DETERMINANTS OF HOUSEHOLD EXPENDITURE ON FRESH VEGETABLES

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Current concern about the health effects of American dietary habits has led to recommendations by government officials and nutrition experts that consumers increase their consumption of vegetables (U.S. Congress, Council for Agricultural Science and Technology). From a nutritional viewpoint, vegetables contribute substantially to meeting the requirements for a balanced diet because they are rich sources of fiber, carbohydrates, minerals, and vitamins. From an economic viewpoint, while occupying on the average only 5 to 6 percent of the household food budget, vegetables comprise approximately 20 percent of the per capita consumption (dry weight) of food in the United States (USDA).

The extant literature on household expenditure patterns for vegetables is incomplete in several respects. First, in past studies, vegetables have been commonly aggregated into a single group without consideration to either individual items or product forms (Aitchison and Brown; Prais and Houthakker; Buse and Salathe; Salathe). Second, although Raunikar, Purcell, and Elrod; Hymans and Shapiro; and Price, Price, and West considered particular vegetable items and product forms, their research was region specific. These studies employed survey data from the states of Georgia, Michigan, and Washington, respectively. Third, when investigating household expenditure patterns for vegetables, researchers have given virtually no recognition to nonpurchasing households. This omission creates sample selection bias (Heckman). Finally, past studies have not typically been used to make predictions of household expenditure on vegetables, given information on socioeconomic characteristics.

This research is motivated by the need to gain a better understanding of how socioeconomic factors affect household expenditure patterns for vegetables, taking into account the aforementioned limitations of past studies. Despite the nutritional and economic importance of vegetables, a scarcity of research exists to answer questions about how socioeconomic characteristics not only affect the probability of making vegetable purchases, but also the magnitude of vegetable purchases. Answers to these questions would be valuable to industry and government efforts to anticipate changes in household demand for vegetables. Given that fresh vegetables constitute approximately 70 percent of per capita vegetable consumption in the United States (USDA), consideration is given to this product form in this paper.[1] The source of data for this research is the *1972–74 Bureau of Labor Statistics Consumer Expenditure Diary Survey.*

MODEL DEVELOPMENT

Empirical investigations of household expenditure behavior, such as those by Prais and Houthakker, Brown and Deaton, and Ferber have dealt with numerous determinants of food consumption. This study hypothesizes that the following socioeconomic characteristics influence household expenditure on fresh vegetables: (1) household income and age-sex composition, (2) region, (3) population density, (4) earner composition, (5) education of the household manager, (6) race of the household head, and (7) food stamp participation.

Household income and age-sex composition were the most common variables put forward in previous analyses to influence vegetable expenditures. Changes in household income are viewed as changes in the opportunity to purchase various forms. Differences in household age-sex composition lead to differences in nutritional requirements or in levels of acceptance of vegetables.

Aitchison and Brown provided evidence to indicate that increases in vegetable expenditures are rapid as income rises, but saturation levels are approached at relatively low levels of income. Past research dealing with the construction of unit-equivalent scales (Prais and Houthakker; Price; Buse and Salathe) provided criteria to specify various age-sex categories for the number of household members. This study, however, does not attempt to estimate unit-equivalent scales for fresh vegetables. Instead, attention is given to the number of male and female members that fall into the 0 to 4, 5 to 12, 12 to 19, 20 to 64, and over-65 year age categories. This delineation, constituting a decomposition of household size, not only takes into account potential impacts of sex, but also potential impacts of preschool children, preadolescent children, adolescents, adults,

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[1] Canned vegetables constitute approximately 25 percent of per capita vegetable consumption in the United States, while frozen vegetables constitute the remaining 5 percent.

and elderly adults on household expenditure for fresh vegetables. The results of Price, and Buse and Salathe suggested that the impact of additional members on food expenditures decreases with increases in household size. To indicate the possibility of saturation levels and the possibility of economies of household size in age-sex composition, income and the number of household members in each age-sex category are squared. Estimated coefficients associated with income and the number of persons in any category are hypothesized to be positive, and estimated coefficients associated with the squared terms are hypothesized to be negative.

Population density, or degree of urbanization, may affect expenditure behavior through opportunities for home gardens and choices of retail market, while regional differences may reflect disparities in prices, distribution costs, general availability, and cultural habits. Households located in areas outside standard metropolitan statistical areas (SMSA's) are expected to expend less on fresh vegetables than households located within SMSA's. Similarly, households located in the South, the North Central, and the West are hypothesized to expend less on fresh vegetables than households located in the Northeast.

Level of education of the household manager reflects degree of awareness of the importance of vegetables in the diet. Education is therefore hypothesized to positively affect household expenditure patterns on fresh vegetables. Earner composition, defined as whether one, both, or neither of the male and female household heads are employed, reflects the opportunity cost inherent in meal preparation, thereby influencing the choice of vegetables purchased. The opportunity cost increases with the employment of the respective household heads. Therefore, household expenditure on fresh vegetables is hypothesized to decline when the opportunity cost of meal preparation increases.

Race affects household expenditures for fresh vegetables through ethnic and cultural influences. Prior information is insufficient for the hypothesis concerning the impact of race on fresh vegetables. The purchase of food stamps represents explicit efforts by the government to increase the opportunity to obtain food and provide adequate nutrition for low-income households. Consequently, food stamp program participation is hypothesized to positively impact on household expenditure for fresh vegetables.

The socioeconomic characteristics in this study, with few exceptions, are traditional variables found in previous analyses to influence household expenditure on vegetables. Price, Price, and West went beyond traditional bounds in their study of household expenditures on vegetables. They argued for recognition of psychological need levels of household members, liquid assets of the household, as well as various management styles as effective determinants of expenditure patterns. These nontraditional variables are not included in this analysis because of data limitations.

Table 1. Explanatory Variables in the Statistical Model

INC	= total annual household income
INC2	= total annual household income squared
M1	= number of males, ages 0-4 years
M12	= number of males, ages 0-4 years squared
M2	= number of males, ages 5-12 years
M22	= number of males, ages 5-12 years squared
M3	= number of males, ages 13-19 years
M32	= number of males, ages 13-19 years squared
M4	= number of males, ages 20-64 years
M42	= number of males, ages 20-64 years squared
M5	= number of males, ages 65 + years
M52	= number of males, ages 65 + years squared
F1	= number of females, ages 0-4 years
F12	= number of females, ages 0-4 years squared
F2	= number of females, ages 5-12 years
F22	= number of females, ages 5-12 years squared
F3	= number of females, ages 13-19 years
F32	= number of females, ages 13-19 years squared
F4	= number of females, ages 20-64 years
F42	= number of females, ages 20-64 years squared
F5	= number of females, ages 65 + years
F52	= number of females, ages 65 + years squared
OME	= 1 if only male household head present and employed
OMU	= 1 if only male household head present and unemployed
OFE	= 1 if only female household head present and employed
OFU	= 1 if only female household head present and unemployed
BEU	= 1 if male and female household heads present and male employed
BUE	= 1 if male and female household heads present and female employed
BUU	= 1 if male and female household heads present and both unemployed
EDHM1	= 1 if education of household manager exceeds high school
RAC	= 1 if race of household head is black
FST	= 1 if food stamps purchased during month prior to survey
MCC	= 1 if household resides in SMSA, central city of 1 million or more
MOC	= 1 if household resides in SMSA, outside central city of 1 million or more
LCC	= 1 if household resides in SMSA, central city of 1 million or less
LOC	= 1 if household resides in SMSA, outside central city of 1 million or less
NER	= 1 if household located in Northeast
NCR	= 1 if household located in North Central
WER	= 1 if household located in West

Reference household is defined as non-black, with male and female household heads present, both employed, household manager (spouse, if present) not college educated, living outside SMSA, in the South, and not purchasing food stamps during month prior to survey.

The model regressand, household expenditure for fresh vegetables, is defined as the two-week total dollar amount of fresh vegetable purchases recorded by the household during the survey period. The model regressors (Table 1), income, age-sex composition, and other socioeconomic factors, range in nature from continuous to binary variables. Total household income is recorded in dollars, the range of which ensures reasonable continuity. The number of persons recorded in any age-sex category are necessarily integers. The remainder of the regressors—race, educational level, earner composition, region, population density, and food stamp participation—are defined as binary variables.

This study employs binary variables as intercept shifters, implying that they affect mean vegetable expenditures. The estimated coefficients from such binary variables indicate the numerical amount by which the included classifications of discrete variables differs from the reference intercept.[2]

DATA

This analysis includes data from usable schedules for 10,145 households in the second sample year, July 1973 to June 1974, of the *Bureau of Labor Statistics Consumer Expenditure Diary Survey* (BLSCEDS). Because relevant data were missing, 1,976 households were eliminated from the analysis. The BLSCEDS contains two-week expenditure records from 23,186 households obtained during June 1972 to July 1974. The second sample year was chosen because of the in-

[2] The use of interaction variables (slope shifters) may have merit in this analysis to reflect, for example, differences in the marginal propensity to spend on fresh vegetables by race, education, or earner composition. However, the introduction of slope-shifter variables led to irreconcilable collinearity problems among the regressors.

Table 2. Descriptive Statistics of Variables in the Statistical Model

Variable	Mean	Stnd Deviation	Minimum	Maximum
Fresh Vegetable Expenditure				
EXP	1.0723	1.5256	0	13.76
Household Income				
INC	11,464	9350.9	12	127,000
Age-Sex Category				
M1	.1140	.3647	0	3
M2	.2520	.5697	0	4
M3	.2160	.5380	0	4
M4	.7355	.5474	0	3
M5	.1120	.3170	0	2
F1	.1285	.3847	0	3
F2	.2155	.5283	0	4
F3	.1995	.5008	0	3
F4	.8120	.5261	0	4
F5	.1470	.3570	0	2
Earner Composition				
OME	.0120	.1089	0	1
OMU	.0025	.0499	0	1
OFE	.0535	.2250	0	1
OFU	.0345	.1825	0	1
BEU	.2690	.4435	0	1
BUE	.0205	.1417	0	1
BUU	.0730	.2602	0	1
Education of Household Members				
EDHM1	.2335	.4231	0	1
Race of Household Head				
RAC	.1020	.3027	0	1
Household Food Stamp Participation				
FST	.0520	.2220	0	1
Population Density				
MCC	.1955	.3966	0	1
MOC	.2620	.4398	0	1
LCC	.1415	.3486	0	1
LOC	.1245	.3302	0	1
Region				
NER	.1905	.3927	0	1
NCR	.2910	.4543	0	1
WER	.2150	.4109	0	1

formation concerning spouse education and household food stamp participation, not available from the first sample year. It is assumed that the 10,145 usable schedules adequately represent fresh vegetable expenditure patterns of U.S. households.

Descriptive statistics of the variables in the statistical model are exhibited in Table 2. The average two-week expenditure on fresh vegetables by households in the sample was $1.07, and the average household income was $11,464. Means of the binary vegetables reflect the proportions of households that fall into particular categories. For example, only 5.2 percent of the households in the sample participated in the food stamp program.

Households not recording vegetable purchases during the specified period, but having otherwise complete records of socioeconomic characteristics are included in the sample. The reasons for nonpurchases of fresh vegetables may be due to sufficient household inventory, response to market prices, or to general nonpreference for fresh vegetables. Approximately 37 percent of the households (3,803 out of 10,145) reported no vegetable expenditures during a two-week period. Fresh vegetable expenditure data containing zero as well as positive purchase amounts are consequently distributed over a limited range. Rather than alter or dispose of household records containing zero expenditures, Tobit analysis (Tobin) is employed to account for this information to adequately portray the full range of household behavior.

TOBIT ANALYSIS

The statistical model for the research study is given by $Y = X\beta + e$, where Y is the two-week household expenditure for fresh vegetables, X contains as elements values of the explanatory variables listed in Table 1, β is a conformably defined parameter vector, and e represents the stochastic disturbance term of the regression. The β coefficients are estimated by the method of maximum likelihood (assuming normality of the disturbance term) and are decomposed to determine both changes in the probability of making fresh vegetable purchases and changes in the magnitude of fresh vegetable purchases (McDonald and Moffit). The maximum likelihood estimation procedure assures the large-sample properties of consistency and asymptotic normality of the estimated coefficients so that conventional tests of significance are applicable. For all statistical tests, the critical level is 10 percent.

RESULTS

The results in Table 3 indicate that the socioeconomic factors explain a statistically significant amount of variation in household expenditure on fresh vegetables.[3] Columns one and two show the coefficients and their asymptotic t-ratios.[4] Column three shows the change in probability of purchasing vegetables due to a change in each independent variable. Columns four and five show the two components of a total change in E(Y), given a change in each independent variable. Column four represents the change in E(Y) for purchasing households only, weighted by the probability of purchasing fresh vegetables. Column five represents the change in probability of purchasing fresh vegetables, weighted by the conditional expected value of expenditure, E(Y*). F(z) denotes the cumulative standard normal distribution function.

Data in columns one and two indicates apparent success in model specification and choice of functional form.[5] The coefficients on household income and age-sex categories indicate that saturation levels are approached as income increases, and economies of scale are apparent only in households with adult females (F4, F42). Households with increasing numbers of adult males (M4) show increases in fresh vegetable expenditures. However, the number of both male and female children under the age of 19 years and the number of elderly males and females in the household are not statistically significant factors in influencing fresh vegetable expenditure.

[3] The statistical test used to make this inference is a likelihood ratio test: $-2\ln\lambda \sim \chi 2p$, where p is the number of regressors in the statistical model. This test is the analogue of the F-test used in traditional multiple regression analyses to determine model adequacy.

[4] The format of reporting results closely follows that of Hagemann. Preliminary results using the *1977–78 Nationwide Food Consumption Survey* are in most instances strikingly similar to those reported here.

[5] The Theil Goodness-of-Fit Statistic (0.4849) is given by $(1 - e'e/s^2n))$, where $e'e$ is the residual sum of squares, s^2 is the estimated variance of the dependent variable, and n is the number of observations (Hagemann).

Table 3. Summary Statistics for Tobit Analysis of Household Expenditures on Fresh Vegetables

Variable	β	Asymptotic t-ratio	$\frac{\partial F(z)}{\partial x}$	$\frac{\partial E[Y^*]_{F(z)}}{\partial x}$	$\frac{\partial F(z)_{E[Y^*]}}{\partial x}$
INC	0.4097D-04	3.47	0.7372D-05	0.9463D-05	0.1313D-04
INC2	-0.1298D-09	-0.81			
M1	-0.4301	-1.31	-0.0726	-0.0932	-0.1294
M12	0.2442	1.26			
M2	0.0632	0.30	0.0120	0.0154	0.0214
M22	-0.0022	-0.24			
M3	0.1210	0.50	0.0261	0.0335	0.0465
M32	0.0315	0.28			
M4	0.4978	1.91	0.0697	0.0895	0.1242
M42	-0.0939	-0.79			
M5	0.2411	0.22	0.0558	0.0716	0.0994
M52	0.2077	0.20			
F1	-0.0937	-0.26	0.0255	0.0328	0.0455
F12	-0.1480	-0.64			
F2	-0.1093	-0.47	-0.0027	-0.0035	-0.0048
F22	0.2210	2.01			
F3	-0.1928	-0.78	-0.0242	-0.0311	-0.0431
F32	0.1700	1.42			
F4	1.8448	7.07	0.1985	0.2549	0.3536
F42	-0.5058	-4.63			
F5	0.6087	0.77	0.1510	0.1939	0.2690
F52	0.5775	0.79			
OME	-0.5057	-0.99	-0.0981	-0.1259	-0.1758
OMU	-0.0455	0.45	0.0088	0.0113	0.0157
OFE	0.2174	0.89	0.0421	0.0541	0.0750
OFU	0.3070	1.04	0.0595	0.0764	0.1060
BEU	0.2340	1.86	0.0454	0.0582	0.0809
BUE	-0.0743	-0.21	-0.0144	-0.0185	-0.0256
BUU	0.4813	1.97	0.0933	0.1198	0.1662
EDHM	-0.6555	-0.08	-0.1271	-0.1632	-0.2264
RAC	2.9418	0.51	0.5708	0.7327	1.0166
FST	0.2614	1.07	0.0507	0.0650	0.0903
MCC	0.7223	4.87	0.1401	0.1799	0.2495
MOC	0.3271	2.38	0.0634	0.0814	0.1129
LCC	0.3200	1.99	0.0620	0.0796	0.1104
LOC	0.3342	2.00	0.0648	0.0832	0.1154
NER	0.3515	2.45	0.0682	0.0875	0.1215
NCR	-0.3754	-2.89	-0.0728	-0.0935	-0.1297
WER	-0.1904	-1.33	-0.0369	-0.0474	-0.0657
CONSTANT	-8.6267	-1.95			

Note: The unconditional expected value of y, at mean x, is 1.0592. The conditional expected value of y, at mean x, is 1.7811. The standard error around the Tobit index is 1.9977. The predicted probability that $y > 0$, at mean x, is 0.5947 and Theil's goodness-of-fit statistic is 0.4849. $z = 0.2397$, $f(z) = 0.3876$.

Source: Computations by the authors.

Spouse unemployment (BEU) and unemployment of both male and female household heads (BUU) are positive factors affecting household expenditure on fresh vegetables, perhaps due to greater opportunities to obtain and prepare vegetables for consumption at home. The coefficient on FST, food stamp participation, suggests that added income restricted to the purchase of food is not at important factor in influencing fresh vegetable expenditure. The statistical nonsignificance of the coefficients on race of the household head (RAC) and education of the house manager (EDHMI) also suggests that these variates are not important factors with regard to explaining fresh vegetable expenditure patterns. As expected, households located within the boundaries of SMSA's, representing densely populated areas, spend significantly more on fresh vegetables than households located outside SMSA's. Households located in the North Central (NCR) and West (WBR) spend less on fresh vegetables than households located in the South. On the other hand, households located in the Northeast spend more on fresh vegetables than households located in other geographic regions. These results are possibly due to differences in availability of fresh vegetables, culture, and climate.

From a comparison of the last two columns in Table

Table 4. Calculated Elasticities from Tobit Coefficients for Fresh Vegetables [a]

Variable	$\eta_{E[Y]}$	$\eta_{E[Y^*]}$	$\eta_{F[z]}$
INC	0.2445	0.1024	0.1421
M1	-0.0239	-0.0100	-0.0139
M2	0.0087	0.0036	0.0051
M3	0.0163	0.0068	0.0095
M4	0.1485	0.0622	0.0863
M5	0.0180	0.0075	0.0105
F1	0.0095	0.0040	0.0055
F2	-0.0016	-0.0007	-0.0009
F3	-0.0139	-0.0058	-0.0081
F4	0.4665	0.1954	0.2711
F5	0.0642	0.0269	0.0373

[a] The elasticity of the probability of making fresh vegetable purchases $\eta_{F(z)}$, and the elasticity of the conditional expected value of expenditure, $\eta_{E(Y^*)}$, sum to equal the elasticity of unconditional expected value of expenditure, $\eta_{E(Y)}$.
Source: Computations by the authors.

4, with no exception, a change in any single regressor has a greater effect on the change in probability of purchase than on the change in magnitude of purchase. The income-expenditure elasticity reported in a column one of Table 4 supports the notion that fresh vegetables are economic necessities. Economic necessities are denoted by expenditure elasticities between zero and one. That is, 1 percent change in income elicits a fraction of 1 percent change in fresh vegetable expenditure. Other researchers report similar elasticities for vegetables (Harmston and Hino; Rockwell; Salathe).

The differences in elasticities between income and age-sex composition, and also among the various age-sex categories, point to the relative importance of adult household members in affecting fresh vegetable expenditure. In particular, the response to a change in the number of adult females on fresh vegetable expenditures is greater than the response to a change in household income. This result suggests potential marketing strategies for effecting changes in fresh vegetable consumption and should be important to industry and government personnel.

This analysis permits the construction of fresh vegetable expenditure profiles based on selected households. A sample profile is presented in Table 5 for households with nonblack male and female household heads present, both employed, household manager not college educated, living outside SMSA's, in the South, and not purchasing food stamps. Each cell contains the estimated two-week expenditure on fresh vegetables.

The sample profile illustrates the impact on fresh vegetable expenditures due to changes in age-sex composition of household members as well as changes in household income. To illustrate, the sample household with an annual income of $30,000 as well as two

Table 5. Household Profile of Two-Week Expenditures on Fresh Vegetables Under Selected Conditions of Annual Income and Age-Sex Composition [a]

Age-Sex Characteristics of Household			Annual Household Income			
Number	Age-Group	Sex	$5,000	$15,000	$30,000	$50,000
			------ (1973-74) dollars ------			
2	5-12	Female	0.47	0.85	1.38	1.99
1	0-4	Male				
2	13-19	Female	0.34	0.73	1.25	1.87
1	5-12	Male				
1	over 65	Female	1.62	2.01	2.53	3.14
1	over 65	Male				

[a] Profile for nonblack male and female household heads present, both employed, household manager not college educated, living outside SMSA's, in the South, and not purchasing food stamps.

female children (5 to 12) and one male child (0 to 4) would spend $1.38 biweekly, in 1973–74 dollars, for fresh vegetables. In contrast, the same household with elderly persons (male and female) would spend $2.53 biweekly for fresh vegetables. The wealth of detail in the classifications of the socioeconomic variates permits the construction of numerous unique profiles of the type in Table 5.

CONCLUSIONS

The impacts of socioeconomic factors on the probability and extent of fresh vegetable purchases provide signals for marketing organizations and firms in the retail food industry. Using this research study, many socioeconomic profiles can be constructed to examine household expenditure behavior for fresh vegetables. Food marketers can perhaps use this information in planning location and format changes in food distribution outlets.

A logical generalization is to conduct analyses for canned and frozen vegetables to take into account additional product forms, as well as for dark green and deep yellow vegetables, light green vegetables, tomatoes, potatoes, and other vegetables to take into account product type. Given that dramatic changes in socioeconomic characteristics are occurring, additional studies of household expenditure behavior are likely to pay dividends to the vegetable industry.

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