FOOD DEMAND ANALYSIS

Implications for Future Consumption

Edited by

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A SYSTEMATIC ANALYSIS OF HOUSEHOLD FOOD CONSUMPTION BEHAVIOR WITH SPECIFIC EMPHASIS ON PREDICTING AGGREGATE FOOD EXPENDITURES

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Introduction

Prospective changes in the levels and distributions of U.S. household income and household size have important implications to public and private food production and distribution policies. Consequently, aggregate household food expenditure predictions may facilitate strategic food production and distribution decisions. This paper describes a model of household resource allocation and develops a set of relationships for predicting aggregate household food expenditures under projected changes in selected demographic characteristics of the U.S. households.

Previous studies have shown that the socioeconomic characteristics of households are key determinants of household food consumption behavior (Adrian and Daniel, 1976; Davis, 1982; Blanchiforti, Green and Lane, 1981; Smallwood and Blaylock, 1981; West and Price, 1976). Also, as will be shown later, there are marked categorical differences in the food consumption behavior of households. Households in different income groups and household size groups exhibit group specific patterns of food expenditures in terms of absolute or relative total and disaggregate food expenditures. These patterns suggest that changes in the level and distribution of household income and household size have important effects on aggregate household food consumption. Marginal changes in the aggregate household consumption of food, in general, and specific food items, in particular, have important consequences to food production and distribution sectors.

Therefore, starting with household resource allocation behavior, a series of relationships is derived to characterize and estimate food consumption behavior of the households. Subsequently, aggregate consumption projections are derived from the estimated food expenditure structure relative to household income and household size distributions.

Theoretical Basis: Household Resource Allocation Behavior

Following the seminal work by Becker (1965), several aspects of household behavior, both market and nonmarket activities, have entered the domain of economic analysis. Specifically, there are now several

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applications of the household production function to the analysis of fertility (Willis, 1973; De Tray, 1973), labor market (Gronau, 1973), and consumption behavior of households. The household is envisioned as a decision-making unit characterized by a utility function, market and household production activities and a set of resource endowments.

For ease of exposition, let there be two sets of household activities or commodities (Gronau, 1973), "standard of living" (S) and "child services" (C). The production inputs for S and C are the time, T, of the members of the household, and market goods, X; mathematically,

$$S = S(X_s, T_{sm}, T_{sf}) \tag{1a}$$

$$C = C(X_c, T_{cm}, T_{cf}) \tag{1b}$$

where it is assumed, for simplicity, that the family consists of two adult working members, husband, m, and wife, f, and that the children do not contribute to household production. T_{sm} T_{sf} are the time inputs of the husband and wife, respectively, in producing S. Similarly, T_{cm} and T_{cf} are the time input for producing C.

The household utility function is assumed to be a monotonic, twice continuously differentiable, and strictly concave function:

$$U = U(S, C) \tag{2}$$

where S is the standard of living and C is child services.

The maximization of the utility function is subject to two sets of constraints: (a) a household budgetary constraint,

$$\Sigma\, x_i p_i \equiv w_m T_{mw} + w_f + w_f T_{f2} \equiv y_h \tag{3}$$

where x_i is the quantity and p_i is the price of the ith market good purchased, w_m, w_f are the wage rates and T_{mw}, T_{fw} are the labor market times of the husband and wife, respectively; y_h is the total household income; and (b) household time constraint,

$$\Sigma\, T_{sg} + \Sigma\, T_{cg} + \Sigma\, T_{wg} = T,\ g = m,\ f. \tag{4}$$

The Lagrangian equation for the maximization of the household utility (2) subject to the budgetary and time constraints (3-4) and the household production technology (1a-1b) is (5)

$$\begin{aligned}\Psi = {} & U(S, C) + \lambda_1\{S - S(x_s, T_{sm}, T_{sf})\} \\ & + \lambda_2\{C - C(X_c, T_{cm}, T_{cf})\} \\ & + \lambda_3\{y_h - x_{hi}p_{hi}\} \\ & + \lambda_4\{T - T_{sg} + T_{cg} + T_{mw}\}\end{aligned} \tag{5}$$

The optimum conditions consistent with the constrained maximization of the household utility are derived from (5)

$$\partial\Psi/\partial\lambda_1 = S - S(x_s, T_{sm}, T_{sf}) = 0, \quad (6)$$

$$\partial\Psi/\partial\lambda_2 = C - C(x_c, T_{cm}, T_{cf}) = 0, \quad (7)$$

$$\partial\Psi/\partial\lambda_3 = y_h - p_i x_{hi} = 0 \quad (8)$$

$$\partial\Psi/\partial\lambda_4 = T - T_{sg} + T_{cg} + T_{mw}) = 0. \quad (9)$$

Conditions (6) and (7) ensure being on the household production function. Equation (8) ensures optimum expenditures of household income on market goods and (9) gives condition for optimal allocation of total household time.

The preceding relationships suggest some variables that can be used to specify an empirical model of the determinants of household food expenditures in terms of household socioeconomic characteristics. Following De Tray (1973), Equation (7) may be reformulated so that child services, C, is decomposed in terms of child quality, Q, and numbers of children, N. Assuming similar production inputs,

$$C = C(N, Q) \quad (10)$$

$$N = N(X_c, T_{cm}, T_{cf}) \quad (11)$$

$$Q = Q(X_c, T_{cm}, T_{cf}) \quad (12)$$

Equations (10-12) then establish direct relationship between the number of children or family size and market goods (food). Subsequently, the household socioeconomic variables, in this case family size, becomes an integral part of the household food expenditure model.

Data

The data used for the analysis are from the diary component of the Bureau of Labor Statistics 1980 Consumer Expenditure Survey. The diary survey data are collected from a nationwide probability sample of households designed to be representative of the total civilian noninstitutional population. In the diary survey, consumer units are asked to list all their expenses for two one-week periods for small and frequently purchased items which are, otherwise, difficult to recall. These items include expenditures for food, gas, beverages, electricity and similar other items. These, together with data on household characteristics (age, sex, marital status, income, work experience and earnings), provide useful data for analyzing household expenditures.

Additional data regarding the household income, age of head, and household size distributions are from several publications of the U.S. Bureau of the Census.

Demographic Profile of U.S. Households

The U.S. Bureau of the Census population projections show that between 1982 and 1990 the U.S. population will increase by 10.2 percent, and by 18.0 percent in the year 2000. Over the same periods, there are projected decreases in the percentage distribution of those under 44 years and increases for those over 44 years. A profile of U.S. household as well as projections of changes in the demographic characteristics of the U.S.households are presented in Tables 1 and 2, respectively. The income and household size groups are similar to those used for statistical and public policy purposes.

Projections of changes in the U.S. household income and household size distributions are in Table 2. Specifically, the projected changes of the total U.S. households in the years 1990 and 2000 (base year 1982) are made for each income category and each household size group. Relative to the 1982 U.S. household income distribution, there are projected decreases in the percentage households in the lowest two income categories (under $10,000 and $10,000-$19,999). The percentage of U.S. households in the top income group (over $34,999) is projected to increase, successively, in 1990 and 2000. Finally, the percentages of U.S. households in the middle income category ($20,000-$34,999) are projected to increase in 1990 and decrease below the 1982 level in the year 2000.

Projections of the household size distributions to 1990 and 2000 show, in general, increases in the percentage of the smaller size

Table 1. Profile of U.S. Households: Income and Household Size Distributions

Variables and Categories	Group Size	Percent of U.S. Total	Mean Household	
			Income	Size
	(1,000)	(%)	($)	(no.)
Income:				
Under $10,000	10,191	16.6	4,805	NA
$10,000-$19,999	15,041	24.5	14,521	NA
$20,000-$34,999	19,523	31.8	26,618	NA
Over $34,999	16,638	27.1	45,660	NA
Household Size:				
Single-member	14,243	23.2	NA	1.0
Two-member	19,462	31.7	NA	2.0
Three to Four	20,198	32.9	NA	3.5
Over Four	7,489	12.2	NA	6.8

Note: NA denotes not applicable.

Source: Money Income of Households, Families, and Persons in the United States: 1982, Bureau of the Census, Series P-60, No. 142.

Table 2. Projected Changes in the Income and Household Distributions of U.S. Households (Actual 1982 = 100)

Category	1982	1990	2000
		%	
Income:			
Under $10,000	100	93.34	98.80
$10,000-$19,999	100	79.18	64.08
$20,000-$34,999	100	101.28	91.05
Over $34,999	100	123.98	144.28
Household Size:			
Single-member	100	120.26	135.34
Two-member	100	105.99	110.41
Three to Four	100	99.70	99.40
Over Four	100	46.72	2.29

Source: Projections of the Population of the United States, by Age, Sex and Race: 1983 to 2080, Bureau of the Census, Series P-25, No. 952.

households and decreases in the percentages of the larger size households. With the exception of the medium size households (three to four persons), considerable increases are projected for single member households and more-than-proportionate decreases in the percentage of U.S. households are projected for the larger households (over four persons).

The projected distributions of household size show that the percentages of single and two-member households will increase and larger size households (over four members) will decline over the next two decades. The percentage of households in the mid-size category (three to four members) is projected to decline slightly between 1990 and 2000. On the whole, the number of all households will be 10.06 percent and 22.4 percent higher in 1990 and 2000, respectively, than in 1982.

Household Food Expenditures

Food expenditure patterns by income category and household size are summarized in Tables 3 and 4, respectively. In general, the higher the income the lower the percentage of total income spent for total food and the specific food groups (Table 3). For all income groups, beef, pork, and poultry, in that order, account for the top share of household income spent for food, and processed fruits, processed vegetables and eggs account for the lowest shares.

In general, the larger the household size the higher the percentage of household income spent for food. However, the mean percentage household income spent for food by single member households is exceeded

Table 3. Summary of Computed Household Food Expenditures by Income Categories: Individual and Total Food Expenditures as Percentages of Total Household Income (Means)

Food Item	Under $10,000	$10,000-$19,999	$20,000-$34,999	Over $34,999
	%			
Bakery	3.42	1.33	0.93	0.61
Beef	7.87	3.41	2.05	1.44
Cereal	2.61	1.02	0.59	0.34
Dairy	3.46	1.32	0.87	0.58
Eggs	1.48	0.51	0.29	0.20
Fish	1.48	0.51	0.79	0.55
Fruits (F)	2.82	0.99	0.61	0.42
Fruits (P)	2.39	0.87	0.54	0.34
Milk	3.10	1.17	0.78	0.45
Pork	5.58	2.09	1.31	0.74
Poultry	4.33	1.60	0.96	0.59
Sugar	2.81	1.00	0.65	0.37
Vegetables (F)	2.62	0.95	0.55	0.36
Vegetables (P)	2.13	0.73	0.47	0.26
All Food	50.87	19.69	11.99	8.19

Note: F and P denote fresh and processed, respectively.

only by that of households with five or more members. The pattern tends to hold for the individual food items as well. Single member households spend the highest percentage of household income on cereal, dairy, eggs, fish, fresh fruits, poultry, processed fruits and sugar. The largest households spend the highest percentage of household income on bakery, beef, milk, and pork. In all cases, the rest of the household size groups spend medial percentages of household income relative to the single and large size households

Another dimension of the relative expenditure pattern by income and household size groups is shown in Table 5, where aggregate and disaggregate food expenditures are expressed in terms of the mean percentage expenditures of the lowest income group and single member households, respectively. As exhibited in Table 5, households in the $10,000 to $19,999 income groups, relative to those with income under $10,000, allocate on the average a lower percentage of the total food budget to bakery and a higher percentage to beef. Similarity, two-member households allocate a lower percentage of the total food budget to bakery and a higher percentage to beef than do the single member households. Similar information for the other income and household size

Table 4. Summary of Computed Household Food Expenditures by Household Size Category: Individual and Total Food Expenditures as Percentages of Total Household Income (Means)

Food Item	Household Size Category			
	Single Member	Two Members	Three to Four Members	Over Four Members
	%			
Bakery	1.33	1.03	1.11	1.41
Beef	2.89	2.56	2.43	3.21
Cereal	1.08	0.69	0.68	1.03
Dairy	1.59	1.07	1.03	1.24
Eggs	0.63	0.39	0.36	0.51
Fish	1.78	1.09	0.89	0.99
Fruits (F)	1.31	0.82	0.77	0.89
Fruits (P)	1.08	0.73	0.66	0.78
Milk	1.07	0.76	0.96	1.40
Pork	2.04	1.63	1.46	2.12
Poultry	1.91	1.22	1.12	1.56
Sugar	1.31	0.83	0.76	0.86
Vegetables (F)	1.31	0.73	0.68	0.83
Vegetables (P)	0.89	0.59	0.57	0.66
All Food	15.73	13.95	14.98	19.56

Note: F and P denote fresh and processed, respectively.

groups and the selected food items is shown in Table 5. Finally, the mean household food expenditures for selected food items by income and household size groups, respectively are shown in Tables 6 and 7.

Empirical Model

With the household as the unit of analysis, the household food expenditures, E, are expressed as a linear function of household income, y, household size, z, and age of head, g.

$$E_i = a + b_1 y_i + b_2 z_i + b_3 g_i + e_i \qquad (13)$$

where a is the intercept, b_1, b_2, and b_3 are the coefficients, and e_i is the error term, i = 1,2,...,N is the households.

To incorporate the distributional effects explicitly, consider the following linear spline transformations (Poirier, 1976):

Table 5. Comparative Shares of Total Household Food Budget: Group Expenditures as Percentages of Lowest Income and Smallest Household Size Groups (Under $10,000 = 100; Single-member = 100)

Food Item	Income Group			Household Size Group		
	I	II	III	I	II	III
	%					
Bakery	99.56	96.12	97.67	89.04	88.64	85.02
Beef	100.85	100.91	106.40	118.57	119.09	115.52
Cereal	109.09	94.90	106.54	85.91	97.03	107.65
Dairy	97.09	109.20	95.76	92.84	96.14	91.70
Eggs	90.81	90.46	76.68	97.13	91.39	94.26
Fish	95.18	103.73	87.94	99.79	86.87	77.62
Fruits (F)	89.49	107.96	98.57	105.37	100.48	100.81
Fruits (P)	99.49	96.12	97.67	89.04	88.64	85.02
Milk	95.93	102.57	80.77	95.12	100.89	114.41
Pork	112.61	99.79	125.03	109.17	111.68	113.86
Poultry	103.28	97.81	101.25	117.89	105.09	113.75
Sugar	100.89	99.33	98.17	87.59	85.51	84.66
Vegetables (F)	103.81	95.71	103.65	90.40	88.68	83.67
Vegetables (P)	93.76	101.85	108.20	103.98	114.24	105.13
All Food	116.99	127.62	153.15	183.73	244.81	331.08

Note: Income group: I = $10,000-$19,999; II = $20,000-$34,999; III = Over $34,999. Household size group: I = two-members; II = three to four members; III = over four members. F and P denote fresh and processed, respectively.

$$m_1 = y \ , \tag{14a}$$

$$m_1 = y - y_k^o \quad \text{if } y > y_k^o \tag{14b}$$

$$= 0 \quad \text{if } y \leq y_k^o \tag{14c}$$

$$k = 2, 3, \ldots, K \tag{14d}$$

where y_k^o are specific values of household income exogenously given, which in (14a-14d) represent the upper limit of the annual household income of kth income group.

With the transformed variables in Equations (14a-14c), the household expenditure model (13) is reformulated for estimation as:

Table 6. Mean Household Food Expenditures by Income Group: Annualized Values for U.S. Households

Food Item	Income Groups			
	Under $10,000	$10,000-$19,999	$20,000-$34,444	Over $34,999
	----------	----------	% ----------	----------
Bakery	164.32	193.44	242.84	278.72
Beef	378.04	494.52	530.40	658.32
Cereal	124.80	147.68	155.48	159.69
Dairy	166.40	192.40	226.20	267.28
Eggs	71.24	73.84	74.78	93.08
Fish	157.56	179.40	204.51	251.16
Fruits (F)	135.72	144.04	159.64	190.58
Fruits (P)	114.92	126.36	141.44	157.64
Milk	169.52	169.53	203.32	209.30
Pork	265.20	303.16	341.12	336.44
Poultry	208.00	232.44	250.64	271.44
Sugar	135.20	148.20	171.60	169.68
Vegetables (F)	125.94	137.28	143.52	164.32
Vegetables (P)	102.44	106.44	121.68	119.13
All Food	2,444.00	2,888.60	3,160.04	3,768.44

Note: F and P denote fresh and processed, respectively.

$$E_i = \alpha + \beta_1 m_{1i} + \beta_2 m_{2i} + \beta_3 m_{3i} + \beta_4 m_{4i} + \pi_1 z_i + \pi_2 g_i + \varepsilon_i \quad (15)$$

where β_1 is the "main" income effect and β_k $(k > 1)$ is the change in the income effect between the kth and (k+1)th income group. The other coefficients, π_1, π_2 have the usual interpretations.

Household size distributional effects are estimated separately by making similar transformations (14a-14d). The joint estimation of income, household size, and age of head distributional effects is not possible with the existing data set.

Let the annualized mean expenditures for the gth income group be:

$$\bar{E}_g = \alpha + \Sigma \tau_g y_g, \quad g, k = 1,2,3,4 \quad (16)$$

and

$$\tau_1 g_i = \Sigma \beta_k$$

Table 7. Mean Household Food Expenditures by Household Size Group: Annualized Values for U.S. Households

Food Item	Income Group			
	Under $10,000	$10,000-$19,999	$20,000 $34,444	Over $34,999
	----------	----------	% ----------	----------
Bakery	109.20	177.32	234.00	307.79
Beef	243.88	439.40	514.28	698.36
Cereal	88.92	119.08	143.94	223.60
Dairy	132.08	183.14	218.24	270.40
Eggs	52.00	66.56	75.92	110.76
Fish	147.16	186.00	188.76	217.20
Fruits (F)	108.16	140.40	163.96	193.44
Fruits (P)	108.99	125.94	143.42	180.70
Milk	88.72	130.00	202.80	305.76
Pork	169.42	279.76	308.88	461.24
Poultry	158.08	208.00	236.29	340.08
Sugar	89.44	124.80	139.05	169.62
Vegetables (F)	73.84	100.88	120.17	144.04
Vegetables (P)	108.16	141.96	160.32	187.10
All Food	2,401.87	2,408.20	3,187.13	4,310.84

Note: F and P denote fresh and processed, respectively.

where τ_g is the marginal propensity to spend for the gth income group. Then within households in the gth income group, the aggregate food expenditures, E_o, is

$$E_o = \Sigma n_g \bar{E}_g \tag{17}$$

and

$$\tau_1 g_i = \Sigma \beta_k \ .$$

By substituting the projected values of n for 1990 and 2000 in (17), projections of changes in aggregate households expenditures for total food and the selected food groups are expressed as

$$PE_{it} = \{(E_{it} - E_{io})/E_{io}\}*100, \ t = 1990, \ 2000 \tag{18}$$

where PE_{it} is the projected percentage change from 1982 of the aggregate expenditures on the ith item in the t-th year. Similar procedures are followed in the case of changes in the household size distribution.

Our projections assume, if only implicitly, that (a) supply conditions remain the same; (b) relative food prices remain the same; (c) public policy and other factors which influence food demand such as income, advertising, promotions, and taste also remain the same.

Empirical Results

The estimated parameters of the U.S. household food expenditures are reported in Tables 8 and 9 for total food and individual food groups, respectively. Table 8 contains results for the income distribution equations and Table 9 the household size distribution equations.

In general, the "main" income and households size effects have the expected signs, and there is considerable evidence of changes in the income and household size effects across income or household size groups.

With the emphasis on projections, projected aggregate household food expenditures expressed in terms of percentage changes from 1982 levels are contained in Tables 10 and 11. The projections are for the selected food groups and total food (grocery). At current income levels but with changes in household income distributions, aggregate total household food expenditures are projected to increase by approximately 7.5 percent in 1990 and 18.2 percent in the year 2000. Moderate increases (less than 15 percent) are projected for beef, eggs, fresh fruits, fresh vegetables, and processed fruits in 1990. Considerable increases (15-50 percent) are projected for bakery, fish, poultry, processed vegetables and sugar. Much higher increases (more than 50 percent) are projected for cereal and dairy in 1990. However, the only decrease (-10.14 percent) is projected for milk.

Projections to the year 2000 bear the some basic similarities with those for 1990. More specifically, eight of the food groups: bakery, beef, eggs, fresh fruits, fresh vegetables, pork, processed fruits and sugar have projected changes of less than 50 percent. Fish, poultry and processed vegetables are projected to increase by over 50 percent but less than 100 percent in the year 2000. Dairy and cereal are projected to increase by more than 100 percent in the year 2000. Finally, aggregate expenditures on milk are projected to decrease by approximately 20.5 percent in the year 2000.

Just for the sake of simple comparison, Table 12 contains a summary of actual changes in aggregate expenditures expressed as percentages of 1960 levels. Although these bear some structural similarities to our projections, the obvious differences emphasize the nature of our projections.

Table 8. Estimated Coefficients of U.S. Household Food Expenditures (t-ratios in parentheses)

Variable	Bakery	Beef	Cereal	Dairy	Eggs
Constant	1.373	-0.069	0.0773	1.3497	0.635
	(1.2)**	(-0.1)	(1.1)**	(1.7)*	(2.4)*
Income (β_1)	0.000183	0.00035	0.000055	0.000036	0.000028
	(1.7)*	(1.8)*	(0.9)	(0.5)	(1.1)**
Income (β_2)	-0.00019	-0.00012	-0.000038	0.000099	-0.00004
	(-0.9)	(-0.4)	(-0.4)	(0.9)	(-1.0)**
Income (β_3)	-0.000078	-0.0004	-0.0001	-0.000125	-0.000015
	(-0.6)	(-1.6)*	(-1.4)*	(-1.4)*	(-1.5)*
Income (β_4)	0.000036	0.00014	0.000042	-0.000011	0.000012
	(1.0)**	(2.2)*	(2.1)*	(-0.5)	(1.5)*
Size (γ_1)	1.02575	1.32958	0.73812	0.64723	0.24957
	(7.4)*	(5.2)*	(9.6)*	(6.9)*	(7.8)*
Age (γ_1)	-0.00417	0.01783	-0.00691	0.000435	-0.00306
	(-0.3)	(0.7)	(-0.9)	(0.1)	(-0.9)
R^2	0.13	0.11	0.18	0.15	0.12

Variable	Fish	Fruits(F)	Fruits(P)	Milk	Pork
Constant	0.7651	0.9005	0.82301	-0.117112	0.78402
	(0.9)	(1.2)*	(1.3)*	(-0.1)	(0.5)
Income (β_1)	-0.000002	0.000033	0.000073	0.000013	0.000185
	(-0.1)	(0.5)	(1.3)*	(0.1)	(1.3)*
Income (β_2)	0.000115	0.000006	-0.000026	0.000047	-0.000205
	(0.9)	(0.1)	(-0.3)	(0.3)	(-0.9)
Income (β_3)	-0.000144	-0.00004	-0.000096	-0.000023	0.000070
	(-1.5)*	(-0.6)	(-1.4)*	(-0.2)	(0.4)
Income (β_4)	0.000006	0.000007	0.000033	-0.000043	0.000030
	(0.2)	(0.3)	(1.7)*	(-1.2)**	(0.6)
Size (γ_1)	0.262621	0.59346	0.489392	1.216249	1.021067
	(2.7)*	(7.1)*	(6.6)	(9.1)*	(5.7)*
Age (γ_1)	0.011176	0.002213	0.003872	0.015251	-0.001674
	(1.1)**	(0.2)	(0.5)	(1.1)**	(-0.1)
R^2	0.04	0.11	0.18	0.15	0.12

Table 8. (Continued)

Variable	Poultry	Veg(F)	Veg(P)	Sugar	Eggs
Constant	0.74258	0.823009	0.57385	0.562139	10.32196
	(0.8)	(1.2)**	(1.2)**	(0.8)	(1.4)*
Income (β_1)	0.000035	0.000073	0.000019	0.000086	0.001073
	(0.4)	(0.5)	(0.4)	(1.4)*	(1.6)*
Income (β_2)	0.000042	-0.000026	0.000030	-0.000045	-0.000228
	(0.3)	(0.1)	(0.4)	(-0.5)	(-0.2)
Income (β_3)	-0.000137	-0.000096	-0.000096	-0.000067	-0.001316
	(-1.3)*	(-0.6)	(-1.7)*	(-0.9)	(-1.6)*
Income (β_4)	0.000035	0.000033	0.000019	0.000006	0.000317
	(1.2)*	(0.3)	(1.3)*	(0.3)	(1.4)*
Size (γ_1)	0.641362	0.489392	0.381129	0.369310	9.381595
	(5.8)*	(7.1)*	(6.6)*	(4.6)*	(10.9)*
Age (γ_1)	0.005910	0.003872	0.000743	0.005986	0.045623
	(0.5)	(0.2)	(0.1)	(0.6)	(0.5)
R^2	0.08	0.11	0.10	0.15	0.24

Note: F and P denote fresh and processed, respectively. β_1 is the income effect; β_2, β_3, β_4 are the income effects at $10,000, $20,000 and $35,000, respectively.

*significant at 10% level.

**significant at 15% level.

Table 9. Estimated Coefficients of U.S. Household Food Expenditures (t-ratios in parentheses)

Variable	Bakery	Beef	Cereal	Dairy	Eggs
Constant	1.4456	-1.51455	1.00251	0.63357	0.513955
	(1.1)**	(-0.6)	(1.4)*	(0.7)	(1.7)*
Size (β_1)	1.67478	3.70589	0.900615	1.346066	0.513471
	(2.4)*	(2.9)*	(2.4)*	(2.9)*	(3.2)*
Size (β_2)	-0.50161	-2.54602	-0.235468	-0.58603	-0.35182
	(-0.6)	(-1.5)*	(-0.5)	(-0.9)	(-1.7)*
Size (β_3)	-0.36839	1.97962	0.720923	0.1924	0.37078
	(-0.4)	(1.1)**	(-1.3)*	(-0.3)	(1.6)*
Size (β_4)	-0.16194	-3.92197	-1.061532	-1.013227	-0.46546
	(-0.2)	(-2.1)*	(-1.9)*	(-1.5)*	(-1.9)*
Age (γ_1)	-0.00504	0.01164	-0.008201	-0.002206	-0.00394
	(-0.4)	(0.5)	(-1.1)**	(0.2)	(-1.2)**
Income (γ_1)	-0.000019	0.00008	-0.000007	0.000016	-0.000005
	(-0.9)	(2.4)*	(-0.7)	(2.2)*	(-1.8)*
R^2	0.13	0.11	0.18	0.14	0.12

Variable	Fish	Fruits(F)	Fruits(P)	Milk	Pork
Constant	-0.05394	0.51311	0.41445	0.47859	-0.13121
	(-0.1)	(0.7)	(0.8)	(0.4)	(-0.1)
Size (β_1)	1.1449	1.10752	0.90293	0.71086	0.87662
	(2.4)*	(2.7)*	(3.2)*	(1.1)**	(2.1)*
Size (β_2)	-1.19616	-0.75618	-0.42131	1.25356	-0.87920
	(-1.9)*	(-1.4)*	(-1.1)**	(1.4)*	(-0.8)
Size (β_3)	0.36793	0.52652	0.30382	-0.88929	0.51964
	(0.5)	(0.9)	(0.8)	(-0.9)	(1.2)**
Size (β_4)	0.00232	-0.33675	-0.95689	-0.69816	-0.91660
	(0.1)	(-0.5)	(-2.3)*	(-0.7)	(-2.2)*
Age (γ_1)	0.00430	-0.00128	-0.00027	0.02009	1.00155
	(0.4)	(-0.1	(-0.09)	(1.5)*	(0.1)
Income (γ_1)	0.000007	0.000021	-0.000001	0.000004	0.000053
	(1.2)**	(1.5)*	(0.02)	(0.2)	(2.2)*
R^2	0.04	0.12	0.13	0.16	0.11

Table 9. (Continued)

Variable	Poultry	Veg(F)	Veg(P)	Sugar	All Food
Constant	-0.02926	0.91228	0.09133	0.39889	4.67553
	(-0.1)	(1.3)*	(0.2)	(0.5)	(0.6)
Size (β_1)	1.56096	0.89213	0.85129	1.04668	18.23476
	(2.9)*	(2.4)*	(2.9)*	(2.6)*	(4.3)*
Size (β_2)	-1.35339	-0.67885	-0.37937	-0.87087	-9.50296
	(-1.9)*	(-1.4)*	(-1.0)	(-1.7)*	(-1.7)*
Size (β_3)	2.10496	0.46965	-0.34420	0.81672	7.76758
	(2.8)*	(0.9)	(-0.8)	(1.4)*	(1.3)*
Size (β_4)	-2.57772	-0.07116	-0.06617	-1.06071	-15.17335
	(-3.2)*	(-0.1)	(0.2)	(-1.8)*	(-2.4)*
Age (γ_1)	0.00071	-0.00046	-0.00027	0.00089	0.01670
	(0.1)	(-0.1)	(-0.6)	(0.1)	(0.2)
Income (γ_1)	0.000009	0.000021	-0.000001	0.000007	0.000233
	(0.7)	(2.1)*	(0.2)	(0.6)	(1.9)*
R^2	0.09	0.11	0.11	0.06	0.26

Note: F and P denote fresh and processed, respectively. β_1 is the household size effect; β_2, β_3, β_4 are changes in the household size effects at household sizes 1, 2 and 4, respectively.

*significant at 10% level.

**significant at 15% level.

Table 10. Projected Percentage Changes in Aggregate Household Food Expenditures for Given Changes in Household Income Distributions (Base Year = 1982)

Food Category	Projections to: 1990	2000
	---------%	---------
Bakery	17.55	35.61
Beef	10.11	25.68
Cereal	203.41	328.99
Dairy	77.91	143.45
Eggs	11.63	26.44
Fish	27.31	52.61
Fruits (F)	10.28	22.03
Fruits (P)	8.33	20.67
Milk	-10.14	-20.52
Pork	17.85	35.60
Poultry	28.70	35.63
Sugar	18.17	36.28
Vegetables (F)	8.33	20.63
Vegetables (P)	40.92	74.84
Total Food	7.45	18.61

Note: F and P denote fresh and processed, respectively.

Table 11. Projected Changes in Aggregate Household Food Expenditures for Given Changes in Household Size Distributions (Base Year = 1982)

Food Category	Projections to: 1990	2000
	---------%--------	
Bakery	-0.15	7.92
Beef	22.84	44.25
Cereal	5.38	16.47
Dairy	9.05	22.30
Eggs	9.92	23.95
Fish	-13.65	-14.96
Fruits (F)	2.62	12.89
Fruits (P)	10.28	89.85
Milk	-5.53	-1.08
Pork	8.75	21.50
Poultry	16.31	33.45
Sugar	14.17	23.76
Vegetables (F)	7.76	21.18
Vegetables (P)	-3.38	2.61
Total Food	12.14	27.24

Note: F and P denote fresh and processed, respectively.

References

Adrian, J., and Daniel, R., "Impact of Socioeconomic Factors on Consumption of Selected Food Nutrients in the United States," American Journal of Agricultural Economics, 58(1976):31-38.

Blanchiforti, L.; Green, R.; and Lane, S., "Income and Expenditure for Relatively More Nutritious versus Relatively Less Nutritious Food Over the Life Cycle," American Journal of Agricultural Economics, 63(1981):255-260.

Becker, G. S., "A Theory of the Allocation of Time," Economic Journal, 75(1965):493-517.

Davis, Carlton G., "Linkages Between Socioeconomic Characteristics, Food Expenditure Patterns, and Nutritional Status of Low Income Households: A Critical Review," American Journal of Agricultural Economics, 64(1982):1017-1025.

De Tray, Dennis N., "Child Quality and the Demand for Children," Journal of Political Economy, 81(1973):S70-S95.

Table 12. Computed Changes in Aggregate Household Food Expenditures (Base Year = 1982).

Food Category	Projections to: 1990	2000
	-------%-------	
Bakery	NA	NA
Beef	51.3	53.9
Cereal	NA	NA
Dairy	-2.7	5.5
Eggs	3.9	2.9
Fish	37.4	77.7
Fruits (F)	-1.8	19.5
Fruits (P)	16.9	-2.3
Milk	3.7	6.7
Pork	5.9	19.8
Poultry	64.9	128.3
Sugar	18.3	8.0
Vegetables (F)	6.2	28.8
Vegetables (P)	33.9	46.9
Total Food	69.7	427.04

Note: F and P denote fresh and processed, respectively.

Gronau, Reuben, "The Effect of Children on the Housewife's Value of Time," Journal of Political Economy, 81(1973):S200-S201.

Poirier, D. J., The Econometrics of Structural Change With Special Emphasis on Spline Functions, Amsterdam: North Holland Publishing Company, 1976.

Smallwood, D., and Blaylock, J., "Impact of Household Size and Income on Food Spending Patterns," Washington, D.C.: U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service Technical Bulletin 1650. May 1981.

U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 952, Projections of the Population of the United States, by Age, Sex, and Race: 1983 to 2080, Washington, D.C.: U.S. Government Printing Office, 1984.

West, D., and Price, D. W., "The Effects of Income, Assets, Food Programs and Household Size on Food Consumption." American Journal of Agricultural Economics, 58(1976):725-730.

Willis, Robert J., "A New Approach to the Economic Theory of Fertility Behavior," Journal of Political Economy, 81(1973):S14-S64.