997) revealed the presence of the heteroscedasticity implicit in the structure of the model. Thus, following the suggestion of Shonkwiler and Yen (1999), the variance-covariance matrix of the consistent second-step parameters was adjusted using the methodology of Murphy and Topel (1985).

After estimating the model for each ethnic group, the corresponding income and household size elasticities at the sample means were calculated from the estimated regression coefficients. For the semi-logarithmic model, the income elasticities for the k^{th} food group were estimated as the ratio between the corresponding estimated coefficient associated to the logarithm of income (β_{1k}) and the sample mean of the demanded quantity (q_k). Household size elasticities were estimated in identical way, computing the ratio between the coefficient for logarithm of household size (β_{2k}) and the demanded evaluated at the sample mean (q_k). Since the elasticities can be expressed as ratios of normally distributed random variables, confidence intervals for these elasticities can be constructed using linear Taylor series approximations (Dorfman, Kling and Sexton, 1990). Consequently, we used the "delta method" (Hogg and Craig, 1995, p. 251), which allows us to specify the limiting normal distribution for functions of random variables, to construct 90% confidence level intervals for the estimated income and household size elasticities.

Results and Discussion

A detailed characterization of the sample of Hispanic households is offered in Lanfranco, Ames, and Huang, 2000b). A comparison of some of the sample characteristics and expenditure patterns among the three ethnic groups, is presented in Table 1. From the inspection of the statistics illustrated in this table, we can rapidly notice that Hispanics (HP) and African-Americans (AA) spent a higher share of their total budget on total food than non-Hispanic white (WH) households, 29.4%, 26.4%, and 18.2%, respectively. As expected, the group with the smallest budget share for total food spent comparatively more of this share in food consumed away from home and vice versa.

Considering the weekly expenditures in absolute values, we observe that African-American households spent less money on food, either consumed at home or away from home. Somewhat surprisingly, Hispanics spent more money on total food ($105.83), and especially on food eaten at home ($88.66), while, as expected, non-Hispanic white households spent more in food eaten away from home ($23.26).

Non-Hispanic white households had the greatest level of income ($769.59), followed by Hispanics ($509.58), and African-Americans ($484.04). However, noting that the size of the household, measured in adult equivalents was, on average, greater for Hispanics (3.07) than for African-American (2.48) and white non-Hispanic households (2.33) gives some insight of this situation. In terms of adult equivalents we see that weekly incomes of non-Hispanic whites ($362.92) almost doubles the income of Hispanics, who showed the lowest average income level ($192.10). We found it useful then to present these statistics also in a per adult-equivalent basis (the figures in parenthesis). For each variable presented in this way, the samples were tested using the usual statistical procedures for the comparison of means, in order to identify statistically significant differences (Montgomery, 1997). Now it is clear that both Hispanics and African-Americans spent almost the same amount of money on food per adult equivalent, whereas non-Hispanic whites disposed of a substantially higher amount of money for food.

Examining the average levels of consumption of each of the food groups, also in terms of adult equivalents, we observe that Hispanic households reported by far the largest consumption level of legumes, nuts, and seeds, and the lowest consumption of vegetables. In addition, both Hispanic and non-Hispanic white households consumed more fruits and dairy products than African American households. On the other hand, non-Hispanic whites consumed consistently more fats, sugar, beverages, and vegetables than the other two groups. The African-American community clearly showed the highest level of per adult-equivalent consumption of meats.

The results of the estimated Engel curve systems for Hispanic, African-American, and non-Hispanic white households are reported respectively in Tables 2 to 4. In each table, the estimated parameters for the decision and level equations of each food group are presented, along with their corresponding corrected standard errors (in parenthesis). The statistical significance at the 10%, 5%, and 1% level is highlighted with a corresponding number of asterisks accompanying the specific estimates. Due to the expected difference in the number of observations for each ethnic group, the estimates for the non-Hispanic white households showed the greatest level of statistical significance.

The parameters associated with weekly income showed positive sign both in the decision and level stage of the consumption process, whenever they were significantly different from zero, except with Hispanic's consumption of legumes, which seems to be a very basic ingredient in their diet, especially in low-income households. Hispanics showed the highest consumption of this food category but as their income level increased, households decided more often not to consume. On the other hand, the size of the household always showed stronger positive effects than income. The age of the household head showed a positive effect, when significant, except for milk where the effect was negative and statistically significant for all the three ethnic groups. The consumption of beverages also showed negative sign in all cases but was only statistically significant for non-Hispanic whites. The effect of sex was not clear depending on the food category and the ethnic group.

For Hispanic households, the education level of the household head was positive and significant for grains and fats. This effect was also positive and significant for grains, vegetables, fruits, meat, and fats, in the case of African Americans, and for grains, vegetables, fruits, milk, fats, sugar, and beverages, in the case of non-Hispanic white households. For the latter, education had a negative and significant effect in the consumption of legumes.

For all three ethnic communities, participation in the WIC program showed a strong association with higher consumption levels dairy products. For Hispanic and non-Hispanic white households, the consumption of fruits was also associated with the variable for WIC, whereas both Hispanic and African Americans showed a positive effect on the consumption of legumes. On the other hand, the effect of WIC participation of Hispanic households was negative and significant for fats and beverages, and for the other two groups is was also negative and statistically significant for grains, vegetables, meats, fats, sugar, and beverages.

Finally, the estimated income and household elasticities for each ethnic community and food category is presented in Table 5. The common practice of reporting only point estimates of elasticities and flexibilities in economic studies has been criticized (Miller, Capps, and Wells, 1984; Dorfman, Kling, and Sexton, 1990). For this reason, although the elasticities were computed at the means of the data, we reported each point estimate with the lower and upper bounds corresponding to its 90% confidence interval.

It can be noted then that the reported confidence intervals showed a wide variation in the magnitudes of the elasticities, suggesting that inferences using values estimated at the sample means should be addressed with care, especially for policy analysis. Park et al. (1996) recommended that if the emphasis is on households poverty status, then analysts should employ demand parameters using observations pertaining to the proper income level, and not average estimates for the population as a whole.

With this caveat in mind, it can be noted from the magnitudes of the income point elasticities that, in general, they were less than one in absolute value, and more specifically less than 0.3. An apparent exception was the case of fats, that appeared to be very elastic for Hispanic households (2.34) and moderately elastic to elastic for non-Hispanic white households

(0.85). Fruits appeared to be elastic (0.92) for non-Hispanic whites. The income elasticity of beverages was close to unitary elastic but negative for African-Americans (-0.97). In addition, the consumption of grains and vegetables of Hispanic households was moderately elastic with respect to income (0.49 and 0.56, respectively). The milk category showed a lower magnitude in all cases, ranging from 0.18 to 0.20, while the magnitude of income elasticity for meat was less than 0.10 for all three household groups. In all other cases, the consumption of the different food categories was, on the average, very inelastic with respect to income.

In general, the magnitudes of the household size elasticities were higher than income elasticities for the three communities (>0.50). The household size elasticity of sugar and milk was positive and greater than one for African-Americans and non-Hispanic whites, and moderately high for Hispanics. The magnitude of this elasticity was also greater than one for fruits and meat, and close to unity for fats and beverages, with non-Hispanic whites, while moderate elastic for the other groups. Household elasticity was also positive and greater than one for legumes but negative and almost unitary for fats, in the case of Hispanic households.

Conclusions

The lack of information regarding expenditures on specific food groups inhibited us from making inferences about budget shares among the food groups, limiting the analysis of individual food categories to physical quantities. However, we consider that the contribution of the present article is useful in two aspects. First, it improved the estimates reported by the aforementioned study, confirming their conclusions about the effect of different demographic and socioeconomic characteristics in the demand for food of the Hispanic community in the U.S. Second, it provides a valid comparison between the food consumption patterns for Hispanic households with other ethnic groups in the U.S.

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Table 1 – Characteristics of Hispanic, African-American and non-Hispanic White households in the U.S., 1994-96

Variable	Hispanics	African-Americans	Non-Hispanic Whites
Age of Household Head (Years)	41	37	42
Household Size (Adult Equivalents)	3.07	2.48	2.33
Household Weekly Income ($ / wk)	509.58 (192.10)	484.04 +(223.75)	769.59 ♦(362.92)
Expenditures in Total Food ($ / wk)	105.83 (38.46)	86.13 (37.82)	104.20 ♦(47.99)
Expenditures in Food-at-Home ($ / wk)	88.66 (31.91)	73.02 (31.98)	80.84 ♦(36.58)
Expenditures in Food-Away-From-Home ($ / wk)	17.17 (6.54)	13.11 (5.84)	23.36 ♦(11.41)
Share of Total Food (%)	29.40	26.36	18.23
Share of Food-at-Home (%)	25.81	23.43	14.79
Share Food-Away-From-Home (%)	3.58	2.93	3.44
Consumption of Grains (gr/wk)	688.55 (242.12)	531.70 (227.80)	520.34 (235.42)
Consumption of Vegetables (gr/wk)	327.33 (118.94)	308.47 +(145.41)	351.28 ♦(170.40)
Consumption of Fruits (gr/wk)	460.51 ♦+(163.68)	315.81 (140.33)	329.60 +(152.72)
Consumption of Milk (gr/wk)	777.86 ♦(258.79)	450.10 (176.95)	571.69 ♦(246.00)
Consumption of Meat (gr/wk)	423.89 (147.93)	391.45 ♦(173.24)	338.60 (157.18)
Consumption of Legumes, Nuts, and Seeds (gr/wk)	118.78 ♦(38.35)	59.07 (24.36)	46.75 (21.86)
Consumption of Fats (gr/wk)	17.24 (6.81)	15.07 (7.20)	26.22 ♦(12.82)
Consumption of Sugar (gr/wk)	45.24 (15.30)	43.16 (17.60)	51.05 ♦(22.19)
Consumption of Beverages (gr/wk)	1422.59 (507.82)	1184.45 (542.09)	1632.71 ♦(779.25)
Number of Observations (n)	643	834	5507
Proportion of Total Sample (%)	9	12	79

Note: Household level data, except figures in parenthesis that report per adult equivalent levels.
Symbols ♦ and + in per adult equivalent levels denote means significantly different at least at 5%.

Table 2. Parameter Estimates of Food Consumption for Hispanic Households in the U.S., 1994-96

Variables	Food Consumption of Hispanic Households								
	Grains	Vegetables	Fruits	Milk	Meat	Legumes	Fats	Sugar	Beverages
Decision Equation (Probit Estimation – MLE)									
Constant	3.24860	1.12185	0.039483	2.19152	0.340336	2.24310***	-1.72163**	-1.19729	0.532773
	(3.44460)	(1.24254)	(0.896615)	(1.55596)	(1.68891)	(0.815378)	(0.730952)	(0.774747)	(1.03525)
LINCWK	-0.046277	0.110038	0.156204*	0.209311	-0.033872	-0.179550**	0.239133***	0.032106	-0.089524
	(0.318632)	(0.127677)	(0.089721)	(0.152385)	(0.190060)	(0.078931)	(0.074372)	(0.077395)	(0.104753)
LHHSIZE	0.099571	0.080575	0.487705***	0.152881	0.363840	0.618086***	-0.135135	0.076516	0.020244
	(0.524589)	(0.192836)	(0.141534)	(0.226025)	(0.286626)	(0.126817)	(0.117207)	(0.124261)	(0.172361)
LAGE	-0.091262	-0.013292	-0.066060	-0.428759	0.490308	-0.248228	0.282353*	0.486427***	0.407562*
	(0.706828)	(0.263001)	(0.184983)	(0.320883)	(0.393966)	(0.170010)	(0.155312)	(0.168714)	(0.229069)
Level Equation (System Estimation - MLE)									
Constant	-1676.14**	-1548.64	467.894	1226.57***	-15.3284	-55.3542	-513.322*	55.9561	2766.15
	(734.854)	(1805.93)	(894.690)	(460.915)	(693.904)	(257.850)	(297.389)	(920.258)	(6427.40)
LINCWK	337.801**	184.636	29.5334	152.082*	42.2438	9.01229	40.2844*	8.29818	394.638
	(197.014)	(167.044)	(83.4157)	(101.874)	(31.8358)	(55.03436)	(21.5104)	(12.3503)	(360.616)
LHHSIZE	-224.259	223.523*	238.948	652.696***	236.553**	222.608	-15.5729	35.8687	710.546***
	(436.805)	(131.3147)	(243.716)	(110.603)	(105.642)	(186.978)	(12.2260)	(26.7541)	(197.117)
LAGE	737.956*	-32.4576	-125.056	-666.048***	7.95761	-30.4752	45.0295*	-16.7115	-770.322
	(396.334)	(52.7258)	(91.2628)	(219.712)	(141.445)	(89.1903)	(26.0873)	(154.081)	(1593.27)
SEX	86.5791*	16.6213	-47.0268	6.16457	-9.64867	7.20660	3.70579	8.67082	60.7439
	(52.4415)	(28.7079)	(48.5044)	(59.0637)	(36.2611)	(26.8152)	(2.74245)	(7.91022)	(127.263)
EDU1	152.383***	17.5676	-45.5005	20.8390	-33.9961	20.0217	8.02040***	3.14053	186.124
	(54.0602)	(29.6882)	(49.5707)	(61.1085)	(37.4488)	(27.5657)	(2.83566)	(8.12594)	(131.400)
EDU2	248.269***	-8.88326	35.1222	75.9071	-63.2098	-28.7620	7.72962**	4.87862	37.2445
	(62.5553)	(34.3440)	(57.6741)	(78.3086)	(43.3984)	(31.4589)	(3.35636)	(9.39793)	(152.005)
OWNER	-118.249	-7.22027	-34.3359	-46.9594	-55.8773	-77.8013**	-1.85172	1.71698	-36.0728
	(73.2327)	(40.3059)	(67.4701)	(61.6927)	(50.6527)	(37.3203)	(3.87871)	(11.0277)	(177.966)
FSTAMP	54.5483	26.7868	-60.4074	108.652	31.3067	-2.84360	1.91772	18.2702*	76.7250
	(69.2045)	(38.2238)	(64.1055)	(78.5757)	(47.7981)	(34.2173)	(3.85961)	(10.4558)	(166.353)
WIC	110.203	-0.650025	191.602***	243.624***	-43.9138	56.4566*	-6.60527*	-6.18138	-328.168*
	(69.9889)	(37.9638)	(62.4860)	(77.9181)	(47.9222)	(33.4065)	(3.85675)	(10.6784)	(169.033)
Correction Factor	-238092	8175.19	468.070	5914.12*	-386.552	342.839	306.712	-97.4841	-11055.2
	(159101)	(9699.61)	(1494.36)	(3494.92)	(3692.48)	(732.097)	(188.084)	(766.761)	(17739.1)

Note: Std. errors in parenthesis. Significance of 2-tail t-test: *** - 1% level; ** - 5% level; * - 10% level.

Table 3. Parameter Estimates of Food Consumption for African-Amarican Households in the U.S., 1994-96

Variables	Food Consumption of African-American Households								
	Grains	Vegetables	Fruits	Milk	Meat	Legumes	Fats	Sugar	Beverages
Decision Equation (Probit Estimation - MLE)									
Constant	1.14208	2.23788*	0.045251	1.00151	2.40408	-0.577149	-0.737502	-0.470866	1.58125*
	(3.75108)	(1.18598)	(0.647799)	(0.779579)	(2.34551)	(0.598437)	(0.602898)	(0.628342)	(0.885283)
LINCWK	-0.000598	-0.081100	0.086249	0.167828**	0.290793	-0.052000	0.029831	-0.015538	0.058569
	(0.346557)	(0.111365)	(0.062358)	(0.074858)	(0.227679)	(0.059110)	(0.059245)	(0.062282)	(0.083837)
LHHSIZE	2.25147	0.533531***	0.296171***	0.570906***	0.371370	0.518363***	0.120847	0.527052***	0.003329
	(2.08891)	(0.188894)	(0.102652)	(0.124400)	(0.350878)	(0.099752)	(0.097441)	(0.104217)	(0.139578)
LAGE	0.322151	-0.063264	0.020740	-0.300709**	-0.448011	0.293645**	0.299863**	0.255170*	-0.109524
	(0.736177)	(0.241640)	(0.138278)	(0.162012)	(0.491044)	(0.129528)	(0.129447)	(0.134131)	(0.189750)
Level Equation (System Estimation - MLE)									
Constant	541.110**	-278.802*	-165.637	364.323	326.838	-59.6640	-33.1033	-175.265	11668.3
	(266.177)	(168.465)	(1800.26)	(358.019)	(202.820)	(797.331)	(465.678)	(252.816)	(7635.41)
LINCWK	-30.2545	-10.6254	14.4547	84.0523*	-25.0013	5.11014	0.011858	-3.11679	-1147.67
	(25.5053)	(21.5316)	(97.5095)	(46.5114)	(24.8626)	(23.6211)	(6.35594)	(5.72047)	(828.633)
LHHSIZE	482.046***	219.583**	198.288	732.039***	227.457***	79.6034	9.30795	113.168*	511.615***
	(48.38038)	(92.5263)	(325.138)	(132.313)	(34.1330)	(188.204)	(24.0669)	(60.9046)	(109.724)
LAGE	-78.6090	90.3012**	41.2083	-397.711***	9.99146	16.0855	7.40755	9.46867	2260.33
	(52.0049)	(36.9937)	(53.7363)	(95.8609)	(48.2399)	(108.721)	(60.4768)	(30.4906)	(1541.65)
SEX	36.5866	32.9302	30.7318	76.9099**	-8.23907	-4.96271	-0.233483	3.68265	-0.211982
	(33.2242)	(21.1444)	(32.6116)	(38.1266)	(25.2403)	(18.3541)	(2.35564)	(7.02198)	(86.3903)
EDU1	66.4037*	61.4349***	68.8892*	11.3569	78.4193***	-21.1235	3.77741	8.44791	158.392
	(37.0456)	(23.7311)	(36.4774)	(42.7441)	(28.2090)	(20.5388)	(2.64881)	(7.86237)	(96.4289)
EDU2	67.9110	75.1718**	163.864***	48.2722	22.4421	15.3838	10.4090***	2.69842	-11.1474
	(52.2712)	(33.4791)	(53.0409)	(64.1094)	(40.2887)	(28.7006)	(3.65909)	(11.1156)	(139.345)
OWNER	-7.19786	28.0404	-10.9016	-3.06005	-15.2012	-6.51648	1.23794	0.422059	60.3352
	(58.6478)	(37.4870)	(58.7658)	(70.4285)	(45.0300)	(32.1398)	(4.10945)	(12.4046)	(96.64758)
FSTAMP	66.2688	-0.213687	1.12881	170.381***	30.6055	8.92232	4.49844	3.23016	59.3531
	(43.1480)	(27.5165)	(42.9696)	(50.4129)	(32.9406)	(23.6094)	(3.07646)	(9.10129)	(155.060)
WIC	-169.856***	-60.2770*	47.7898	219.518***	-147.015***	48.7808*	-7.57278*	-25.7336**	-609.257***
	(53.8009)	(34.0762)	(51.06108)	(59.2806)	(40.8806)	(28.7236)	(3.91375)	(11.0492)	(140.309)
Correction Factor	3754.88**	927.379	147.040	2032.00***	-1587.51	98.1606	27.0866	317.923	-93083.2
	(1833.83)	(1256.84)	(2649.14)	(745.259)	(1281.28)	(777.928)	(424.644)	(275.908)	(62282.8)

Note: Std. errors in parenthesis. Significance of 2-tail t-test: *** - 1% level; ** - 5% level; * - 10% level.

Table 4. Parameter Estimates of Food Consumption for non-Hispanic White Households in the U.S., 1994-96

Variables	Food Consumption of non-Hispanic White Households								
	Grains	Vegetables	Fruits	Milk	Meat	Legumes	Fats	Sugar	Beverages
Decision Equation (Probit Estimation - MLE)									
Constant	0.237282	0.262333	-1.56448***	0.590026	0.155676	-0.152772	-1.75203***	-0.831705***	-0.080288
	(1.36869)	(0.496146)	(0.285135)	(0.433431)	(0.490634)	(0.253699)	(0.290951)	(0.277184)	(0.386539)
LINCWK	0.317145**	0.165373***	0.273762***	0.169357***	0.038270	0.007737	0.152116***	0.075578***	-0.072018
	(0.147038)	(0.048898)	(0.027811)	(0.041223)	(0.048911)	(0.024660)	(0.028775)	(0.027152)	(0.039986)
LHHSIZE	0.387571	0.177643**	0.231657***	0.476749***	0.318894***	0.413006***	0.099323**	0.397399***	-0.234741***
	(0.270742)	(0.086608)	(0.048169)	(0.073022)	(0.084392)	(0.043083)	(0.050479)	(0.047454)	(0.070200)
LAGE	0.154567	0.143269	0.163471***	-0.054792	0.351113***	0.069901	0.461066***	0.251128***	0.608763***
	(0.278426)	(0.100535)	(0.057303)	(0.086945)	(0.100558)	(0.051083)	(0.058814)	(0.055975)	(0.081235)
Level Equation (System Estimation - MLE)									
Constant	-271.320**	-1222.03***	-3722.16***	-424.005*	-1229.77***	276.283	-490.681***	-257.107	8028.38***
	(132.268)	(310.994)	(652.670)	(217.631)	(315.133)	(391.305)	(93.6670)	(169.442)	(1183.15)
LINCWK	59.6736***	71.5412***	302.545***	104.812***	27.2253***	-6.10859	22.2602***	5.40680	197.719***
	(13.3997)	(24.0185)	(54.3530)	(22.1810)	(9.10480)	(5.20254)	(4.04134)	(5.55690)	(43.9424)
LHHSIZE	414.047***	220.688***	438.183***	837.960***	381.058***	-10.2388	24.1961***	96.1414***	1545.32***
	(17.7251)	(26.3509)	(47.0780)	(50.3717)	(42.7792)	(98.3740)	(2.99111)	(26.1745)	(113.571)
LAGE	-0.273573	198.172***	231.967***	-210.461***	228.439***	17.7347	68.1566***	25.8429	-1768.51***
	(18.9667)	(23.6600)	(36.2057)	(24.5397)	(48.6585)	(18.2173)	(12.2327)	(16.9248)	(283.037)
SEX	3.81726	-20.3391**	36.0505***	21.5023	-18.9355**	-10.5621*	1.42059	8.03109***	-97.3770**
	(12.3503)	(9.02706)	(12.8536)	(15.8212)	(9.27075)	(5.93392)	(1.10862)	(2.86157)	(48.4201)
EDU1	48.7056***	32.6172***	71.0940***	52.6272***	14.3694	-32.1047***	9.20057***	23.3822***	195.591***
	(14.7508)	(10.8119)	(15.6371)	(18.8162)	(11.1412)	(7.14159)	(1.34641)	(3.46630)	(57.4684)
EDU2	84.9161***	52.3195***	197.325***	129.458***	-4.69204	-22.3187*	11.3257***	23.8207***	22.1128
	(24.6141)	(18.0790)	(27.0165)	(31.8355)	(18.4223)	(11.9759)	(2.19090)	(5.73568)	(93.4161)
OWNER	0.662921	13.7125	9.10310	31.5231	-10.2992	-10.2615	-0.615611	0.267513	-87.8123
	(25.9897)	(19.0925)	(28.2979)	(18.86098)	(19.4624)	(12.6176)	(2.31743)	(6.05296)	(98.9824)
FSTAMP	-21.2736	-23.9268	-13.0660	22.4697	-3.52485	-20.5868*	-3.35822	-4.90991	-60.4347
	(25.1149)	(18.5832)	(28.2901)	(32.0999)	(18.8564)	(11.8986)	(2.37969)	(5.92345)	(98.16264)
WIC	-103.055***	-65.0704***	101.530***	170.965***	-87.9149***	22.6651	-8.32559***	-27.8996***	-631.523***
	(31.6012)	(23.1509)	(33.8190)	(39.5571)	(23.7213)	(14.2127)	(3.02616)	(7.25117)	(127.58713)
Correction Factor	9397.38***	2788.37**	2679.16***	4486.94***	4299.11***	-279.762	334.228***	273.835*	-15130.8***
	(1709.96)	(1109.56)	(506.458)	(594.932)	(1035.03)	(457.250)	(72.4180)	(163.271)	(2286.91)

Note: Std. errors in parenthesis. Significance of 2-tail t-test: *** - 1% level; ** - 5% level; * - 10% level.

Table 5. Income and Household Size Elasticities at the Mean for Hispanic, African-American, and non-Hispanic White Consumers, 1994-96

Food Group	Income Elasticities			Household Size Elasticities		
	HP	AA	WH	HP	AA	WH
Grain	.4906 (-.4049, 1.3861)	-.0569 (-.1756, .0618)	.1147 (-.0564, .2858)	-.3257 (-1.4853,.8340)	.9066 (-.5147, 2.3279)	.7957 (-.3559, 1.9474)
Vegetables	.5641 (-.3923, 1.5214)	-.0345 (-.1505, .0817)	.2037 (.0901, .3172)	.6829 (-.1814, 1.5471)	.7119 (.1047, 1.3190)	.6283 (.4958, .7607)
Fruits	.0641 (-.2564, .3847)	.0458 (-.4699, .5614)	.9179 (-.8572, 2.6931)	.5189 (-.7746, 1.8123)	.6279 (-1.461, 2.7168)	1.3295 (-1.2222, 3.881)
Milk	.1955 (-.1831, .5741)	.1867 (-.2221, .5956)	.1833 (-.1270, .4937)	.8391 (-.5172, 2.1954)	1.6264 (-1.6482, 4.901)	1.4658 (-.9664, 3.8979)
Meat	.0997 (-.1100, .3093)	-.0639 (-.2080, .0802)	.0804 (-.0537, .2145)	.5581 (-.4750, 1.5911)	.5812 (-.3330, 1.4952)	1.1254 (-.6588, 2.9096)
Legumes	.0528 (-.5069, .6124)	.0511 (-.3686, .4708)	-.0786 (-.3333, .1761)	1.3030 (-2.493, 5.0986)	.7964 (-3.161, 4.7539)	-.1317 (-2.2487, 1.985)
Fats	2.3367 (-3.362, 8.0352)	.0008 (-.6932, .6948)	.8488 (-.9331, 2.6308)	-0.9033 (-3.266, 1.4597)	.6178 (-2.487, 3.7222)	.9227 (-1.0037, 2.849)
Sugar	.1834 (-.4934, .8603)	-.0722 (-.3800, .2355)	.1059 (-.2267, .4385)	.7929 (-1.603, 3.1883)	2.6222 (-5.599, 10.843)	1.8835 (-3.1711, 6.938)
Beverages	.2776 (-.3456, .9008)	-.9690 (-2.9160, .9781)	.1211 (-.0804, .3257)	.4995 (-.3646, 1.3635)	.4657 (-.3044, 1.2358)	.9465 (-.5939, 2.4868)

Note: HP – Hispanic households; AA – African-American households; SS – non-Hispanic White households