Determinants of U.S. Household Expenditures on Fruit and Vegetables: A Note and Update

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Abstract

This study examines the various factors affecting household expenditures on fresh and processed fruit and vegetables in the U.S. using the 1992 Consumer Expenditure Survey. Empirical results suggest that higher income, better educated, larger, and older households spend more on fresh and processed fruit and vegetables than do other households. Seasonal and regional variations are also evident.

Key Words: consumption, expenditure, fruit and vegetables, generalized Heckman procedure

Introduction

Fruit and vegetable consumption in the United States has increased significantly during the last decade. On an average annual per capita basis, fruit consumption rose from 80 to 92 pounds between 1972 and 1992 while vegetable consumption increased from 110 pounds to 136 pounds in the same period (McMath). Furthermore, Blisard and Blaylock estimate that total expenditures on fruit and vegetables between 1990 and 2010 will increase 29.6 and 25.4 percent, respectively, the highest among the food groups considered.

Demand for fruit and vegetables has been stimulated by numerous sociodemographic and lifestyle changes, including shifts in income distribution, ethnic composition, household size, and overall aging of the population (Cook). Nutrition awareness has also become a factor in consumer buying decisions (McClure). Consumers' awareness of the importance of consuming fruit and vegetables has been bolstered by the "Five A Day Program for Better Health" project which aims to double the amount of produce consumed by U.S. consumers. Reports from the American Heart Association, the American Cancer Society, and the National Academy of Sciences indicating that fruit and vegetable consumption reduces the risk of heart disease and some forms of cancer have also boosted the consumption of these products (Duff).

The growing popularity of fruit and vegetables has expanded the business of produce departments in supermarkets. A typical produce department now stocks roughly 240 items. The top six produce groups are: apples, citrus fruits, tomatoes, potatoes, bananas, and lettuce (Litwak and Cepeda). The Food Marketing Institute reported in 1989 that a primary customer criterion for selecting which grocery store to shop in was the quality of the produce department. Consequently, fresh produce has become an important component of the supermarket or grocery business. Recent industry reports, however, indicate that many sellers of fruit and vegetables do not exactly know who their buyers are (Moulton). Scant information is available concerning the determinants of household

expenditures on fruits and vegetables. No known published study has determined the sociodemographic factors affecting purchase of fresh and processed fruit and vegetables by U.S. households since the work of Blisard and Blaylock using the 1988 Consumer Expenditure Survey. Published bulletins from the Bureau of Labor Statistics do not provide this information because of their rather descriptive nature.

This article attempts to fill this void by identifying the sociodemographic factors affecting household expenditures on fresh and processed fruit and vegetables using the Bureau of Labor Statistics' 1992 Consumer Expenditure Survey. The findings of this study are useful in analyzing consumption behavior and assisting in developing specific marketing programs for fruit and vegetables. For instance, by knowing a profile of consumers who are purchasing more fresh and processed fruit and vegetables, marketers could target these individuals in their promotion and advertising campaigns to further increase sales. Moreover, the results of this study can be combined with projections for the relevant explanatory variables to forecast future household expenditures on fresh and processed fruit and vegetables.

Empirical Model and Data

Studies dealing with the analysis of household expenditure behavior using cross-sectional data have emphasized the Engel curve. However, preferences for the commodity in question may not be the same across households due to sociodemographic factors such as location, tastes and preferences, culture, and infrastructure of households (Cheng and Capps). Thus, the effects of sociodemographic factors and income on expenditure patterns should be considered simultaneously.

Mathematically, the empirical model describing fruit and vegetable expenditures is given by:

$$E_i = a_i + \sum_j b_j quarter_j + \sum_k c_k region_k + \quad (1)$$

$$\sum_m d_m Z_m + e_i M \qquad j,k = 1,2,3$$

$$m = 1,...,7$$

where E_i is the ith household's weekly expenditure on fresh fruit (*FRSHFRUT*), processed fruit (*PROCFRUT*), fresh vegetables (*FRSHVEG*), or processed vegetables (*PROCVEG*). Dummy variables for *quarter1*, *quarter2*, and *quarter3* are included to capture possible seasonal effects. Similarly, dummy variables for the regions are also incorporated into the analysis to reflect regional effects. Part of the regional and seasonal variations in expenditures may represent price differentials. However, prices were not included due to unavailability of data. *M* is household income and Z_m represents a vector of socioeconomic variables containing household size, absence of children below 18 years old in the household, age, race, and education level of the head of household. These variables are commonly used in cross-sectional expenditure studies (Nayga).

Some households report no expenditure on particular items. Nonpurchases may be due to sufficient household inventory, responses to market price, or to nonpreference. If only the observations with nonzero purchases are used in the estimation, ordinary least squares procedures would yield inconsistent estimates from selectivity bias (Maddala). Consequently, a generalized Heckman procedure is used in this study to estimate the models. This two-stage procedure has been employed by Heien and Wessells, and Nayga to circumvent the zero-expenditure problem and to generalize the Heckman specification to a system of equations.

In the first stage, probit analysis is used to determine the inverse of Mills ratio (MR_{hi}) for the hth household for the ith item. The dependent variables are given a value of one if the household reports an expenditure and zero otherwise. The MR_{hi}, which is a proxy for sample selection bias (Heckman), is then calculated for each observation and is incorporated as an additional regressor in the second stage estimation of a system of expenditure equations. Mathematically, the inverse of Mills ratio (MR_{hi}) is calculated as:

$$MR_{hi} = \ominus(X_h\hat{\alpha})/\ominus(X_h\hat{\alpha}) \text{ for } Y_{hi} = 1 \text{ and} \quad (2)$$

$$MR_{hi} = \ominus(X_h\hat{\alpha})/(1-\ominus(X_h\hat{\alpha})) \text{ for } Y_{hi} = 0, \quad (3)$$

where $\ominus$ and Θ are the standard normal density and cumulative probability functions, respectively, X_h is a vector of regressors, $\hat{\alpha}$ is the coefficient vector, and Y_{hi} is an indicator variable that takes a value of one if expenditure occurs for the ith item by the hth household and zero otherwise.

The second stage in the generalized Heckman procedure involves the estimation of the expenditure equations as a system using all the observations in the sample. Each equation has the same set of regressors except for the MR_{hi}'s. Consequently, the equations are estimated using the seemingly unrelated regression technique to gain efficiency and to account for possible contemporaneous correlation among the disturbance terms. The two-step estimator resulting from this procedure is consistent and asymptotically more efficient than other two-step estimators (Lee).

Due to the effects of MR_{hi}, the coefficients from the seemingly unrelated regression in the second stage are adjusted following the procedure suggested by Saha, Capps, and Byrne. The adjusted marginal effect of the hth variable of the ith equation X_{hi} on E_i is computed as:

$$\partial E_i / \partial X_{hi} = \beta_{hi} - \alpha_{hi}\gamma_i[\delta_i(\hat{Y}_i MR_i^A + (MR_i^A)^2) \qquad (4)$$

$$+ (1-\delta_i)(\hat{Y}_i MR_i^B - (MR_i^B)^2)]$$

where

$\beta_{hi} =$ the coefficient of the hth variable in the ith stage 2 equation,

$\alpha_{hi} =$ the coefficient of the hth variable in the ith stage 1 equation,

$\gamma_i =$ the coefficient of MR_{hi} in the ith stage 2 equation,

$\delta_i =$ the proportion of observations for which $Y_{hi}=1$,

$\hat{Y}_i =$ the fitted value, evaluated at the means of the variables, from the ith stage 1 equation,

$MR_i^A =$ inverse of Mills ratio when $Y_{ij}=1$, evaluated at the sample means,

$MR_i^B =$ inverse of Mills ratio when $Y_{ij}=0$, evaluated at the sample means (see Saha, Capps, and Byrne for details).

The β_{hi} represents the conventional expression for calculating the marginal effect of the hth variable in the ith equation. The expression of the adjusted marginal effect in equation (4) will be equal to β_{hi} when $\gamma_i=0$. However, this happens only when the covariance between the errors of the first and second stage equations is equal to zero.

The data set used in this study is the Diary component of the 1992 Consumer Expenditure Survey (CES) of the Bureau of Labor Statistics[1]. The total number of households (diaries) in the survey was 11,412. However, observations with incomplete socioeconomic and demographic information were dropped from the analysis. In addition, households with expenditure or income levels lower than the 1st percentile and greater than the 99th percentile of the sample as well as households with reported negative income values were deleted from the sample to limit the influence of outliers in the data. Consequently, the number of households analyzed in the study is 10,094. The mean weekly expenditures on fresh and processed fruit are \$2.58 and \$1.99, respectively. The mean weekly expenditures on fresh and processed vegetables, on the other hand, are \$2.56 and \$1.49, respectively[2].

Empirical Results

The seemingly unrelated regression estimates of the coefficients obtained in the second stage of the generalized Heckman procedure and the adjusted marginal effects are presented in table 1. Differences between the coefficient estimates and the adjusted marginal effects are indicative of the average bias that would occur without the adjustment procedure. These differences, however, are generally very small.

Based on the adjusted marginal effects[3], weekly household expenditures on fresh fruit are higher by about 45 and 38 cents during the second and third quarters of the year, respectively, than during the fourth quarter of the year, *ceteris paribus*. Weekly expenditures on processed fruit, however, are 17 cents lower during the second quarter than during the fourth quarter of the year. Weekly expenditures on processed vegetables are also 24 and 30 cents lower during the second and third quarters of the year than during the fourth quarter of the year perhaps due to the Thanksgiving and Christmas Holiday season.

Table 1. Seemingly Unrelated Regression Estimates (Adjusted Marginal Effects) Obtained in the Second Stage of the Generalized Heckman Procedure

Variable		FRSHFRUT	PROCFRUT	FRSHVEG	PROCVEG
Intercept		-0 982[a]	-0 380[a]	-0.616[a]	1.416[a]
Season					
	Quarter1	-0.036	-0.043	-0 002	-0.033
		(-0.014)	(-0.042)	(-0.004)	(-0.038)
	Quarter2	0 414[a]	-0.174[a]	0.114	-0.227[a]
		(0.451)	(-0 173)	(0.123)	(-0.239)
	Quarter3	0 336[a]	-0.045	-0.067	-0.277[a]
		(0.381)	(-0 044)	(-0.055)	(-0.303)
Region					
	Northeast	0 481[a]	0.434[a]	0.521[a]	0.008
		(0 511)	(0 431)	(0.542)	(0.016)
	Midwest	0.188[a]	0.095	-0.174[a]	-0.120
		(0.191)	(0.096)	(-0.169)	(-0.117)
	West	0 566[a]	0 307[a]	0 423[a]	-0 072
		(0 623)	(0.306)	(0 455)	(-0 072)
Household Size		0.417[a]	0.301[a]	0 523[a]	0.223[a]
		(0.457)	(0 299)	(0.551)	(0.242)
Absence of Children		-0.057	-0.391[a]	0.182	-0.189[a]
		(-0.068)	(-0.388)	(0.181)	(-0.210)
Age of Head		0 027[a]	0 023[a]	0 022[a]	0.005[a]
		(0.031)	(0.023)	(0 024)	(0 006)
Race					
	Black	-0.152	-0 195[a]	-0.357[a]	0.099
		(-0.190)	(-0.194)	(-0.378)	(0.083)
	Other	0 708[a]	0 082	1.242[a]	0.267[a]
		(0 729)	(0.081)	(1.266)	(0.254)
Education					
	Less than H.S.	-0.364[a]	-0 443[a]	-0.278[a]	-0.021
		(-0 399)	(-0 441)	(-0.299)	(-0.021)
	College Grad.	0 295[a]	0.327[a]	0.334[a]	0.039
		(0.329)	(0.326)	(0.337)	(0.035)
Household Income		0 00001[a]	0.00001[a]	0 00001[a]	0.000007[a]
		(0.00001)	(0 00001)	(0.00001)	(0.000007)
MR_{hi}[b]		0.365[a]	0 310[a]	0.098[a]	0.703[a]

[a]Statistically significant at the 0.05 level. Standard errors are available from the author upon request.
[b]Inverse of Mills ratio
Note: Adjusted marginal effects are in parentheses.

In terms of region, the results are consistent with the ones by Lutz et al.. Households located in the Northeast spend more (between 43 and 54 cents per week) on fresh and processed fruit, and fresh vegetables than do households located in the South. Households located in the Midwest, on the other hand, spend 17 cents less on fresh vegetables but 19 cents more on fresh fruits per week than do households in the South. Households located in the West spend more on fresh fruit and vegetables, and processed fruit (between 30 and 62 cents per week) than do households located in the South.

Household size is positively related to household expenditures on all four product groups.

Results suggest that a one person increase in household size increases weekly expenditures by about 46, 30, 55, and 24 cents for fresh fruit, processed fruit, fresh vegetables, and processed vegetables, respectively, *ceteris paribus*. Expenditure elasticities with respect to household size, however, are inelastic. Elasticities for fresh and processed fruit are 0.457 and 0.386, respectively, while the elasticities for fresh and processed vegetables are 0.553 and 0.417, respectively. The results for vegetables are not in agreement with the analysis conducted by McCracken. Her study revealed that weekly per capita expenditures were 87 percent higher for one-person households than for households with more than six members.

Households without children spend about 39 and 21 cents less on processed fruit and vegetables per week, respectively, than do households with children. The reason for this result is not clear. However, it may be possible that households with children purchase more processed fruit than households without children because children normally prefer processed (or sweetened) fruit over fresh fruit.

Empirical results also suggest that households with an older household head spend more on all four products than do households with a younger household head. Leonard indicated that older Americans are becoming the "healthy eaters" because they tend to shift to eating foods which help prevent heart disease and cancer. It is, therefore, possible that older household heads influence their household's consumption patterns by purchasing more fruit and vegetables for health reasons. In addition, it has been reported that people consistently increase their expenditures on fruit and vegetables as they age. In fact, people in the 55-64 year old age group consume 39 percent more fresh fruit and vegetable than the national average (The Food Institute).

Households headed by a black person spend about 19 and 38 cents less on processed fruit and fresh vegetables, respectively, per week than do households headed by a white individual. Interestingly, households headed by an individual of "other" race (non-black and non-white) spend about 73 cents, $1.27, and 25 cents more on fresh fruit, and fresh and processed vegetables per week, respectively, than do households headed by a white individual. Lutz et al., using the 1987-88 NFCS, revealed that white households consume more fresh fruit but less fresh vegetables than do households of "other" races, in terms of average annual household food use. McCracken, on the other hand, revealed that nonwhite and nonblack households spend substantially more on vegetables.

In terms of education, households headed by an individual with at least a college degree spend more (about 33 cents each per week) on fresh fruit

and vegetables, and processed fruit than do households headed by an individual with only a high school degree. But households headed by an individual with only a high school degree spend more (between 30 and 44 cents per week) on these products than do households headed by an individual with less than a high school degree. It is possible that higher educated households are better informed of the benefits of consuming fruit and vegetables to increase fiber intake than lower educated households. This group might also be more likely to consume more expensive items than their less educated counterparts.

Income is positively related to expenditures on all four products. The Food Institute reported that consumers earning $40,000 or more a year spend 28 percent more on fresh fruit and 25 percent more on fresh vegetables than those earning $20,000-29,999 a year. This result is also consistent with that reported by Lutz et al.. The expenditures are inelastic with respect to income indicating that household expenditures on fresh and processed fruit and vegetables are not very responsive to changes in household income. Elasticities for fresh and processed fruit are 0.102 and 0.132, respectively while elasticities for fresh and processed vegetables are 0.103 and 0.124, respectively.

Concluding Comments

This study determined the effect of sociodemographic factors on household expenditures of fresh and processed fruit and vegetables using a relatively new data set and a generalized Heckman procedure. The empirical results suggest that seasonal and regional differences in the expenditures on these products exist. Generally, the results also indicate that larger, older, better educated, and higher income households spend more on fresh and processed fruit as well as fresh vegetables than do others. The differences in the results between equations justify separating the analyses into the four product classes. These results also underscore the importance of including sociodemographic characteristics in Engel curve relationships to explain fruit and vegetable expenditures.

References

Blisard, N. and J. Blaylock, "Food Expenditure Projections: 1990-2010", *Agribusiness*, 10(1994):105-114.

Cheng, H. and O. Capps, Jr., "Demand Analysis of Fresh and Frozen Finfish and Shellfish in the United States", *Amer. J. Agr. Econ.*, 70(1988):533.

Cook, R.L., "Challenges and Opportunities in the U.S. Fresh Produce Industry", *J. Food Distr. Res.*, 21(1990):67.

Duff, M., "Nutrition: New Rules Rally the Healthful", *Supermarket Business*, 44(April 1989):21-28.

Food Marketing Institute, "1989 Trends: Consumer Attitudes and Supermarket", Washington, D.C., 1989.

Heckman, J.J., "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models", *Annals Econ. and Soc. Meas.*, 5(1976):475.

Heien, D. and C.R. Wessells, "Demand Systems Estimation with Microdata: A Censored Regression Approach," *J. Bus. & Econ. Stat.*, 8(1990):365-371.

Lee, L. "Simultaneous Equation Models with Discrete and Censored Dependent Variables." in *Structural Analysis of Discrete Data with Econometric Applications*, P. Manski and D. McFadden, eds., Cambridge, MA: MIT Press, 1978.

Leonard, R.E., "Nutrition Profiles: Diet in the '80s", *Comm. Nutr.*, 1(1982):12.

Litwak, D. and J. Cepeda, "Consumer Expenditure Study: Produce", *Supermarket Business*, 46(September 1991):169.

Lutz, S.M., D.M. Smallwood, J.R. Blaylock, and M.Y. Hama, "Changes in Food Consumption and Expenditures in American Households during the 1980s", U.S. Department of Agriculture Statistical Bulletin No. 849, Human Nutrition Information Service and Economic Research Service, Washington, DC, December 1992.

Maddala, G.S., *Limited Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, 1983.

McClure, B.H., "A Look Ahead: Key Trends that will Affect Supermarket Sales in the Next 10 Years", *Supermarket Business*, 46(September 1991):21.

McCracken, V.A., "The U.S. Demand for Vegetables", In *Vegetable Markets in the Western Hemisphere: Trends, Policies, and Trade Linkages*, R.A Lopez and L.C. Polopolus, eds., Ames, Iowa: Iowa State University, 1992.

McMath, R., "Produce Market is Ripe for Branded Fruit, Vegetables", *Brandweek*, 34(June 7, 1993):26.

Moulton, K.S., "Issues in the Marketing of Fruits, Vegetables and Tree Nuts", *American Agricultural Law Association 1989 Convention Handbook*, 19(1989):1.

Nayga Jr., R.M., "Microdata Expenditure Analysis of Disaggregate Meat Products," *Rev. Agr. Econ.*, 17,3(September 1995):in press.

Saha, A., O. Capps, Jr., and P. Byrne, "Calculating Marginal Effects in Models for Zero Expenditures in Household Budgets Using a Heckman Type Procedure", Texas Agricultural Experiment Station Bulletin, September 1994.

The Food Institute, *Demographic Directions*, Fair Lawn, New Jersey, July 1989.

U.S. Department of Labor, "Consumer Expenditures in 1992", Bureau of Labor Statistics, Report No. 861, December 1993.

Endnotes

1. The CES was designed to collect information on expenditures incurred by the respondents during the survey week. The respondents are part of a national probability sample of households designed to represent the total civilian population. The eligible population includes all civilian noninstitutional persons and all people residing in group quarters such as housing facilities for students and workers. Military personnel living on base are not included (U.S. Department of Labor).

2. These are mean expenditures of the sample based on all 10,094 households. Mean expenditures for only the purchasing households are $4.39 and $4.08 for fresh and processed fruit, and $4.17 and $3.32 for fresh and processed vegetables, respectively. Sample statistics of the independent variables are available from the author upon request.

3. These marginal effects denote the magnitude and direction of change in weekly expenditures ($) per unit change in an independent variable, *ceteris paribus*.