Demand for Nutrients:
The Household Production Approach

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Abstract

This study uses the household production theory to study the demand for nutrients, i.e., households purchase a combination of food items from the market and produce the needed nutrients from these food items. By following the traditional household production approach, shadow prices for nutrients in food consumption are calculated. The cost function that generates the shadow prices appears plausible in terms of its elasticities of substitution and factor demand. After obtaining the calculated shadow prices of nutrients, the nutrient demand functions are estimated. Results show that the own-price elasticity of demand for nutrient is inelastic, whereas the expenditure elasticities indicate that nutrients are normal goods. Cross-price elasticities show that there appears to be complementarity in the demand for nutrients. This seems a logical result.

Key words: Household production theory, food, nutrients

JEL Classification Code: D12

Demand for Nutrients: The Household Production Approach

Public health and commodity group campaigns in the United States try to change consumers' diet patterns toward balance and healthy ones. The Dietary Guidelines for Americans advise consumers to choose a diet low in fat, sugar, and salt (USDA and DHHS 1995; USDA/CNPP 1996); the California Department of Health Services' five-a-day for better health campaign advises consumers to consume five to nine servings of colorful fruit and vegetables a day to obtain vitamins, minerals, and phytochemicals; and the American Dairy Association's 3-a-day campaign promotes dairy products' calcium and protein for strong bones. By conveying the nutritional importance of different food items, these campaigns help determine consumers' knowledge about nutrient contents in different food items and may play an important role in the food items purchased and consumed. The information from these campaigns and other sources has likely made nutrient contents important factors in consumers' choices of food items.

A number of studies have incorporated nutritional factors into food demand analysis. Brown and Schrader, and Capps and Schmitz used a cholesterol information index as an explanatory variable in their demand equations; Adrian and Daniel, Devaney and Fraker, and Basiotis et al. considered nutrient intake levels as functions of income and sociodemographic variables; and Gould et al., Pitt, and Sahn added nutrient variables directly to their demand models. Huang explored how prices and income influenced the demand for nutrients using Lancaster's consumer technology approach. In the Huang study, price and income elasticities for individual purchased foods were used to derive price and income elasticities for nutrients using disappearance data complied by the U.S. Department of Agriculture. A similar approach was taken in a recent study by Huang and Lin in applying the almost ideal demand system to the 1987-88 Nationwide Food Consumption Survey (NFCS) data. In the Huang and Lin study, the income elasticity of average price was used to adjust for food quality.

The approach used in the current study differs from these previous studies. Instead of adding nutrient variables in the demand equation or assuming that food prices and expenditure directly influence the demand for nutrients, we assume that the consumers look for nutrients in food. For example, for health reasons, a consumer may be interested in lowing his fat intake, therefore, he looks for food items with low fat contents to minimize he consumes. In this study, we assume that consumers' goal is to obtain a combination of nutrients from food to keep them alive and healthy. The nutrients cannot be purchased directly, they have to be obtained from the food that consumers purchased and consumed. Based on this assumption, we use the household production theory to study the demand for nutrients, i.e., households purchase a combination of food items from the market and produce the needed nutrients from these food items.

A Theoretical Model

The approach used in this study is base on household production theory (Mincer, 1962; Becker, 1965; Michael and Becker, 1973; Deaton and Muellbauer, 1980). Essentially, two related optimization problems are considered. First, the household is assumed to minimize the expenditures necessary to achieve a given level of various nutrients and food consumed.

Differentiating this expenditure or cost function then allows the calculation of shadow prices of nutrients in food consumption. Next, an alternative representation of the household's optimization problem, which explicitly depends on these calculated shadow prices, is then formulated. The solution to this problem provides a system of equations that relates the demand for nutrients to the shadow prices of nutrients, food expenditure, and household composition.

Assume that the vector $\mathbf{z} = [z_1,..., z_{g+1}]$ represents g+1 factors consisting of the levels of g nutrients (z_i, $i \leq g$) and the number of meals equivalent consumed (z_{g+1}). According to household production theory, it may be argued that, in order to produce the nonmarket vector **z**, the household must purchase a vector of food inputs (q_is, $i = 1, . . ., n$; n food items) and labor inputs (l_js, $j = 1, . . ., r$; r types of labor inputs), $\mathbf{q} = [q_1, . . ., q_n, l_1,. . . , l_r]$, at given market prices (p_is) and wages (s_js) vector, $\mathbf{p} = [p_1, . . ., p_n, s_1, ..., s_r]$.

At the first stage the household may be characterized by cost-minimizing behavior, with food inputs assumed to be weakly separable from all other commodity groups (Deaton and Muellbauer, 1980), allowing the expenditure allocation among food groups to be in isolation from other commodities. The household's consumption choices then may be written as:

$$\begin{aligned} (1) \qquad & \min C = \mathbf{p}' \, \mathbf{q} \\ & \text{s. t. } \; H(\mathbf{q}, \mathbf{z}; \mathbf{k}) \geq 0, \end{aligned}$$

where $H(\mathbf{q}, \mathbf{z}; \mathbf{k})$ denotes the corresponding transformation function that converts food inputs (q_is), labor inputs (l_rs), and fixed capital stocks (**k**, capital stocks are considered fixed in the short run) into the nonmarket output vector **z**. The solution to equation (1) is the household cost or expenditure function, $C^0 = x(\mathbf{p}, \mathbf{z}; \mathbf{k})$, indicating the minimal short-run cost of obtaining given levels of g nutrients and number of meals equivalent at given prices and wages.

The shadow values of the z_k are defined as (Deaton and Muellbauer, 1980)

$$\pi_k = \partial C/\partial z_k, \qquad k = 1, ..., g + 1. \tag{2}$$

The prominent advantage of utilizing the cost function to characterize the household's transformation of market inputs into nonmarket outputs is that it can provide a direct means of imputing values to the nonmarket goods, **z**. Therefore, given the solution of (1), shadow prices for various nutrients and the number of meals equivalent consumed may be obtained by simple differentiation.

With these shadow prices the second-stage optimization problem of determining the levels of various nutrients and the number of meals equivalent can be defined as

$$\begin{aligned} &\max U(\mathbf{z}, \mathbf{HC}) \\ &\text{s. t. } C^0 = x(\mathbf{p}, \mathbf{z}; \mathbf{k}), \quad \text{or} \quad C^0 = g(\boldsymbol{\pi}'\mathbf{z}); \end{aligned} \tag{3}$$

where U represents a well-defined utility function; **HC** is a vector of household composition variables; $\pi = (\pi_1, ..., \pi_{g+1})$ are the shadow prices; and C^0 is the minimized cost of equation (1) for given **p**. Note that this optimization problem is different from the conventional budget-constrained utility maximization problem of demand theory in the sense that the expenditure constraint in this context is a nonlinear function of $\boldsymbol{\pi}'\mathbf{z}$. This nonlinearity of the expenditure of equation (3), $g(\boldsymbol{\pi}'\mathbf{z})$, is associated with the structure of the household's technology. In fact, the linear expenditure constraint corresponds to the assumption of constant return to scale (Deaton and Muellbauer, 1980). In more general cases concerning the household technology, the nonlinear budget constraint is thus more appropriate.

With the nonlinear budget constraint, the explicit solution to this optimization problem is difficult to obtain. Nevertheless, given the shadow prices of **z**, the implicit form of solution to the second-stage optimization can be written as

$$(4) \qquad z_k = z_k(C^0, \pi, \mathbf{HC}), \qquad k = 1, \ldots, g + 1,$$

which states that the demand for various nutrients and the number of meals equivalent is a function of food expenditures C^0, their shadow values π, -- which are determined by the first-stage optimization, and household composition. Therefore, given estimated shadow values π_is and expenditure, the price and expenditure elasticities for the nonmarket output z_is and the impact of individual members of the family on the demand for nutrients can be obtained.

Data and Model

The data used in this study are from the 1987-88 Nationwide Food Consumption Survey (NFCS). This survey covers the period from April 1987 through the first week of August 1988. The 1987-88 NFCS is the most recent of many USDA studies of food consumption. In this survey, nationwide measurements of nutrient contents in each food item are reported and the amount of nutrients in each consumed food item can be obtained. However, this survey has the potential for sampling bias given the low response rate (35 percent) (FASEB, 1991; USDA, 1994; GAO, 1991). However, the bias is believed to be no greater than that of other, comparable household-level data sets (Murphy et al., 1992).

In this study, food items are grouped into five food categories: dairy; meats and other protein food items; vegetables and fruit; grain products; and other (fats and oils, sugar and sweets, and other miscellaneous). Seven nutrients are considered: carbohydrates; fats and oils;

proteins; vitamin group I (vitamins measured in milligrams, for example, vitamins C and B-6, thiamin, riboflavin, and niacin); vitamin group II (measured in micrograms, for example, folate and vitamin B-12); digestible fibers; and minerals. In order to correct for the household composition effects on food consumption, the total quantity of food consumption is represented by the number of meals equivalent, which is the total number of meals from household food supplies.

A total of 4,155 observations or households were involved in this study. An average household with 2.81 persons consumed 72.84 pounds of food and 48.37 meals, and spent $62.03 on food per week. The average household consumption of dairy products, meats and other protein source products, vegetables and fruit, grains, and all other foods are 20.64, 13.12, 24.24, 5.17, and 9.67 pounds per week, respectively; the respective budget shares of these food groups are 0.125, 0.339, 0.212, 0.165, and 0.159. The average household consumption of carbohydrates, fats and oils, proteins, vitamin I, vitamin II, fibers, and minerals are 5,234 grams, 2,186 grams, 1,689 grams, 3,136 milligrams, 5,694 micrograms, 313 grams, and 165,686 milligrams, respectively.

Since both wage rate of meal preparer and labor inputs in meal preparation were not reported in the 1987-88 NFCS, the wage and labor variables are deleted from **p** and **z** in equations (1) through (4). Given no a priori knowledge about cost function C^0, a translog cost function is adopted. Formally, this cost function can be written as

$$(5) \qquad \ln C = \alpha_0 + \Sigma_i \alpha_i \ln p_i + \Sigma_k \beta_k \ln z_k + \tfrac{1}{2} \Sigma_i \Sigma_j \alpha_{ij} \ln p_j \ln p_j + \tfrac{1}{2} \Sigma_k \Sigma_h \beta_{kh} \ln z_k \ln z_h + \tfrac{1}{2} \Sigma_i \Sigma_k \theta_{ik} \ln p_i \ln z_k.$$

The number of parameters that needs to be estimated can be reduced by imposing theoretically derived restrictions, such as linear homogeneity in prices ($\Sigma_i\alpha_i = 1$, i = 1,..., n; $\Sigma_j\alpha_{ij} = 0$, i, j = 1,..., n; and $\Sigma_i\theta_{ik} = 0$, k = 1,...,g+1) and symmetry of the cross-price and cross-nutrient derivatives ($\alpha_{ij} = \alpha_{ji}$ and $\beta_{kh} = \beta_{kh}$ (Young's theorem)).

Differentiating equation (5) with respect to each of the input prices and applying Shephard's lemma, budget (factor) share equations can be derived as

(6) $\partial \ln C/\partial \ln p_i = w_i = \alpha_i + \Sigma_j\, \alpha_{ij} \ln p_j + ½\Sigma_k\, \theta_{ik} \ln z_k$,i, j = 1, . . . , n; k = 1, . . ., g + 1,

where $w_i = p_i q_i/C$ is the average propensity of total food expenditure to spend on input group i. The parameters α_{ij}s and θ_{ik}s show the effect of changes in **p** and **z** on factor shares. If θ_{ik} equals zero, for all i and k, the household production technology is homothetic, meaning the factor shares are not affected by the levels of various nutrients and the number of meals equivalent at constant input prices.

The elasticities of substitution (Uzawa, 1962) and Hicksian own-price and cross-price elasticities of demand (Binswanger, 1974) can be obtained given the share equation (6). The elasticities of substitution are

(7) $$\sigma_{ii} = (\alpha_{ii}/w_i(w_i - 1))/w_i^2,$$

$$\sigma_{ij} = (\alpha_{ij}/w_i w_j) + 1.$$

Note that, if $\sigma_{ij} = 0$, then the elasticity of substitution equals one. The Hicksian own-price and cross-price elasticities of demand are

(8) $$\eta_{ii} = \sigma_{ii}\, w_i$$

$$\eta_{ij} = \sigma_{ij}\, w_j.$$

In addition, the shadow prices of the elements of **z** can be calculated as

$$(9) \qquad \pi_k = \partial C/\partial z_k = (\partial \ln C/\partial \ln z_k)\,(C/z_k), \qquad k = 1, \ldots, g + 1.$$

Given relationships (9), the demand equations in (4) can be estimated. The approach first requires estimating shadow prices, based on equation (5). The estimation may be accomplished by jointly estimating equation (5) and (n-1) share equations (6). The iterative seemingly unrelated least squares method was used to estimate these parameters.

Results

With five food groups and seven nutrients, the translog cost function has 105 parameters, after imposing the homogeneity and the symmetry conditions. The translog specification (5) appears to fit the data quite successfully -- with 76 of the 105 estimated parameters exceeding twice of their associated standard errors (Table 1).

The estimated parameters of particular interest are θ_{ik}s. Parameter θ_{i8} indicates the effect of changes in the number of meals equivalent on the *i*th food group budget share, and θ_{ik}, $k \leq 7$ indicates the effect of changes in the *k*th nutrient contained in all food groups on the *i*th budget share. The estimated θ_{i8} for the dairy group is positive ($\theta_{18} = 0.0177$), while those for the vegetables and fruit and other groups are negative ($\theta_{38} = -0.0110$ and $\theta_{58} = -0.0039$). This result reflects the fact that budget share for dairy increases as the number of meals consumed by the household increases, while the budget shares of vegetables and fruit and other food groups decrease, assuming constant food prices.

Elasticities of substitution and of factor demand evaluated at the sample means of the budget shares based on equations (7) and (8), respectively, are reported in Table 2. All cross-elasticities of substitution are positive, which reveals that all food groups are substitutes. In

Table 1, all own-price elasticities of factor demand have the correct sign as expected; that is, relatively, the higher the price for one food group, the less food consumed.

Table 3 shows the mean shadow prices of the nutrient variables z_ks, $k \leq 7$ and of the meals variable, z_8. The shadow prices vary from $0.0229 per gram for protein to $0.00002 per milligram for minerals. The variation in shadow prices suggests the unit costs of nutrients are different to consumers. The negative price parameter estimate for vitamin II was unexpected.

The individual nutrient demand equation may now be estimated. The functional form used for equation (4) is

$$(10) \qquad z_k = \psi_{k0} + \Sigma_h \psi_{kh} \pi_h + \psi_{k1} C + \psi_{k2} C^2 + c_{k1}Ag1 + c_{k2}Ag2 + c_{k3}Ag3 + c_{k4}Ag4 + c_{k5}Ag5 + c_{k6}Ag6 + f_k HZ^2, \; k, h = 1, \ldots, g + 1,$$

where C is the expenditure variable; Ag1, Ag2, Ag3, Ag4, Ag5, and Ag6 represent the number of household members of ages from zero to six years, seven to 12 years, 13 to 18 years, 19 to 45 years, 46 to 60 years, and over sixty years, respectively; HZ denotes the household size which is the sum of Ag1 through Ag6. The household-size square is included in the analysis to capture the economies of scale effect in nutrient consumption.

Note that, since all π_ks are themselves functions of the z_k, the estimation of (10) will be biased if the correlations between π_ks and z_ks are not considered. Therefore, a two-stage estimation, using an instrumental variables estimator, provides consistent estimates of π_ks in equation (9), and those consistent estimates are used in the estimation of (10) (Mendelsohn, 1984). In addition to the ability of calculating the price and expenditure elasticities of nutrients, equation (10) also allows us to explore the effects of household composition variables on nutrient demand.

The own-price and expenditure elasticities for nutrient demand calculated at sample means are reported in Table 4. Results show that the (shadow) own-price elasticity estimates are negative except those for vitamin II and the number of meals equivalent. Of the 42 cross-price elasticity estimates, only four have the positive sign, indications that most nutrients are complements. The expenditure elasticity estimates of carbohydrates, proteins, vitamin II, and fibers are inelastic; and the expenditure elasticities for fats and oils, vitamin I, and minerals are around one. The expenditure elasticity estimates suggest that consumers will demand relatively less carbohydrates, protein, vitamin II, and fiber than fats and oils, vitamin I, and minerals as their incomes increase. The expenditure elasticity estimate for the number of meals equivalent is 0.1840, an indication that when food expenditure increases, consumers would not increase their number of meals too much.

The impacts of the addition of household member by age group on individual nutrient intake are also estimated and presented in Table 5. Over a half of the estimated household composition parameters are significantly different from zero at $\alpha = 0.05$ level. On average, the addition of a household member of ages between 7 and 18 years would increase the weekly household carbohydrate intakes and the addition of a household member of ages between 19 and 60 years would decrease the weekly household carbohydrate intakes. The addition of the very young and older member in a household would decrease the consumption of fats and oils. The negative impact estimates of the addition of household member on vitamin I group are unexpected. The addition of members of ages younger than 18 years would likely to increase the consumption of vitamins such as folate and vitamin B-12. The addition of members of ages younger than 7 years and between 19 and 45 years would decrease the consumption fibers.

Results also show that the addition of household member of ages between 13 and 18 would increase the consumption of minerals and the addition of older household members between ages over 19 years old would decrease the consumption of minerals in the household. The addition of a household member of any age would increase the number of meals equivalent by a little more than 2 meals per day; however, the addition of very young (0-6 years old) and older household members (older than 45 years) would increase the number of meals equivalent more than other age groups.

Concluding Remarks

This study attempts to characterize the household's preferences toward nutrients in food consumption. By following the traditional household production approach, shadow prices for nutrients in food consumption are calculated. Further, the cost function that generates the shadow prices appears plausible in terms of its elasticities of substitution and factor demand.

After obtaining the calculated shadow prices of nutrients, the nutrient demand functions are estimated. For each nutrient, these functions show that the own-price elasticity of demand for nutrient is inelastic, whereas the expenditure elasticities indicate that nutrient is a normal component of the demand for food. With other factors constant, increasing expenditures on food lead to increasing nutrients in food consumption. There appears to be complementarity in the demand for nutrients. This seems a logical result.

Table 1. Cost function parameter estimates

	Price of							
	Dairy	Meats	Veg&Fruit	Cereals	Other			
			α_i					
	-0.9751*	1.6507*	0.3383*	0.0416	-0.0555			
	(0.0318)	(0.0388)	(0.0327)	(0.0302)	(0.0426)			
Price of			α_{ij}					
Dairy	0.0544*	-0.0263*	-0.0083*	-0.0163*	-0.0035*			
	(0.0020)	(0.0019)	(0.0016)	(0.0013)	(0.0013)			
Meats		0.1467*	-0.0617*	-0.0480*	-0.0107*			
		(0.0030)	(0.0021)	(0.0016)	(0.0016)			
Veg&Fruit			0.0992*	-0.0259*	-0.0033*			
			(0.0026)	(0.0015)	(0.0015)			
Cereals				0.0953*	-0.0050*			
				(0.0017)	(0.0012)			
Other					0.0225*			
					(0.0018)			
Price of	Nutrient (θ_{ik})							
	Carbohydrate	Fats	Protein	Vitamin I	Vitamin II	Fiber	Minerals	No. of Meals Equivalent
Dairy	-0.0295	-0.0962	-0.1557	-0.0654	0.0348	-0.1292	0.4478	0.0177
	(0.0072)	(0.0063)	(0.0096)	(0.0052)	(0.0067)	(0.0057)	(0.0126)	(0.0047)
Meats	-0.2053	0.1198	0.7276	-0.0208	-0.0133	-0.0368	-0.5718	-0.0064
	(0.0088)	(0.0077)	(0.0118)	(0.0064)	(0.0081)	(0.0069)	(0.0153)	(0.0055)
Veg&Fruit	-0.0806	-0.0608	-0.2644	0.2311	-0.0710	0.1469	0.0857	-0.0110
	(0.0074)	(0.0065)	(0.0100)	(0.0054)	(0.0069)	(0.0059)	(0.0129)	(0.0046)
Cereals	0.2300	-0.0521	-0.1263	-0.1222	0.0620	0.0354	-0.0244	0.0037
	(0.0069)	(0.0060)	(0.0093)	(0.0050)	(0.0064)	(0.0054)	(0.0119)	(0.0044)
Other	0.0853	0.0893	-0.1813	-0.0228	-0.0124	-0.0163	0.0626	-0.0039
	(0.0097)	(0.0086)	(0.0129)	(0.0071)	(0.0090)	(0.0076)	(0.0168)	(0.0002)

Continue

Table 1. Cost function parameter estimates (continue)

	Nutrient							
	Carbohydrate	Fats	Protein	Vitamin I	Vitamin II	Fiber	Minerals	No. of Meals Equivalent
				β_k				
	0.1955	-0.3340*	0.3493	0.0563	-0.2382	-0.3622*	1.4534*	0.0649
	(0.2140)	(0.1818)	(0.3208)	(0.1595)	(0.2007)	(0.1769)	(0.4841)	(0.1511)
Nutrient				β_{hk}				
Carbohydrate	0.0358	-0.0700*	0.0825*	-0.0255	-0.0175	0.0735*	-0.0379	-0.0408*
	(0.0327)	(0.0203)	(0.0315)	(0.0178)	(0.0230)	(0.0209)	(0.0423)	(0.0177)
Fats		0.0945*	-0.0952*	0.0136	-0.0357*	0.0029	0.0847*	0.0208
		(0.0205)	(0.0286)	(0.0156)	(0.0195)	(0.0164)	(0.0354)	(0.0148)
Protein			0.2788*	-0.0731*	0.0121	-0.0466*	-0.0885	-0.0725*
			(0.0611)	(0.0247)	(0.0299)	(0.0259)	(0.0641)	(0.0233)
Vitamin I				0.0101	0.0412*	0.0124	0.0269	-0.0006
				(0.0180)	(0.0173)	(0.0135)	(0.0313)	(0.0125)
Vitamin II					-0.0747*	-0.0040	0.0691*	0.0079
					(0.0250)	(0.0172)	(0.0385)	(0.0164)
Fiber						-0.0756*	0.0387	-0.0027
						(0.0170)	(0.0320)	(0.0131)
Minerals							-0.1548	0.0322
							(0.0952)	(0.0290)
No. of Meals Equivalent								0.0641
								(0.0160)*

[a] The coefficient estimate for α_0 is –8.2978 with a standard error of 1.3520.

*Statistically different from zero at $\alpha = 0.05$ level. The values in parentheses are standard errors of estimates.

Table 2. Elasticities of substitution and factor demand calculated at sample means

	Dairy	Meats	Veg&Fruit	Cereals	Other
Elasticity of Substitution					
Dairy	-3.5218	0.3776	0.6862	0.2033	0.8248
	(0.1286)	(0.0459)	(0.0621)	(0.0641)	(0.0655)
Meats		-0.6729	0.1435	0.1392	0.8015
		(0.0261)	(0.0285)	(0.0294)	(0.0298)
Veg&Fruit			-1.5098	0.2595	0.9024
			(0.0568)	(0.0434)	(0.0431)
Cereals				-1.5590	0.8085
				(0.0617)	(0.0459)
Other					-4.3862
					(0.0725)
Elasticity of Factor Demand					
Dairy	-0.4387	0.1280	0.1458	0.0334	0.1315
	(0.0160)	(0.0156)	(0.0132)	(0.0105)	(0.0104)
Meats	0.0470	-0.2282	0.0305	0.0229	0.1278
	(0.0057)	(0.0088)	(0.0060)	(0.0048)	(0.0048)
Veg&Fruit	0.0855	0.0487	-0.3207	0.0427	0.1439
	(0.0077)	(0.0097)	(0.0121)	(0.0071)	(0.0069)
Cereals	0.0253	0.0472	0.0551	-0.2565	0.1289
	(0.0080)	(0.0100)	(0.0092)	(0.0102)	(0.0073)
Other	0.1027	0.2718	0.1917	0.1330	-0.6992
	(0.0082)	(0.0101)	(0.0092)	(0.0075)	(0.0116)

*Statistically different from zero at $\alpha = 0.05$ level. The values in parentheses are standard errors of estimates.

Table 3. Mean and standard deviation of shadow price

Nutrient	Mean	Std Dev
Carbo	0.0014	0.0013
Fats	0.0025	0.0020
Protein	0.0229	0.0098
Vit I	0.0031	0.0018
Vit II	-0.0002	0.0004
Fibers	0.0121	0.0174
Minerals	0.00002	0.0001
# Meals	0.0084	0.0614

Table 4. Nutrient expenditure and price elasticity estimates[a]

	Expenditure	Shadow Price of							
		Carbohydrate	Fats	Protein	Vitamin I	Vitamin II	Fiber	Minerals	No. of Meal Equivalent
Carbohydrate	0.8500	-0.1131	-0.1093	-0.2546	-0.1537	0.0354	-0.0181	-0.0220	-0.0057
	(0.0163)	(0.0064)	(0.0072)	(0.0160)	(0.0114)	(0.0033)	(0.0038)	(0.0018)	(0.0009)
Fats	1.0393	-0.1372	-0.0220	-0.5288	-0.0326	0.0233	-0.0123	-0.0158	-0.0004
	(0.0169)	(0.0066)	(0.0074)	(0.0165)	(0.0118)	(0.0034)	(0.0039)	(0.0018)	(0.0010)
Protein	0.9091	-0.0553	-0.0506	-0.4873	-0.0093	-0.0009	-0.0274	-0.0299	-0.0080
	(0.0102)	(0.0040)	(0.0045)	(0.0100)	(0.0071)	(0.0021)	(0.0024)	(0.0011)	(0.0006)
Vitamin I	1.0054	-0.0992	-0.0136	-0.1757	-0.4108	0.0111	-0.0137	-0.0030	0.0027
	(0.0189)	(0.0074)	(0.0083)	(0.0185)	(0.0132)	(0.0038)	(0.0044)	(0.0020)	(0.0011)
Vitamin II	0.8519	-0.0238	-0.1215	-0.1864	-0.2631	0.0658	-0.0275	-0.0176	0.0061
	(0.0191)	(0.0075)	(0.0084)	(0.0187)	(0.0133)	(0.0039)	(0.0044)	(0.0021)	(0.0011)
Dietary Fibers	0.8555	-0.0332	-0.0860	-0.3284	-0.0614	0.0287	-0.1231	-0.0289	-0.0017
	(0.0194)	(0.0077)	(0.0086)	(0.0191)	(0.0136)	(0.0040)	(0.0045)	(0.0021)	(0.0011)
Minerals	0.9502	-0.0867	-0.0371	-0.4867	-0.0141	-0.0123	-0.0322	-0.0383	-0.0002
	(0.0107)	(0.0042)	(0.0047)	(0.0106)	(0.0075)	(0.0022)	(0.0025)	(0.0012)	(0.0006)
No. of Meal Equivalents	0.1840	-0.0384	-0.0049	-0.1604	0.0072	-0.0017	-0.0119	-0.0089	0.0086
	(0.0081)	(0.0033)	(0.0038)	(0.0080)	(0.0060)	(0.0017)	(0.0020)	(0.0009)	(0.0005)

[a] All elasticities are statistically different from zero at $\alpha = 0.05$ level. The values in parentheses are standard errors of estimates.

Table 5. Estimated impact of household member of the demand for nutrient

	Household Member Age Group					
	0-6 yrs	7-12 yrs	13-18 yrs	19-45 yrs	46-60 yrs	60+ yrs
Carbohydrate	101.69	247.99*	328.02*	-108.51*	-116.93*	-129.93
	(73.35)	(70.10)	(67.40)	(61.96)	(69.87)	(81.40)
Fats	-56.12*	18.96	25.17	14.90	-45.95	-91.91*
	(31.62)	(30.22)	(29.06)	(26.71)	(30.12)	(35.09)
Protein	-32.50*	-1.49	19.84	-14.37	-5.02	-33.96*
	(14.81)	(14.16)	(13.61)	(12.51)	(14.11)	(16.44)
Vit I	-121.08*	-33.80	22.61	-122.04*	-11.37	-45.63
	(50.80)	(48.54)	(46.68)	(42.91)	(48.39)	(56.37)
Vit II	-4.27	184.45*	285.33*	-192.13*	15.28	-28.30
	(93.17)	(89.04)	(85.61)	(78.70)	(88.75)	(103.39)
Fibers	-8.80*	-5.65	-4.59	-13.71*	-1.80	-3.00
	(5.23)	(4.99)	(4.80)	(4.41)	(4.98)	(5.80)
Minerals	-1,391.67	2,388.66	3,594.40*	-4,737.91*	-3,607.31*	-5,847.84*
	(1,528.11)	(1, 460.38)	(1,404.17)	(1,290.90)	(1,455.74)	(1,695.81)
No. Meals	16.47*	13.39*	12.03*	12.67*	14.02*	15.17*
	(0.25)	(0.27)	(0.27)	(0.23)	(0.26)	(0.32)

*Statistically different from zero at $\alpha = 0.05$ level. The values in parentheses are standard errors of estimates.

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