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ABSTRACT

Household income, size, composition, location of residence, race, education, and employment status determine the percentage of income a household spends for food. This study develops a model that measures and reveals relationships among these household characteristics. The model can be applied to predict future shifts in consumer demand for food pricing and consumption movements.

Keywords: Adult equivalent scales, household food expenditures, household size and composition, income, socioeconomic characteristics.

CONTENTS

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SUMMARY

Food price and consumption forecasting models can be improved by including demographic and socioeconomic factors of the population. An econometric model is presented that illustrates the effect these characteristics have on the amount of household income spent for food.

Adult equivalent scales (AES) develop a means to analyze the impact of household size and composition on household food purchase decisions. AES makes it possible to pool data from households differing by composition, to examine the effects of a changing age distribution of the population on aggregate food demand, and to compare expenditures among high and low income groups. To interpret the results, marginal propensities to spend and expenditure income elasticities are provided that isolate the net impact of income and other socioeconomic characteristics.

Food purchasing behavior is influenced by location of residence (including region and urbanization), race, education, and employment status. Analyzing each characteristic separately reveals that households in the Northeast spend the most on food while their counterparts in the South spend the least. Rural nonfarm households also spend less on food than their counterparts in either an urban or rural farm locality. Similarly, AES indicates that female children consume less total food, vegetables, beef and pork, and fruit, but consume more grain and dairy products than middle-aged females.

These results show that socioeconomic and demographic characteristics are important factors in determining household consumption patterns, and provide a sound basis for economic policy in regard to future food price and consumption movement predictions.

Household Food Consumption Patterns in the United States

Larry E. Salathe and Rueben C. Buse 1/

INTRODUCTION

The socioeconomic characteristics of the U.S. population have changed over the past couple of decades. These changes include an increase in the average age of the population, growth in the number of working females, a decline in average family size, movements of families from central cities to suburbs, and an increase in disposable income. Little is known regarding the influence of these changes on expenditure behavior.

This report presents a comprehensive behavioral model that isolates the net impact of income and other socioeconomic characteristics on household food expenditures. 2/ The model can be applied to predict future shifts in consumer demand for food which result from changes in the socioeconomic characteristics of the domestic population. Such a model will be of considerable interest to economists attempting to predict future food price and consumption movements. Since the model focuses on the household as the decision unit, the model will also be of interest to economists and policymakers who want to evaluate the influence of existing and proposed legislation that affects household income. The model is particularly well suited for evaluating the impact of income taxation policies and welfare programs on household food purchases.

Data collected in the 1965 U.S. Department of Agriculture's household food consumption survey (HFCS) are used to verify the model, because it is the most comprehensive survey of its nature (9). Food prices have changed dramatically since 1965, causing changes in consumer demand for food. However, the differences discussed here for households varying by race, location, size and composition, income, and other characteristics are not expected to change when the model is applied to new data.

Economic theory suggests that the percentage of income spent on total food declines as average income rises. As shown in table 1, the proportion of weekly income spent on food by the least educated head of household was nearly twice as high as the proportion of income devoted to food by the most educated group. 3/ Similar differences were observed for other household characteristics. Obviously, such things as education, income level, race, region, urbanization, and employment status are all related and the net impact of each on a particular food expenditure

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1/ Salathe is an agricultural economist with the U.S. Department of Agriculture's Economics, Statistics, and Cooperatives Service, and Buse is a professor of agricultural economics at the University of Wisconsin.

2/ A similar model based on Canadian data is presented in (6). (Underscored numbers in parentheses refer to references listed at the end of this report.)

3/ In source (9), information on race, education, and employment status were recorded only for household's female head. Thus, it has been assumed that race and education level of the head of household would be similar regardless of the individual's sex.

Table 1--Average income, meals eaten at home, and proportion of income spent on foods for various partitions of households

Characteristic	Households surveyed	Average income per week 1/	Proportion of meals eaten at home	Proportion of income spent on: Total food	Grain products	Vegetables	Beef and pork	Dairy products	Fruits
	Number	Dollars							
Sample	5,592	120	0.774	0.244	0.029	0.030	0.054	0.031	0.020
Region:									
Northeast	1,389	131	.792	.247	.029	.028	.055	.032	.021
North Central	1,567	125	.776	.237	.027	.029	.055	.030	.020
South	1,821	102	.766	.257	.031	.033	.055	.032	.019
West	815	130	.755	.226	.026	.027	.049	.029	.021
Urbanization:									
Urban	3,916	127	.778	.228	.027	.027	.052	.028	.019
Rural nonfarm	1,324	106	.766	.271	.033	.034	.056	.036	.022
Rural farm	352	97	.753	.338	.040	.046	.077	.046	.029
Race:									
White	4,818	126	.760	.234	.027	.029	.052	.030	.020
Black	652	78	.858	.336	.042	.038	.076	.035	.024
Other	122	105	.851	.304	.038	.037	.059	.039	.029
Education:									
0-7 years	837	68	.811	.314	.040	.039	.065	.038	.022
8-11 years	1,074	87	.793	.298	.036	.038	.065	.037	.024
12-15 years	2,736	130	.771	.245	.029	.029	.056	.031	.020
16 or more years	945	175	.728	.182	.020	.022	.041	.023	.017
Female head:									
Employed	1,654	131	.738	.221	.026	.027	.050	.027	.018
Not employed	3,938	115	.789	.254	.030	.031	.056	.033	.021

1/ Income after taxes.

is not clear. The econometric model disentangles these effects and properly attributes to each variable the net impact of that characteristic on household food purchases.

THE ECONOMETRIC MODEL

In order to estimate the effects of household income, size and composition, and other socioeconomic characteristics on household food expenditures, food expenditures are expressed as a function of these characteristics. Thus, the household's expenditure function is assumed to be of the following mathematical form:

(1) $E_{ik} = E_i(Y_k, A_k, Z_k)$

where E_{ik} is the k^{th} household's weekly expenditure on the i^{th} commodity, Y_k is the k^{th} household's average 1964-65 weekly income, A_k is a variable reflecting the k^{th} household's size and composition, and Z_k is a set of proxies for the k^{th} household's tastes and preferences. The above relationship is commonly termed an Engel function after Ernst Engel, a German statistician, who first used budget surveys to study consumer behavior.

A number of approaches have been used by economists to measure the impact of household size and composition on household expenditure behavior. The oldest approach is to stratify the sample data by the number and age of persons in the family (4). This generally results in the researcher having to estimate many equations for each expenditure group. The approach used in this study is to standardize family size and composition by weighting each family member (1). These weights generally reflect the individual's age, but this weight may vary from one commodity to the next. In the final analysis, each weight is simply a device that specifies the needs, requirements, or expenditures of an individual of a particular age and sex as a proportion of a standard or base person. Generally, the base is taken to be an adult male; hence, the name adult equivalent scale (AES).

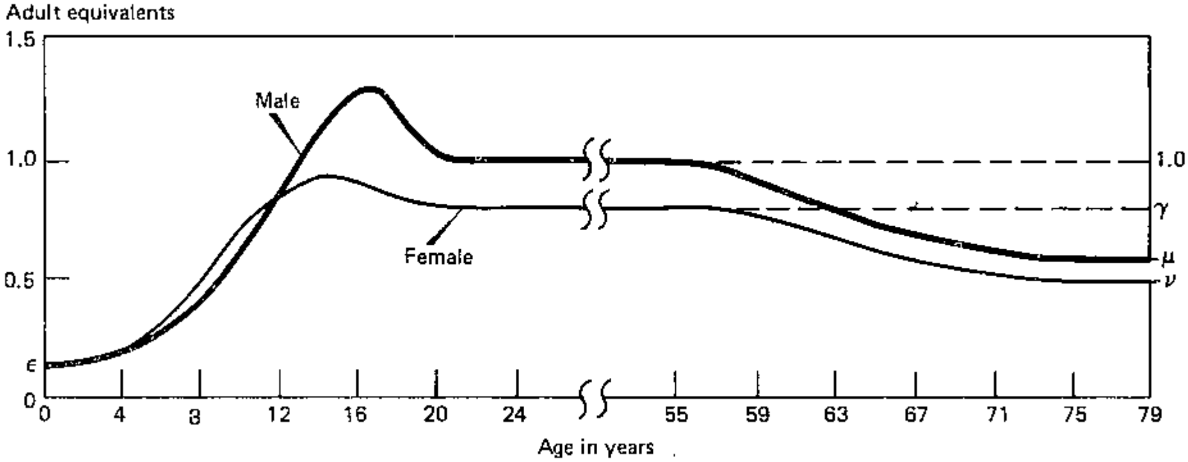
Conceptually, an adult equivalent scale can be written as:

(2) $A_{ijk} = S_i(a_j, s_j)$

where A_{ijk} is the scale value for commodity i for the j^{th} individual in the k^{th} household possessing an age of a_j and sex s_j. In order to make the scale function approximate the way a particular individual affects household purchases throughout that person's life span, certain restrictions are placed on the scale function. The scale is assumed to take the same value at birth for males and females. After birth, the scale is allowed to be different for males than for females, reflecting differences in consumption patterns between the sexes. Furthermore, the scale is not assumed to be monotonically increasing or decreasing from age zero to maturity. It may reach a local maximum or minimum and either decline or increase to some value at biological and psychological maturity (e.g., 20 years), remain constant until the climateric years (e.g., 55 years) in which the scale function begins to decline or increase, and finally become constant in old age (e.g., 75 years). Figure 1 illustrates a hypothetical scale for a food item for males and females. Setting s_j=1 for males and s_j=2 for females, the properties of the scale function $S(a_j,s_j)$ (commodity subscript (i) is suppressed) can be written as:

(I) $S(0,1) = S(0,2) = \varepsilon$
(II) $S(20,1) = S(55,1) = 1$
(III) $S(20,2) = S(55,2) = \gamma$
(IV) $S(75,1) = \mu$
(V) $S(75,2) = \upsilon$

Figure 1–A hypothetical scale for a food commodity



The first property indicates that the male and female scales are equal at birth. The second and third properties indicate that the scale function equals 1 for males and γ for females within the age interval 20 to 55 years. The final two properties require the AES function yield values of μ and ν for males and females, respectively, if they are 75 years of age and older. In addition, the AES function is assumed to be a continuous function of age.

The AES function is derived by using the previously mentioned properties and assuming the scale function can be represented as cubic equations of age with intervals 0 to 55 and greater than 55 for males and females. Assuming the general form of the scale function is given by:

$$(3)\quad S(a_j, s_j) = W_{0s_j} + W_{1s_j} a_j + W_{2s_j} a_j^2 + W_{3s_j} a_j^3$$

the properties of the scale function may be introduced into equation 3 to yield the following four equations: 4/

(3a)--males 0 to 55 years; $S(a_j^*, s_j) = \varepsilon + \delta a_j^* - (0.1\delta + 0.0075\varepsilon - 0.0075) a_j^{*2} + (0.0025\delta + 0.00025\varepsilon - 0.00025) a_j^{*3}$

(3b)--males over 55; $S(a_j^*, s_j) = 1 + (0.0075\mu - 0.0075) a_j^{*2} + (0.00025 - 0.00025\mu) a_j^{*3}$

(3c)--females 0 to 55; $S(a_j^*, s_j) = \varepsilon + \xi a_j^* - (0.1\xi + 0.0075\varepsilon - 0.0075\gamma) a_j^{*2} + (0.0025\xi + 0.00025\varepsilon - 0.00025\gamma) a_j^{*3}$

(3d)--females over 55; $S(a_j^*, s_j) = \gamma + (0.0075\nu - 0.0075\gamma) a_j^{*2} + (0.00025\gamma - 0.00025\nu) a_j^{*3}$

4/ See (2) for the derivation of these equations in detail.

where a_j* is the recoded age of persons in the household defined as:

$$a_j* = a_j \text{ if } a_j \leq 20$$

$$a_j* = 20 \text{ if } 20 \leq a_j \leq 55$$

$$a_j* = a_j - 55 \text{ if } 55 \leq a_j \leq 75$$

$$a_j* = 20 \text{ if } a_j \geq 75$$

Equations 3a to 3d give AES values for each household member. By summing these equations across all household members and combining like terms, the following expression can be derived for the number of adult equivalents in the household:

$$(4) \quad \sum_{j=1}^{n} A_{jk} = A_k = P_k + \gamma Q_k + \varepsilon R_k + \delta S_k + \xi T_k + \mu U_k + \nu V_k$$

where P_k, Q_k, R_k, S_k, T_k, U_k, and V_k are as follows:

$$(4a) \quad P_k = \sum_{j=1}^{M_1} (0.0075a_j*^2 - 0.00025a_j*^3) + M_2 - \sum_{j=1}^{M_2} (0.0075a_j*^2 - 0.00025a_j*^3)$$

$$(4b) \quad Q_k = \sum_{j=1}^{F_1} (0.0075a_j*^2 - 0.00025a_j*^3) - \sum_{j=1}^{F_2} (0.0075a_j*^2 - 0.00025a_j*^3) + F_2$$

$$(4c) \quad R_k = M_1 - \sum_{j=1}^{M_1} (0.0075a_j*^2 - 0.00025a_j*^3) - \sum_{j=1}^{F_1} (0.0075a_j*^2 - 0.00025a_j*^3) + F_1$$

$$(4d) \quad S_k = \sum_{j=1}^{M_1} (a_j* - 0.1a_j*^2 + 0.0025a_j*^3)$$

$$(4e) \quad T_k = \sum_{j=1}^{F_1} (a_j* - 0.1a_j*^2 + 0.0025a_j*^3)$$

$$(4f) \quad U_k = \sum_{j=1}^{M_2} (0.0075a_j*^2 - 0.00025a_j*^3)$$

$$(4g) \quad V_k = \sum_{j=1}^{F_2} (0.0075a_j*^2 - 0.00025a_j*^3)$$

where M_1 and F_1 are defined as the number of males and females in the k^{th} household between 0 and 55 years of age, respectively, and M_2 and F_2 are defined as the number of males and females in the k_{th} household 55 years old or older, respectively. The scale parameters ε, γ, δ, ξ, μ, and ν may vary among expenditure groups and will be estimated by substituting the expression for A_k given in equation 4 into the household's expenditure function (equation 1).

Particular values or combinations of values of the AES parameters have special significance. For example, if the value of ε, γ, μ, and ν are all equal to 1 and $\delta = \xi = 0$, equation 4 collapses to a household size specification. If $\mu = \nu$, $\delta = \xi$, and $\gamma = 1$, the sex of the household's members is statistically not important in explaining household expenditure patterns.

Finally, the household's expenditure behavior is hypothesized to be related to the household's tastes and preferences. It is assumed these tastes and preferences are determined by various socioeconomic characteristics, such as the household's race, and location of residence.

Economic theory sheds little light on the precise manner in which socioeconomic characteristics affect household expenditure behavior. Thus, empirical analyses previously conducted to determine the appropriate specifications of the household's socioeconomic characteristics consisted of estimating Engel functions and analyzing the resultant regression residuals (8). This procedure suggested that the marginal propensity to spend on food is related to the race and education of the head of household and whether the female head was employed outside the home. Interactions were also observed between family size and region, urbanization, and race. 5/

Initially in this study, a linear relationship was hypothesized between household expenditures for each food item, the interaction variables, the number of adult equivalents in the household (A_k), and the percentage of meals eaten at home (M). 6/ However, if the impact of adult equivalents is linear, it presumes that a change in food expenditure due to a change in household size is independent of the size of the household. There is evidence to suggest that such a restriction is not consistent with observed household expenditure behavior (7). Therefore, the square of the number of adult equivalents (A_k^2) and its interaction with region, urbanization, and race were included as additional explanatory variables in the household Engel function.

Previous research also indicates household food expenditures vary nonlinearly with household income, and that the proportion of income spent on food varies directly with the number of adult equivalents in the household. As a result, household income squared (Y_k^2) and household income times the number of adult equivalents (Y_kA_k) were also included as independent variables in the Engel function.

In order to obtain estimates of the AES parameters ε, γ, δ, ξ, μ, and ν that are based on observed household expenditure behavior, equation 4 is substituted for A_k in equation 1. This substitution along with the inclusion of A_k^2 in the household Engel function requires that a nonlinear regression procedure be employed to obtain consistent estimates of the AES parameters. 7/ Furthermore, the high degree of correlation between A_k, A_k^2, Y_k, Y_k^2, and A_kY_k hampered the ability of the nonlinear regression algorithm to give a solution (3). Consequently, Y_k^2 and A_kY_k were dropped as independent variables from the nonlinear regression model. After estimates were obtained for the AES parameters (table 2) by using nonlinear regression, the number of adult equivalents were calculated for each household, A_k, by employing equations 4a to 4g. After these calculations were completed, Y_k^2 and A_kY_k were introduced into the Engel function and all parameters were reestimated by ordinary least squares (OLS) (appendix table 1).

Many of the variables included in the regression model are binary variables. Constraining the parameters of the binary variables in each stratification such that their weighted coefficients sum to zero permits the estimation of the marginal pro-

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5/ The categorical classifications of each socioeconomic characteristics are presented in the appendix figure 1.

6/ The percentage of meals eaten at home is included in the Engel function, since the 1965 HFCS did not include the money value of each food item consumed away from home.

7/ The k^{th} household $A_k = P_k + \gamma Q_k + \varepsilon R_k + \delta S_k + \xi T_k + \mu U_k + \nu V_k$ where ε, γ, δ, ξ, μ, and ν are unknown parameters. When A_k^2 is also included in the regression model, several estimates for each of these parameters will be obtained. These estimates will not be consistent unless all estimates for γ, for example, are constrained to be the same.

pensities to spend and the income-expenditure elasticities for any desired group in the sample. 8/

In estimating the OLS equations, the coefficients of the binary variables accounting for the impact of education, race, employment status, region, and urbanization were constrained so that the weighted sum across all subclassifications for every characteristic equalled zero. Under these conditions, the coefficients of the binary variables are interpreted as adjustments to the grand mean. From table 3, it is observed that weekly food expenditures are dependent upon the level of income and household size (i.e., the coefficients of income (Y, Y^2) and adult equivalents (A, A^2). For total food expenditures (table 3), the Engel function (with household subscript k suppressed) is:

$$(5) \quad E = 5.573 + 0.049Y - 0.000050Y^2 + 7.598A - 0.281A^2 + 0.00504AY$$

The estimated AES can be used to assess the impact of household size and composition (A) on household expenditures. Given the age and sex of an individual, an equivalent in terms of an adult male can be determined by using the scale equations 3a to 3d. Summing the scale values (previously mentioned) across all household members, the number of adult equivalents for selected household types by food group are presented in table 4.

It is easiest to interpret the results by examining the marginal propensities to spend and the expenditure-income elasticities. The marginal propensity to spend is defined as the additional food expenditure resulting from an increase in income of $1. The expenditure-income elasticity is defined as the percentage change in a particular expenditure associated with a 1-percent increase in household income. Taking the partial derivative of the expenditure equations in table 3 with respect to income, expressions for the marginal propensity to spend for each of the food expenditure categories are as follows:

$$(6a) \quad \text{Total food;} \quad \frac{\partial E}{\partial Y} = 0.0490 - 2(0.000050)Y + 0.00504A$$

$$(6b) \quad \text{Vegetables;} \quad \frac{\partial E}{\partial Y} = 0.0045 - 2(0.0000035)Y + 0.00022A$$

$$(6c) \quad \text{Grain products;} \quad \frac{\partial E}{\partial Y} = 0.0030 - 2(0.0000035)Y + 0.00025A$$

$$(6d) \quad \text{Beef and pork;} \quad \frac{\partial E}{\partial Y} = 0.0153 - 2(0.0000141)Y + 0.00139A$$

$$(6e) \quad \text{Dairy products;} \quad \frac{\partial E}{\partial Y} = 0.0041 - 2(0.0000047)Y + 0.00038A$$

$$(6f) \quad \text{Fruits;} \quad \frac{\partial E}{\partial Y} = 0.0060 - 2(0.0000065)Y + 0.00033A$$

We find that for a household consisting of two adult equivalents (A=2) having an average weekly income (Y) of $120, a $1 increment to weekly income would increase total food expenditures by 4.7 cents per week (i.e., 0.0490 - 2(0.000050)(120) +

8/ Suppose a region is broken down into four categories and B_1-B_4 denote the parameters associated with each region and N_1-N_4 denote the number of observations in each region. By utilizing the constraint $\sum_{i=1}^{4} B_i N_i = 0$, one B_i is eliminated from the regression model. However, the three B_i's estimated in the regression model can be used to derive the fourth and, thus, all four B_i's can be calculated. The appendix presents the parameter estimates from the regression model and the implied regression coefficient and its standard error for the excluded category in each stratification.

Table 2--Estimated adult equivalent scale parameters 1/

AES parameter	Total food	Vegetables	Grain products	Beef and pork	Dairy products	Fruits
ε	0.4470 (0.068)	0.4770 (0.105)	0.0265 (0.097)	0.3042 (0.100)	1.0488 (0.130)	1.2028 (0.214)
γ	.7667 (.044)	.9903 (.075)	.7099 (.059)	.6623 (.061)	.7081 (.069)	1.2512 (.156)
μ	.7819 (.069)	.8559 (.104)	.7789 (.097)	.8395 (.109)	.7014 (.098)	1.5376 (.218)
ν	.4939 (.056)	.5583 (.084)	.6109 (.080)	.2607 (.088)	.6485 (.083)	1.2007 (.173)
δ	.0101 (.023)	-.0107 (.035)	.3263 (.040)	-.0711 (.032)	.0012 (.042)	-.1036 (.066)
ξ	.0152 (.023)	.0056 (.036)	.2893 (.036)	-.0348 (.033)	-.0114 (.042)	-.1811 (.068)

1/ Standard errors presented in parentheses.

Table 3--The average household coefficients for the Engel function 1/

Expenditure	Constant 2/	Coefficients				
		Y	$Y^2 \cdot 10^{-3}$	A	A^2	$AY \cdot 10^{-2}$
Total food	5.573	0.0490	-0.0500	7.598	-0.281	0.504
Vegetables	.741	.0045	-.0035	.902	-.031	.022
Grain products	.706	.0030	-.0035	.914	-.024	.025
Beef and pork	1.271	.0153	-.0141	1.623	-.048	.139
Dairy products	.653	.0041	-.0047	1.090	-.052	.038
Fruits	.200	.0060	-.0065	.489	-.019	.033

1/ From appendix table 1 assuming households consume all their meals at home (i.e., M = 1.00). The coefficients can be interpreted as the dollar per week change in household expenditures associated with a one-unit change in the corresponding independent variable, A or Y.

2/ M and constant are individual values given in appendix table 1, but they were added together to be the overall constant indicated here.

0.00504(2)). Similarly, a $1 increase to a $120 weekly income for a household consisting of four adult equivalents would increase total weekly food expenditures by 5.7 cents per week. Table 5 contains the estimated marginal propensities to spend and corresponding implied income-expenditure elasticities by food expenditure categories for the average household in the sample consisting of two and four adult equivalents. The expenditure income elasticities are obtained by multiplying each marginal propensity to spend by the corresponding inverse of proportion of income spent on total food for each food category given in table 1.

Given the coefficients in table 3 or appendix table 1, the Engel equations (equation 5) can be collapsed to exclude all but those variables of primary interest. For example, to obtain the total food expenditure equation for an average sample household in the West, the coefficients WEST*A (.4933) and WEST*A^2 (-.0888) must be added to the parameters of A (7.5979) and A^2 (-.2813), respectively. This addition yields:

$$(7)\quad E = 5.573 + 0.0490Y - 0.000050Y^2 + 8.091A - 0.370A^2 + 0.00504AY$$

Evaluating equation 7 at the mean income of $130 per week for households residing in the West and combining like terms yields:

$$(8)\quad E = 5.573 + 0.0490(130) - 0.000050(130)^2 + 8.091A - 0.370A^2 + 0.00504A(130)$$

$$E = 11.098 + 8.764A - 0.370A^2$$

The equation expresses the relationship between total household food expenditures and the number of adult equivalents in the household assuming: (1) the household resides in the West, (2) the household possesses the average income for households in the West, and (3) all meals are consumed at home.

Following the same procedure, equations expressing food expenditures as a function of A, the number of adult equivalents in the household, are derived for the other regions, urbanizations, and races (table 6). Graphs of the relationship for each region and urbanization are presented in figures 2a to 2f and 3a to 3f, respectively. Examination of table 6 illustrates that household food expenditures vary by region, urbanization, and race, and can be compared among different socioeconomic groups for selected foods.

The exact relationship between food expenditures and household size and composition is multidimensional. Since the coefficients are additive, the relationship between household size and food expenditure can be obtained by simply summing the appropriate A and A^2 parameters. For example, the change in food expenditures caused by the addition of one adult equivalent to a Western, white, urban household is equal to the sum of the following coefficients (table 7):

$$(9)\quad \frac{\partial E}{\partial A} = 7.598 + 0.493 - 0.017 - 0.232 + 0.00504Y + 2(-0.281 - 0.089 + 0.017 - 0.020)A$$

If household income is assumed to be $120 per week, then the above equation becomes:

$$(10)\quad \frac{\partial E}{\partial A} = 8.905 - 0.746A$$

Similarly, the change in food expenditure resulting from the addition of one adult equivalent to a Western, black, urban household earning $120 per week is:

$$(11)\quad \frac{\partial E}{\partial A} = 6.741 - 0.356A$$

Table 4--Adult equivalents for selected household types and food expenditures

Household type	Total food	Vegetables	Grain products	Beef and pork	Dairy products	Fruits
	Adult equivalents					
Male age 20 to 55	1.00	1.00	1.00	1.00	1.00	1.00
Female age 20 to 55	.77	.99	.71	.66	.71	1.25
Male and female ages 20 to 55	1.77	1.99	1.71	1.66	1.71	2.25
Male and female age over 75	1.28	1.41	1.39	1.10	1.35	2.74
Male and female age 20 to 55, and male age 5	2.33	2.52	2.81	1.87	2.75	3.13
Male and female age 20 to 55, male age 5, and female age 2	2.81	3.02	3.32	2.13	3.77	4.04

Table 5--Marginal expenditure propensities and income elasticities 1/

Expenditures	Marginal propensities		Income elasticity	
	A = 2 2/	A = 4	A = 2	A = 4
	--- Cents per week ---		--- Percent ---	
Total food	0.0472	0.0573	0.20	0.24
Vegetables	.0041	.0045	.14	.15
Grain products	.0027	.0032	.09	.11
Beef and pork	.0147	.0175	.27	.32
Dairy products	.0037	.0044	.12	.14
Fruits	.0051	.0057	.26	.29

1/ Based upon average sample expenditure equations, table 3.
2/ Denotes number of adult equivalents in the household.

Table 6--Partial Engel functions relating the impact of region, urbanization, and race to household food expenditures 1/

Characteristic	Constant	Coefficient of A	Coefficient of A^2
		Total food	
Region:			
West	11.0982	8.7464	-0.3701
South	10.0510	7.6771	-.2806
North Central	10.9169	7.7813	-.2360
Northeast	11.1341	9.0462	-.2812
Urban:			
Urban	10.9897	8.2268	-.2640
Rural nonfarm	10.2054	8.0584	-.3216
Rural farm	9.8557	8.5554	-.3222
Race:			
Black	11.3372	6.0592	-.1064
White	10.5122	8.4648	-.3009
Other	8.5184	9.2930	-.4420
		Vegetables	
Region:			
West	1.2672	.9565	-.0339
South	1.1640	.9547	-.0369
North Central	1.2492	.8791	-.0258
Northeast	1.2708	.9287	-.0270
Urban:			
Urban	1.2564	.9132	-.0289
Rural nonfarm	1.1791	.9524	-.0376
Rural farm	1.1450	1.0004	-.0280
Race:			
Black	1.4533	.5154	.0014
White	1.1772	.9793	-.0346
Other	.9128	1.1152	-.0576
		Grain products	
Region:			
West	1.0364	.9330	-. 204
South	.9751	.9140	-.0277
North Central	1.0258	.9293	-.0286
Northeast	1.0384	1.0066	-.0181
Urban:			
Urban	1.0300	.9480	-.0230
Rural nonfarm	.9842	.9222	-.0263
Rural farm	.9636	.9842	-.0344
Race:			
Black	.9494	.8075	-.0175
White	1.0153	.9609	-.0253
Other	1.1709	1.0101	-.0314

Characteristic	Constant	Coefficient of A	Coefficient of A^2
		Beef and pork	
Region:			
West	3.0214	1.8738	-0.0855
South	2.6846	1.6846	-.0449
North Central	2.9629	1.7909	-.0373
Northeast	3.0330	1.9785	-.0409
Urban:			
Urban	2.9864	1.8449	-.0465
Rural nonfarm	2.7341	1.6339	-.0568
Rural farm	2.6221	1.7614	-.0268
Race:			
Black	3.0023	1.2449	.0312
White	2.8234	1.8748	-.0591
Other	3.2047	1.3262	-.0192
		Dairy products	
Region:			
West	1.1068	1.1274	-.0473
South	1.0226	1.0483	-.0491
North Central	1.0924	1.0625	-.0458
Northeast	1.1097	1.3386	-.0668
Urban:			
Urban	1.0982	1.1210	-.0502
Rural nonfarm	1.0351	1.1322	-.0545
Rural farm	1.0068	1.3186	-.0658
Race:			
Black	1.0957	.6759	-.0209
White	1.0605	1.1982	-.0564
Other	1.2135	1.1381	-.0508
		Fruits	
Region:			
West	.8697	.6967	-.0343
South	.7440	.4350	-.0152
North Central	.8480	.5131	-.0174
Northeast	.8741	.5703	-.0172
Urban:			
Urban	.8568	.5201	-.0185
Rural nonfarm	.7626	.5265	-.0192
Rural farm	.7204	.6333	-.0254
Race:			
Black	.9557	.3279	-.0079
White	.7894	.5471	-.0199
Other	.4744	.8829	-.0474

1/ Calculated at the sample mean income level for each group as given in table 1.

Figures 2a-2f–Estimated relationship between weekly food expenditures and household size measured in adult equivalents by region

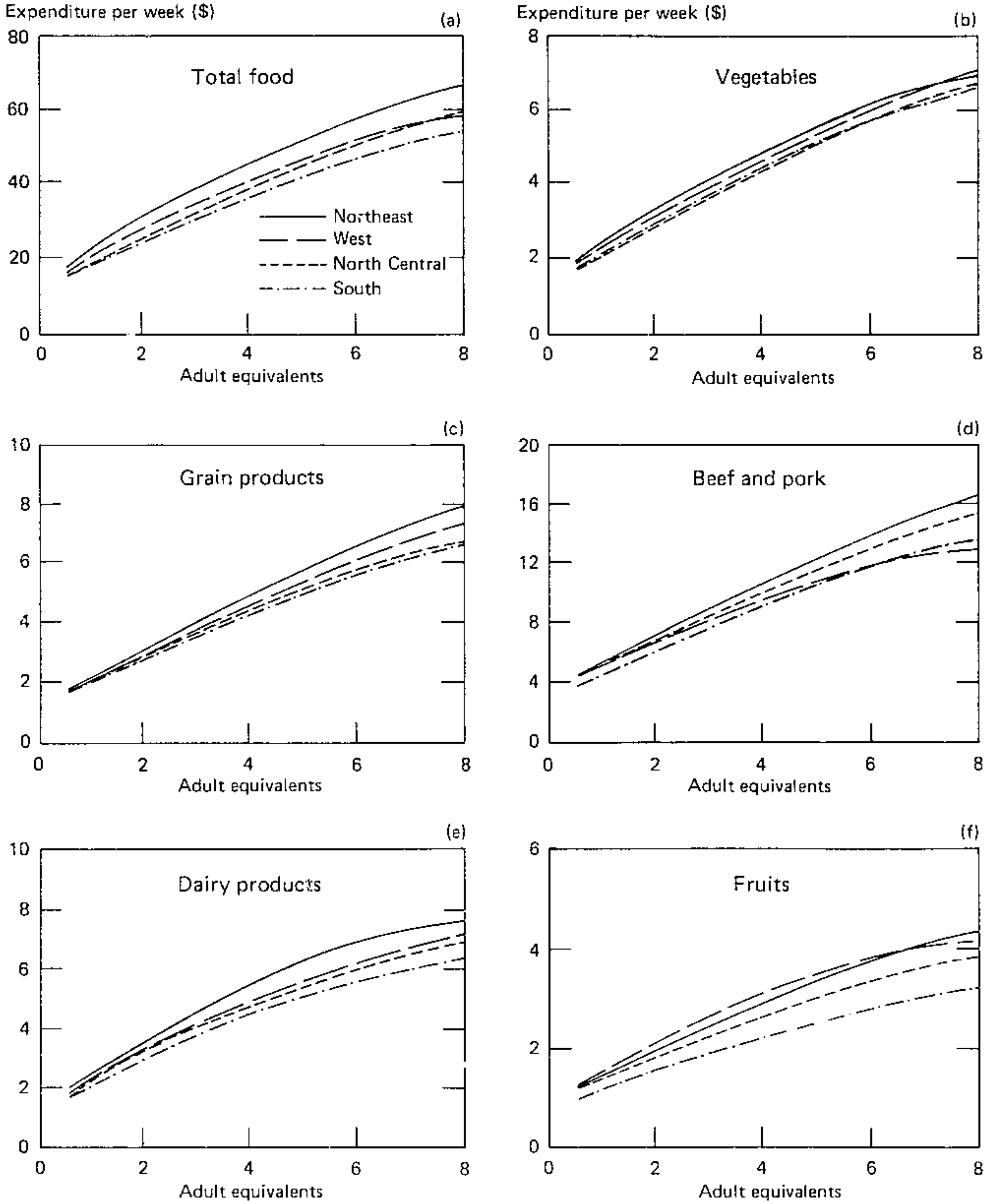


Figure 3a-3f–Estimated relationship between weekly food expenditures and household size measured in adult equivalents by urbanization

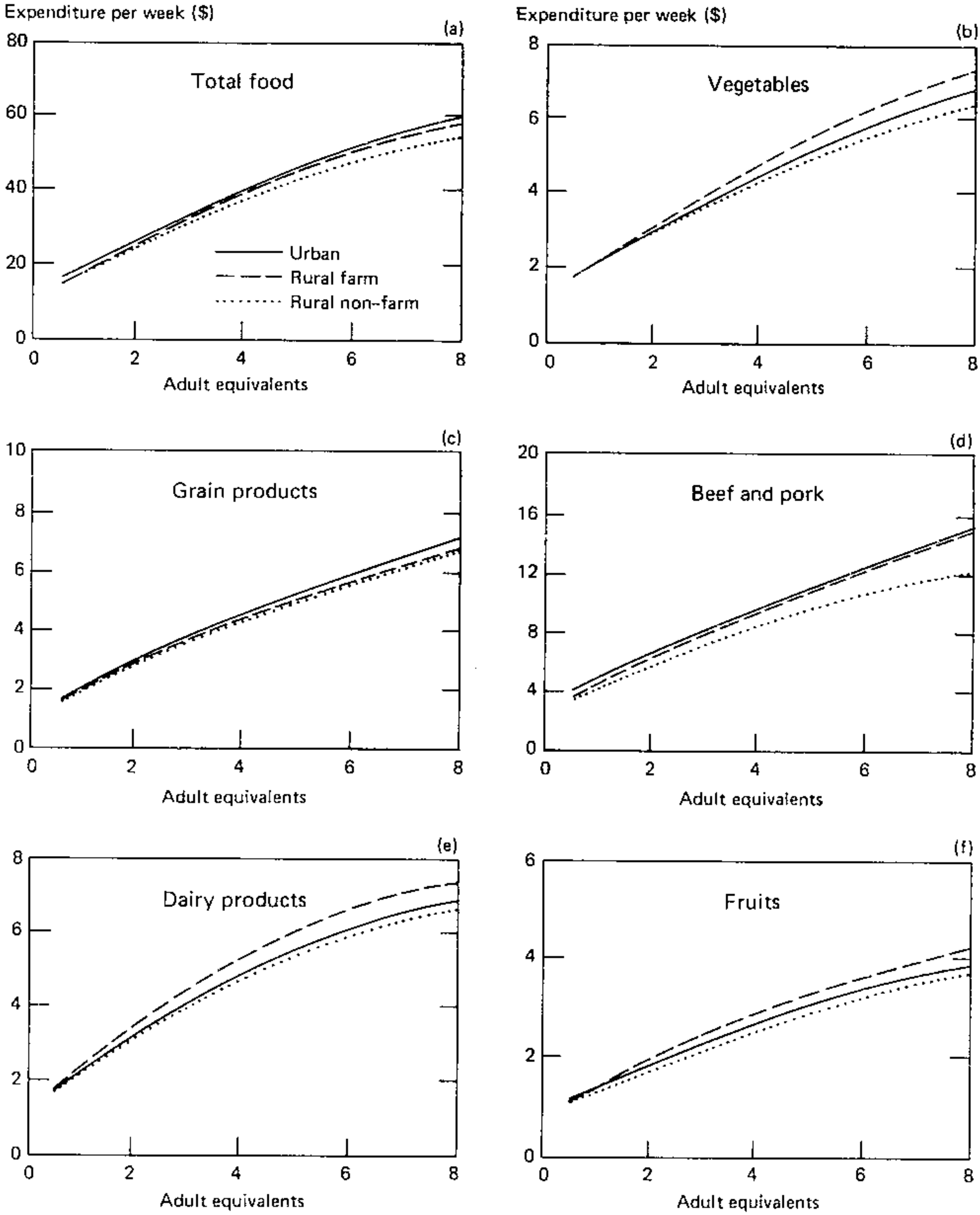


Table 7--Comparison of the marginal expenditures of an adult equivalent as affected by region, urbanization, race, and income

Characteristic	Total food		Vegetables		Grain products		Beef and pork		Dairy products		Fruits	
	Constant	2A	Constant	2A	Constant	2A	Constant	2A	Constant	2A	Constant	2A
Base	7.598	-0.281	0.902	-0.031	0.914	-0.025	1.623	-0.048	1.090	-0.052	0.489	-0.019
Income	.00504		.00022		.00025		.00139		.00038		.00033	
Region:												
Northeast	.788	0	-.002	.004	.060	.006	.174	.007	.198	-.015	.038	.002
North Central	-.447	.045	-.050	.005	-.016	-.004	-.006	.010	-.075	.007	-.017	.002
South	-.438	.001	.030	-.006	-.026	-.003	-.159	.003	-.081	.003	-.088	.004
West	.493	-.089	.026	-.003	-.014	.004	.070	-.038	-.012	.005	.165	-.015
Urbanization:												
Urban	-.017	.017	-.017	.002	.002	.002	.046	.001	-.018	.002	-.011	.001
Rural nonfarm	-.074	-.040	.027	-.007	-.018	-.002	-.136	-.009	.002	-.002	.002	0
Rural farm	.469	-.041	.081	.003	.046	-.010	.004	.021	.191	-.014	.112	-.006
Race:												
White	.232	-.020	.050	-.004	.015	-.001	.077	-.011	.060	-.004	.016	-.001
Black	-1.932	.175	-.404	.032	-.126	.007	-.486	.079	-.444	.031	-.187	.011
Other	1.166	-.161	.190	-.027	.070	-.007	-.442	.029	.008	.001	.351	-.028

Thus, for the white, Western, urban household consisting of two adult equivalents, an additional adult equivalent would increase food expenditures by \$7.41 per week compared to \$6.03 per week for its black counterpart.

Interaction of food expenditures to income is conditioned by race, education, and employment status. To analyze the impact of these characteristics, the relationship between food expenditure and income is given by (table 3): 9/

$$(12)\ E = 5.573 + 7.598(3.55) - 0.2813(3.55)^2 + 0.00504(3.55)Y + 0.0490Y - 0.000050Y^2$$

$$E = 29.0006 + .0669Y - 0.000050Y^2$$

By summing the appropriate coefficients, given in the appendix table, the Engel functions expressing expenditure response-to-income for different education levels, races, and employment status can be derived (table 8).

Comparing the additional food expenditure resulting from an additional dollar of income (marginal propensities to spend) is the simplest way of comparing expenditure patterns across education levels, races, and employment status. The marginal propensity to spend for total food for the average sample household is derived by taking the partial derivative of equation 12 with respect to Y and evaluating this equation at the average sample income (\$120 per week), i.e.:

$$(13)\ \frac{\partial E}{\partial Y} = 0.0669 - 2(0.000050)(120) = 0.0549$$

Similarly, the marginal propensities to spend for the other food groups and socioeconomic characteristics can be derived (table 9). Part of the difference in marginal propensities to spend between different socioeconomic groups is due to differences in income level and the average family size for families possessing various characteristics.

Table 10 contains expressions for the marginal propensities for the entire sample of households and the partial adjustments in the propensities depending upon education, employment status, race, income level, and family size and composition. The partial adjustments in propensities are additive and, as a result, the marginal propensity to spend for a household with certain socioeconomic characteristics is obtained by summing the appropriate values in the table. For example, the marginal propensity to spend on total food consumed at home for a white family containing 3.55 adult equivalents whose household head has less than 8 years of education, is not employed outside the home, and has an average weekly income of \$120 is:

$$(14)\ \frac{\partial E}{\partial Y} = 0.0490 - 2(0.000050)(120) + 0.00504(3.55) + 0.0210 + 0.0029 - 0.0035 = 0.0753$$

Expenditure-income elasticities for each food group as related to the socioeconomic characteristics of the household are presented in table 11. These estimates were derived by multiplying the marginal propensities to spend in table 9 by the corresponding reciprocal of the proportion of income spent on each food group for families possessing different socioeconomic characteristics given in table 1. These are the average elasticities for all households possessing the given characteristics. Table 12 contains the sample average and partial elasticities that can be used to

9/ The mean number of adult equivalents per household were: total food, 3.55; vegetables, 3.93; grain products, 4.13; beef and pork, 2.94; dairy products, 4.03; fruits, 4.85.

Table 8--Engel functions relating level of education, race, and employment status of the household head, and household income to household food expenditures 1/

Characteristic	Constant	Y	Y^2	Characteristic	Constant	Y	Y^2
		Total food				Beef and pork	
Education:				Education:			
< 8 years	25.9089	0.0879	-0.000050	< 8 years	4.8136	0.0213	-0.0000141
8-11 years	27.9304	.0705	-.000050	8-11 years	5.2145	.0213	-.0000141
12-15 years	29.9050	.0609	-.000050	12-15 years	5.9159	.0188	-.0000141
16 or more years	30.3368	.0616	-.000050	16 or more years	5.9928	.0173	-.0000141
Employment:				Employment:			
Employed	29.9093	.0600	-.000050	Employed	5.7271	.0180	-.0000141
Not employed	28.6189	.0698	-.000050	Not employed	5.5881	.0200	-.0000141
Race:				Race:			
White	29.0006	.0634	-.000050	White	5.6292	.0182	-.0000141
Black	29.0006	.0957	-.000050	Black	5.6292	.0274	-.0000141
Other	29.0006	.0512	-.000050	Other	5.6292	.0240	-.0000141
		Vegetables				Dairy products	
Education:				Education:			
< 8 years	3.4749	.0071	-.0000035	< 8 years	4.0318	.0044	-.0000047
8-11 years	3.7113	.0062	-.0000035	8-11 years	3.9403	.0068	-.0000047
12-15 years	3.9415	.0046	-.0000035	12-15 years	4.2100	.0058	-.0000047
16 or more years	3.9353	.0053	-.0000035	16 or more years	4.6140	.0045	-.0000047
Employment:				Employment:			
Employed	3.9793	.0045	-.0000035	Employed	4.3216	.0046	-.0000047
Not employed	3.7622	.0058	-.0000035	Not employed	4.1486	.0060	-.0000047
Race:				Race:			
White	3.8264	.0048	-.0000035	White	4.1998	.0053	-.0000047
Black	3.8264	.0103	-.0000035	Black	4.1998	.0075	-.0000047
Other	3.8264	.0029	-.0000035	Other	4.1998	.0073	-.0000047
		Grain products				Fruits	
Education:				Education:			
< 8 years	4.0729	.0037	-.0000035	< 8 years	1.7948	.0079	-.0000065
8-11 years	4.0282	.0042	-.0000035	8-11 years	2.0137	.0068	-.0000065
12-15 years	4.0865	.0039	-.0000035	12-15 years	2.1117	.0078	-.0000065
16 or more years	4.0246	.0043	-.0000035	16 or more years	2.4654	.0077	-.0000065
Employment:				Employment:			
Employed	4.2602	.0033	-.0000035	Employed	2.2559	.0063	-.0000065
Not employed	3.9799	.0043	-.0000035	Not employed	2.0663	.0081	-.0000065
Race:				Race:			
White	4.0628	.0039	-.0000035	White	2.1224	.0071	-.0000065
Black	4.0628	.0044	-.0000035	Black	2.1224	.0118	-.0000065
Other	4.0628	.0058	-.0000035	Other	2.1224	.0049	-.0000065

1/ Calculated at sample mean for the number of adult equivalents for each item given in text footnote 9.

Table 9--Average sample marginal propensities to spend based upon levels of education, race, and employment status of the household head 1/

Characteristic	Total food	Vege- tables	Grain products	Beef and pork	Dairy products	Fruits
Sample average	0.0549	0.0046	0.0032	0.0160	0.0045	0.0060
Education:						
< 8 years	.0811	.0066	.0032	.0194	.0038	.0070
8-11 years	.0618	.0056	.0036	.0188	.0060	.0057
12-15 years	.0479	.0035	.0030	.0151	.0046	.0061
16 or more years	.0441	.0041	.0031	.0124	.0029	.0054
Employment:						
Employed	.0469	.0036	.0024	.0143	.0034	.0046
Not employed	.0583	.0050	.0035	.0168	.0049	.0066
Race:						
White	.0508	.0039	.0030	.0146	.0041	.0055
Black	.0879	.0098	.0039	.0252	.0066	.0108
Other	.0407	.0022	.0051	.0210	.0063	.0035

1/ The marginal propensities are calculated at the group means as obtained from table 1 and text footnote 8.

Table 10--Sample and partial marginal propensities as related to the household head's education level, employment status, race, and the household's income and size

Characteristic	Total food	Vege- tables	Grain products	Beef and pork	Dairy products	Fruits
Constant	0.0490	0.0045	0.0030	0.0153	0.0041	0.0060
Income	-.00010	-.000007	-.000007	-.0000282	-.0000094	-.000013
Adult equivalents	.00504	.00022	.00025	.00139	.00038	.00033
Education:						
< 8 years	.0210	.0017	-.0003	.0019	-.0012	.0003
8-11 years	.0036	.0008	.0002	.0019	.0012	-.0008
12 to 15 years	-.0060	-.0008	-.0001	-.0006	.0002	.0002
16 or more years	-.0053	-.0001	.0003	-.0021	-.0009	.0001
Employment:						
Employed	-.0069	-.0009	-.0007	-.0014	-.0010	-.0013
Not employed	.0029	.0004	.0003	.0006	.0004	.0005
Race:						
White	-.0035	-.0006	-.0001	-.0012	-.0003	-.0005
Black	.0288	.0049	.0004	.0080	.0019	.0042
Other	-.0157	-.0025	.0018	.0046	.0017	-.0027

Table 11--Estimated income elasticities based upon education, race, and employment status of the household head 1/

Characteristic	Total food	Vege- tables	Grain products	Beef and pork	Dairy products	Fruits
Sample average	0.2257	0.1540	0.1101	0.2968	0.1461	0.3005
Education:						
< 8 years	.2582	.1393	.0809	.3002	.0995	.3224
8-11 years	.2075	.1488	.0998	.2907	.1626	.2371
12-15 years	.1954	.1252	.1034	.2725	.1473	.3043
16 or more years	.2418	.1857	.1592	.3043	.1219	.3144
Employment:						
Employed	.2120	.1326	.0918	.2876	.1261	.2530
Not employed	.2294	.1618	.1162	.2988	.1513	.3139
Race:						
White	.2171	.1345	.1111	.2808	.1367	.2750
Black	.2616	.2579	.0929	.3316	.1886	.4500
Other	.1337	.0595	.1342	.3559	.1615	.1207

1/ Elasticities calculated at the group means as obtained from table 1.

Table 12--Sample and partial income elasticities as related to the household head's education, employment status, race, and income and household size 1/

Characteristic	Total food	Vege- tables	Grain products	Beef and pork	Dairy products	Fruits
Constant	0.2005	0.1512	0.1047	0.2827	0.1322	0.2990
Income	-.000409	-.000235	-.000244	-.000521	-.000303	-.000648
Adult equivalents	.02062	.00739	.00872	.02568	.01226	.01644
Education:						
< 8 years	.0859	.0571	-.0105	.0351	-.0387	.0149
8 to 11 years	.0147	.0269	.0070	.0351	.0387	-.0399
12 to 15 years	-.0246	-.0269	-.0035	-.0111	.0065	.0099
16 or more years	-.0217	-.0034	.0105	-.0388	-.0290	.0050
Employment:						
Employed	-.0282	-.0302	-.0244	-.0259	-.0323	-.0648
Not employed	.0119	.0134	.0105	.0111	.0129	.0249
Race:						
White	-.0143	-.0202	-.0035	-.0222	-.0097	-.0249
Black	.1178	.1646	.0140	.1478	.0613	.2093
Other	-.0642	-.0839	.0628	.0850	.0548	.1345

1/ Based upon equations in table 10 evaluated at average income and expenditures for all households.

estimate the income elasticity for any subgroup in the sample. These parameters are additive.

RESULTS AND CONCLUSIONS

The results support the hypothesis that household size and composition are important in explaining variations in household food expenditures. The inclusion of the socioeconomic and demographic variables to partially control for heterogeneous tastes, family life cycle, and area of residence are highly important in explaining variations in household food expenditure behavior.

Adult Equivalent Scales

The AES parameter estimates for total food and the five food expenditure groups are presented in table 2. The scale parameters, ε, γ, μ, and ν measure the increase in the number of adult equivalents when a newborn baby, an adult female, elderly male, or an elderly female, respectively, is added to a household.

As expected, ε, γ, μ, and ν are positive and at least twice their standard error for every food expenditure category except grain products for the newborn (ε). δ and ξ are not statistically significant in the expenditure equations for total food, vegetables, and dairy products, suggesting that the AES function could be specified as a strict monotonic function of age from youth to maturity for those food groups. 10/

The scale value for a newborn baby, ε, range from approximately zero for grain products to 1.20 for fruits. The estimated ε value for dairy products is 1.05, in contrast to values of 0.45, 0.48, and 0.30 for total food, vegetables, and beef and pork, respectively. Statistical tests (figure 4) lead to rejection of the null hypothesis that a male child's scale value is not significantly different from 1.00 (the AES value for an adult male) for total food, vegetables, grain products, and beef and pork. A similar test leads to the conclusion that a female child's scale values are significantly different from those of an adult female for every food expenditure group.

Using the parameters in table 2 to produce plots (figures 5a to 5f) of the AES for each food group indicates male children have less of an impact on household expenditures for total food, vegetables, and beef and pork, but a greater impact on grain products, and about the same impact on dairy products and fruits as adult males. Conversely, female children have less of an impact on household expenditures for total food, vegetables, beef and pork, and fruits, but have a greater impact on household expenditures for grain and dairy products than adult females.

The adult female scale values (γ) range from 0.66 for beef and pork to 1.25 for fruits, indicating that relative to an adult male the addition of an adult female to the household would increase household expenditures for beef and pork by 0.66 and for fruits by 1.25. Statistical tests lead to the conclusion that the impact of an adult female on household expenditures for total food, grain products, beef and pork, and dairy products are less than that of an adult male, while being approximately the same for vegetable and fruit expenditures.

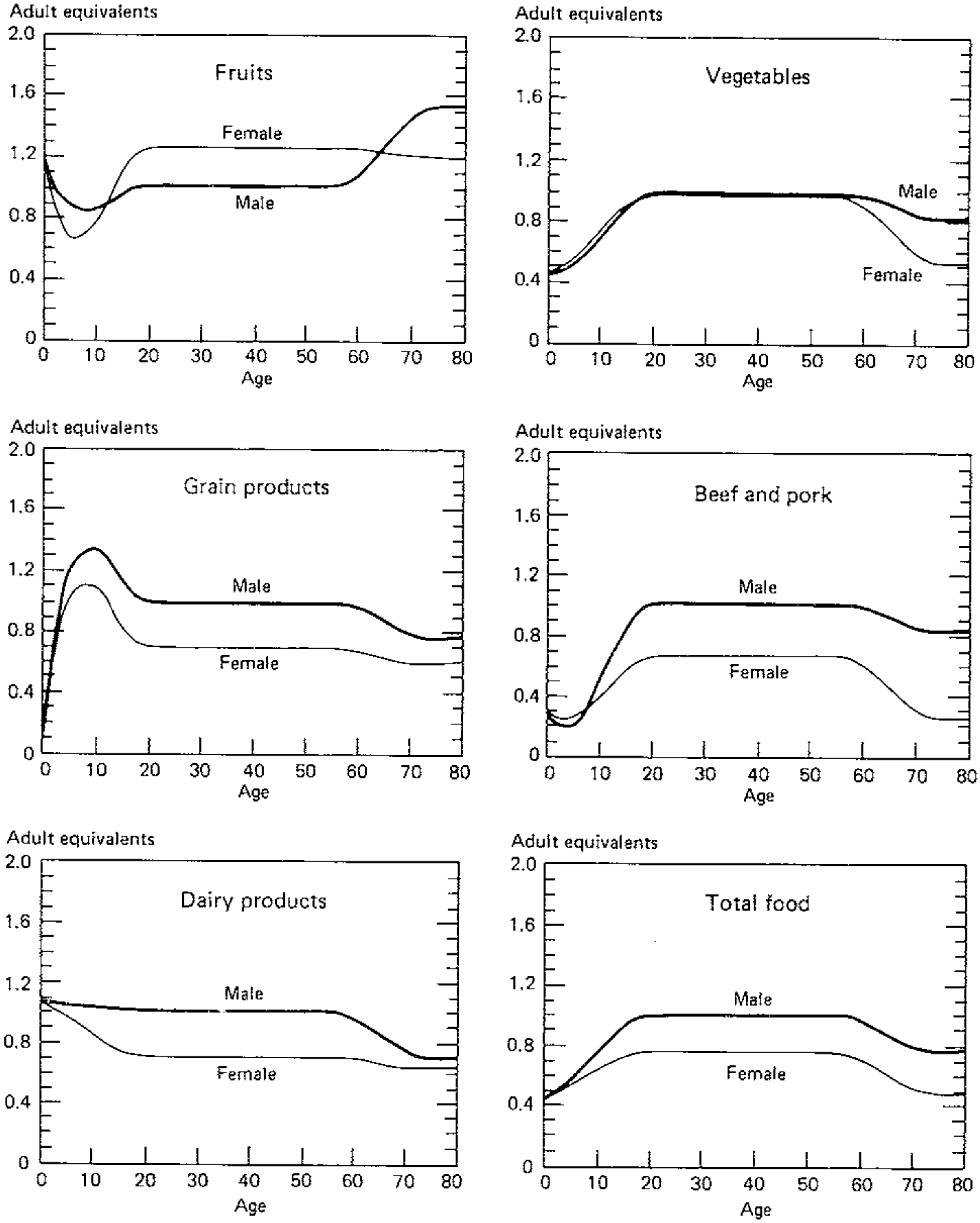
10/ Total food consists of all food consumed at home. Grain products include flour, prepared flour mix, breakfast cereal, other cereal, pastas, bread, and other bakery products. Vegetables consist of fresh, commercially canned and frozen vegetables, vegetable juices, and dried vegetables. Beef and pork include all beef and pork products. Dairy products consist of fresh fluid milk, processed milk cream, frozen milk dessert, and cheese, but excludes butter. Fruits consist of fresh, commercially canned and commercially frozen fruit, fruit juices, and dried fruit.

Figure 4--Results of statistical tests performed on the AES parameters derived from the 1965 USDA Household Food Consumption Survey

Null hypothesis 1/	Food groupings in which hypothesis was rejected
Age and sex not important	Total food, vegetables, grain products, beef and pork, dairy products, fruits
Sex not important	Total food, grain products, beef and pork, dairy products
Sex of adults not important	Total food, grain products, beef and pork, dairy products
Sex of elderly not important	Total food, vegetables, beef and pork
Age of males not important	Total food, vegetables, grain products, beef and pork, dairy products, fruits
Male children not different from adult males	Total food, vegetables, grain products, beef and pork
Elderly males not different from adult males	Total food, grain products, dairy products, fruits
Age of females not important	Total food, vegetables, grain products, beef and pork, dairy products, fruits
Female children not different from adult females	Total food, vegetables, grain products, beef and pork, dairy products, fruits
Elderly females not different from adult females	Total food, vegetables, beef and pork

1/ Tests are significant at the 95-percent confidence level.

Figures 5a-5f–Adult equivalent scales for total food and various food groups



The elderly male scale values (μ) range from a low of 0.70 for dairy products to a high of 1.54 for fruits. Elderly males show less of an impact on household expenditures for total food, grain products, and dairy products than adult males. However, elderly males have a greater impact on household expenditures for fruits than adult males.

The elderly female scale values (ν) range from 0.26 for beef and pork to 1.20 for fruits. Thus, in contrast to females 20 to 55 years old, elderly females have less of an impact on household expenditures for total food, vegetables, and beef and pork. There is not a statistically different impact on household expenditures for grain products, dairy products, and fruits between adult and elderly females.

These scales are not only useful for evaluating the influence of household size and composition on household food expenditures, they also may be applied to analyze adjustments in aggregate food consumption resulting from changes in the age distribution of the U.S. population. For example, between 1960 and 1975, the number of persons in the over-65 age group increased faster than total U.S. population growth. The adult equivalent scales indicate that this trend has a negative influence on per capita consumption of total food, beef and pork, vegetables, grain products, and dairy products, but had a positive influence on per capita fruit consumption. However, this influence is offset by the maturing of post-World War II babies and the decline in the birthrate which caused average per capita consumption of most food products to increase after 1960.

The statistical significance and negative sign of the coefficient of the number of adult equivalents squared (A^2) indicates that household food expenditures increase at a decreasing rate as the number of adult equivalents in the household increases. Holding income constant, the increase in household food expenditures resulting from the addition of a person to a household containing one adult equivalent will be greater than the change in food expenditures resulting from the addition of that individual to a household containing three adult equivalents.

Overall, beef and pork and dairy products exhibit the least response to changing household size, reflecting the ability to benefit from large purchases. The largest response to an increase in household size is in fruits. Fruits provide fewer capabilities for savings through larger purchases.

Socioeconomic and Demographic Characteristics

Household food expenditure behavior varies depending upon the location of the household. Ceteris paribus--food expenditures per adult equivalent are highest for households located in the northeast and lowest for households located in the south. In addition, rural nonfarm households spend less per adult equivalent on food than either rural farm or urban households. Urban residents have the highest average expenditures on total food, grain products, and beef and pork, while rural farm residents spend more on vegetables, dairy products, and fruits. Household food expenditures also are lower for an average Black than for an average White household.

The estimated expenditure-income elasticities over the entire sample of households are 0.226, 0.154, 0.110, 0.297, 0.146, and 0.301 for total food, vegetables, grain products, beef and pork, dairy products, and fruits consumed at home, respectively. Comparing the estimated elasticities with those obtained by George and King (5) reveals that the estimated elasticities are moderately lower for total food, vegetables, and dairy products, higher for grain products and fruits, and about the same for beef and pork. These differences are probably attributable to the more detailed specification of the Engel functions. There is ample evidence that expenditure response to a change in income is conditioned by such things as race, education, household size and composition, and place of residence. Most researchers (including George and King) include, at most, one or two such variables in their Engel functions.

Under traditional estimation procedures, exclusion of these variables will result in their impact being absorbed by the income parameter if they are correlated with income. In this analysis, the inclusion of a wide range of socioeconomic variables and a better specification for household size and composition permits the impact of these variables to be captured by their own regression coefficients. The income coefficient, in turn, reflects more accurately its true partial effect on food expenditures.

The marginal propensity to spend on food varies substantially depending upon the education and race of the household. Analyzing each characteristic separately reveals that as education increases, the marginal propensity to spend declines for total food, vegetables, and beef and pork. The marginal propensity to spend on each of the six food groups is higher for Black households than for White households and higher heads of households who are not employed outside the home.

The income elasticities exhibit considerable fluctations, depending upon the household's characteristics. For example, the income elasticity for food for a Black household consisting of four adult equivalents whose household head has less than 8 years of education and is not employed outside the home is 0.45. This compares to 0.20 for a White household consisting of two adult equivalents whose household head has 8 to 11 years of education and is employed outside the home.

These results indicate that household composition and socioeconomic and demographic characteristics are important in explaining household food purchasing behavior and that changes in the characteristics of the U.S. population will cause corresponding changes in food demand.

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Appendix table 1--Engel curve parameter estimates for selected household food expenditures

Variable 1/	Total food	Vege-tables	Grain products	Beef and pork	Dairy products	Fruits
Constant	-17.6668 2/(.877)	-2.0308 (.151)	-3.0653 (.143)	-2.9784 (.334)	-2.7774 (.155)	-1.3204 (.151)
EDFHLT8	-3.0917 (.518)	-.3515 (.088)	.0101 (.088)	-.8156 (.198)	-.1680 (.094)	-.3276 (.082)
EDFH811	-1.0702 (.518)	-.1151 (.088)	-.0346 (.088)	-.4147 (.198)	-.2595 (.094)	-.0192 (.082)
EDFH1215	.9044 (.259)	.1151 (.044)	.0237 (.044)	.2867 (.099)	.0102 (.047)	-.0107 (.041)
EDFHGT15	1.3362 (.582)	.1089 (.099)	-.0382 (.099)	.3636 (.773)	.4142 (.106)	.3430 (.092)
FHWOH	.9087 (.409)	.1529 (.069)	.1974 (.069)	.0979 (.157)	.1218 (.074)	.1335 (.065)
FHNWOH	-.3817 (.174)	-.0642 (.028)	-.8029 (.028)	-.0411 (.065)	-.0512 (.032)	-.0561 (.028)
Y	.0490 (.0047)	.0045 (.0008)	.0030 (.0008)	.0153 (.0018)	.0041 (.0009)	.0060 (.0007)
EDFHLT8*Y	.0210 (.0046)	.0017 (.0008)	-.0003 (.0008)	.0019 (.0018)	-.0012 (.0009)	.0003 (.0008)
EDFH811*Y	.0036 (.0046)	.0008 (.0008)	.0002 (.0008)	.0019 (.0018)	.0012 (.0008)	-.0008 (.0007)
EDFH1215*Y	-.0060 (.0019)	-.0008 (.0003)	-.0001 (.0003)	-.0006 (.0007)	.0002 (.0003)	.0002 (.0003)
EDFHGT15*Y	-.0053 (.0031)	-.0001 (.0005)	.0003 (.0005)	-.0023 (.0012)	-.0009 (.0006)	.0001 (.0005)
FHWOH*Y	-.0069 (.0027)	-.0009 (.0005)	-.0007 (.0005)	.0014 (.0010)	-.0010 (.0005)	-.0013 (.0004)
FNWOH*Y	.0029 (.0011)	.0004 (.0002)	.0003 (.0002)	.0006 (.0004)	.0004 (.0002)	.0005 (.0002)
OTRAC*Y	-.0157 (.0112)	-.0025 (.0019)	.0018 (.0019)	.0046 (.0043)	.0017 (.0020)	-.0027 (.0018)
WHITE*Y	-.0035 (.0010)	-.0006 (.0002)	-.0001 (.0002)	-.0012 (.0004)	-.0003 (.0002)	-.0005 (.0001)
BLACK*Y	.0288 (.0069)	.0049 (.0012)	.0004 (.0011)	.0080 (.0026)	.0020 (.0012)	.0042 (.0011)

Footnotes at end of table.

Continued--

Appendix table 1--Engel curve parameter estimates for selected household food expenditures--Continued

Variable 1/	Total food	Vegetables	Grain products	Beef and pork	Dairy products	Fruits
A 3/	7.5979	0.9018	0.9141	1.6227	1.0904	0.4891
	(.257)	(.040)	(.034)	(.112)	(.040)	(.034)
WEST*A	.4933	.0261	-.0136	.0704	-.0124	.1647
	(.232)	(.036)	(.032)	(.102)	(.037)	(.029)
SOUTH*A	-.4376	.0305	-.0256	-.1592	-.0809	-.0878
	(.142)	(.022)	(.020)	(.062)	(.023)	(.017)
NC*A	-.4466	-.0502	-.0161	-.0056	-.0754	-.0173
	(.150)	(.023)	(.022)	(.066)	(.024)	(.018)
NE*A	.7881	-.0019	.0597	.1737	.1984	.0380
	(.169)	(.026)	(.024)	(.074)	(.027)	(.020)
URBAN*A	-.0172	-.0165	.0021	.0457	-.0177	-.0109
	(.063)	(.010)	(.009)	(.028)	(.010)	(.008)
RNF*A	-.0737	.0273	-.0184	-.1362	.0015	.0024
	(.171)	(.026)	(.024)	(.075)	(.027)	(.020)
RF*A	.4686	.0809	.0458	.0039	.1913	.1122
	(.356)	(.054)	(.052)	(.158)	(.056)	(.042)
OTRAC*A	1.1659	.1903	.0697	-.4425	.0078	.3512
	(.780)	(.122)	(.115)	(.344)	(.125)	(.102)
WHITE*A	.2319	.0498	.0153	.0770	.0599	.0164
	(.057)	(.009)	(.008)	(.026)	(.009)	(.007)
BLACK*A	-1.9318	-.4036	-.1261	-.4862	-.4441	-.1869
	(.406)	(.062)	(.054)	(.185)	(.062)	(.048)
A^2	-.2813	-.0309	-.0245	-.0477	-.0522	-.0191
	(.028)	(.004)	(.003)	(.015)	(.004)	(.003)
$WEST*A^2$	-.0888	-.0030	.0041	-.0378	.0049	-.0152
	(.039)	(.005)	(.005)	(.070)	(.005)	(.003)
$SOUTH*A^2$	.0007	-.0060	-.0032	.0028	.0031	.0039
	(.023)	(.003)	(.003)	(.012)	(.003)	(.002)
$NC*A^2$	.0453	.0051	-.0041	.0104	.0068	.0017
	(.024)	(.003)	(.003)	(.012)	(.003)	(.002)
$NE*A^2$	.0001	.0039	.0064	.0068	-.0146	.0019
	(.028)	(.004)	(.003)	(.015)	(.004)	(.003)
$URBAN*A^2$	.0173	.0020	.0015	.0012	.0020	.0006
	(.010)	(.001)	(.001)	(.005)	(.001)	(.001)

Footnotes at end of table.

Continued--

Appendix table 1--Engel curve parameter estimates for selected household food expenditures--Continued

Variable 1/	Total food	Vege-tables	Grain products	Beef and pork	Dairy products	Fruits
RNF*A^2	-0.0403	-0.0067	-0.0018	-0.0091	-0.0023	-0.0001
	(.027)	(.004)	(.003)	(.014)	(.004)	(.002)
RF*A^2	-.0409	.0029	-.0099	.0209	-.0136	-.0063
	(.052)	(.008)	(.006)	(.029)	(.008)	(.004)
OTRAC*A^2	-.1607	-.0265	-.0069	.0285	.0014	-.0283
	(.104)	(.015)	(.012)	(.054)	(.014)	(.011)
WHITE*A^2	-.0196	-.0037	.0008	-.0114	-.0042	-.0008
	(.008)	(.001)	(.001)	(.004)	(.001)	(.001)
BLACK*A^2	.1749	.0323	.0070	.0789	.0313	.0112
	(.055)	(.008)	(.006)	(.031)	(.007)	(.005)
M	23.2400	2.7722	3.7708	4.2491	3.4307	1.5200
	(.738)	(.126)	(.121)	(.287)	(.130)	(.119)
A*Y	.00504	.00022	.00025	.00139	.00038	.00033
	(.0008)	(.0001)	(.0001)	(.0004)	(.0001)	(.0001)
Y^2	-.000050	-.0000035	-.0000035	-.0000141	-.0000047	-.0000065
	(.000007)	(.000001)	(.000001)	(.000003)	(.000001)	(.000001)
	4/ R^2 = .59	R^2 = .40	R^2 = .50	R^2 = .34	R^2 = .44	R^2 = .29

1/ See appendix figure 1 for definition of variables.

2/ Numbers in parentheses denote standard errors.

3/ The estimated parameters of the adult equivalent scale function are presented in table 2.

4/ Denotes coefficient of determination.

Appendix figure 1--Definition of variables appearing in Engel curve

EDFHLT8 -- Equals 1 if education of female head is less than 8 years, 0 otherwise.

EDFH811 -- Equals 1 if education of female head is at least 8, but less than 12 years, 0 otherwise.

EDFH1215 -- Equals 1 if education of female head is at least 12, but less than 15 years, 0 otherwise.

EDFHGT15 -- Equals 1 if education of female head is greater than 15 years, 0 otherwise.

FHWOH -- Equals 1 if female head employed outside the home, 0 otherwise.

FHNWOH -- Equals 1 if female head is not employed outside the home, 0 otherwise.

Y -- Average household (after tax) money income in 1964 and 1965.

WHITE -- Equals 1 if female head is white, 0 otherwise.

BLACK -- Equals 1 if female head is black, 0 otherwise.

OTRAC -- Equals 1 if female head is neither white nor black, 0 otherwise.

WEST -- Equals 1 if household resides in the western region, 0 otherwise.

SOUTH -- Equals 1 if household resides in the southern region, 0 otherwise.

NC -- Equals 1 if household resides in the north central region, 0 otherwise.

NE -- Equals 1 if household resides in the northeastern region, 0 otherwise.

URBAN -- Equals 1 if household resides in an urban area, 0 otherwise.

RNF -- Equals 1 if household resides in a rural nonfarm area, 0 otherwise.

RF -- Equals 1 if household resides in a rural farm area, 0 otherwise.

M -- Percent of meals consumed at home.

A -- Number of adult equivalents in the household (equation 4).

* -- Denotes multiplied by.

2 -- Denotes variable squared.

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