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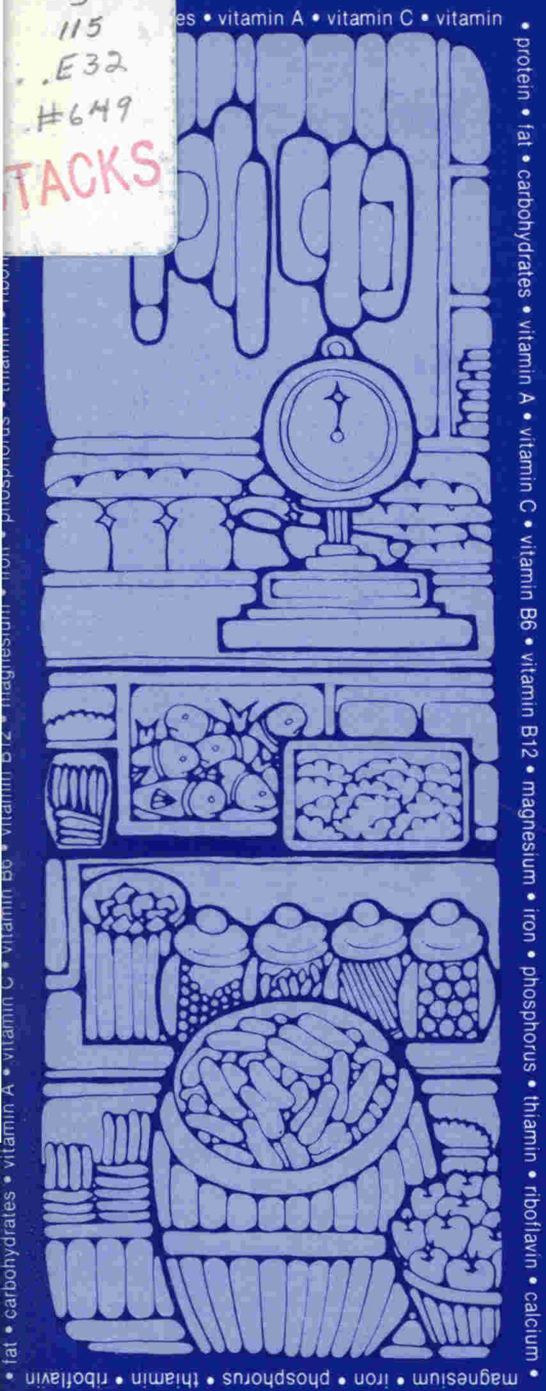

Socioeconomic Factors Affecting the Marginal Implicit Prices of Food Nutrients

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Introduction

Food expenditure and consumption in the United States have changed significantly in recent years. For example, the percent of disposable income spent on food fell from 17.2 to 15.1 between 1970 and 1984.[1] When this is separated into food consumed at home and food consumed away from home, the percents fell from 13.2 to 10.8 for the former and rose from 4.0 to 4.3 for the latter. Furthermore, the proportions of the types of food items consumed have changed. For example, per capita consumption of meat was 203.4 pounds in 1970 and 184.8 pounds in 1984, and per capita consumption of fresh fruits and vegetables rose from 195.4 pounds in 1970 to 208.3 pounds in 1981.

Research into the causes of the changing composition of food demand has focused on two factors. One is the socioeconomic distribution of the population.[2] Food consumption varies by household composition, so changes in the distribution of the population among household types result in changing patterns of food demand. The other factor is the change in consumer attitudes.[3] Increased awareness of the nutritional content of foods and their effects on health change perceptions about the utility derived from food commodities.

Much of the analysis of food demand has been based on the traditional economic analysis of consumer choice.[4] That is, a consumer's utility is assumed to be derived directly from market goods. Models derived within this framework lead to estimation of demand and expenditure equations, Engel functions, adult equivalence scales, and probabilities of purchasing.

Derived demand models have a different perspective of consumer behavior. These models assume that purchases of market goods comprise an intermediate stage in the utility maximization process, as opposed to the market goods being the end objective in the neoclassical framework. One type of derived demand model is the characteristics model. Its starting point is the assumption that consumers obtain utility from the physical properties, called characteristics or attributes, that market goods possess. For example, neoclassical theory assumes that quantities of foods consumed generate utility, whereas characteristics theory assumes that attributes, such as the nutritional content of foods, generate utility. The distinctions among models extend beyond abstract theoretical interest because the different models provide different perspectives on the determinants of consumer demand. Thus, if we are to gain a better understanding of consumer demand, it is essential that these models be developed and estimated to the extent possible.

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[1]Data reported here are found in *Food Consumption, Prices, and Expenditures*, Statistical Bulletin 736, U.S. Department of Agriculture, Economic Research Service (1985).

[2]For example, see Capps.

[3]For example, see Chavas and Kepplinger; Price et al.

[4]An excellent survey of research in this area is found in Capps.

Solving the utility maximization problem within the characteristics framework leads to two relationships that have been reported in the literature [Ladd]. One is the hedonic price equation, in which the market price of a good is a function of the attributes the respective good possesses. Such equations reflect consumers' marginal implicit prices of the characteristics. The other relationship is the attribute demand equation, in which the demand for an attribute is a function of all attribute prices, income, and household demographics.

This study proposes an extension of the characteristics model to a third relationship — the marginal implicit prices of an attribute as a function of socioeconomic variables. A method for generating estimates of this relationship is outlined. Preliminary estimates are presented and evaluated.

The Model

Assume that food is strongly separable from all other goods purchased by a consumer, so attention can focus on food-related decision making alone. A representative consumer is viewed as deriving utility from the attributes contained in the food commodities. Attributes are measurable properties of goods that generate utility. Following Terry (1985), food items contain a common set of m nutritional attributes. Other attributes such as taste, texture, and organoleptic features may be part of the decision making, but it is assumed that these factors are strongly separable from nutritional considerations, so nutritional attributes can be analyzed independently. A common attribute is one which is found in two or more foods. Given the nutritional attribute focus of the present study, the common attribute model is well suited for this analysis. Let X_j represent the quantity of attribute j consumed, so the utility derived from food, U, is a function of the attributes consumed.

$$(1) \qquad U = U(X_1, \ldots, X_m).$$

The amount of each attribute obtained by the consumer depends on 1) the quantities of the goods consumed and 2) the extent to which each good provides the attributes. Let x_{ij} denote the amount of attribute j per unit of good i, Q_i represent the quantity of good i used by the consumer, and n equal the number of food items. Then X_j can be expressed as

$$(2) \qquad X_j = f_j(Q_1, \ldots, Q_n, x_{1j}, \ldots, x_{nj}).$$

Substituting equation (2) into equation (1) indicates that the level of utility is determined by the quantities of attributes contained in a unit of each good and the quantity of each good consumed.

$$(3) \qquad U = U(Q_1, \ldots, Q_n, x_{11}, \ldots, x_{nm}).$$

Given a fixed budget allocated to food expenditure, M, and market prices, P_i, the budget constraint is

$$(4) \qquad M = \sum_{i=1}^{n} P_i Q_i.$$

Utility, as expressed in equation (3), is maximized subject to the budget constraint shown in equation (4) via the Lagrangian expression where λ is the Lagrangian multiplier:

$$(5) \qquad L = U + \lambda(M - \sum_{i=1}^{n} P_i Q_i).$$

The consumer's decision making centers on the marketplace purchases of Q_i, so the first order conditions are obtained from the partial derivatives of L with respect to Q_i and λ. Rearranging these necessary conditions and recognizing that λ is the marginal utility of money leads to equation (6), which Terry has shown to be analogous to that of Ladd and Suvannunt,[5] except that there is no unique attribute term:

$$(6) \qquad P_i = \sum_{j=1}^{m} \frac{\partial X_j}{\partial Q_i} \frac{\partial M}{\partial X_j} \qquad \text{for } i = 1, \ldots, n.$$

The second term on the right-hand side denotes the marginal rate of substitution for the jth attribute, or $\partial M/\partial X_j = (\partial U/\partial X_j)\,(\partial M/\partial U)$. It represents the consumer's marginal valuation of an incremental unit of the respective attribute. Equation (6) is the hedonic price equation. The form of the hedonic price equation has been discussed by Griliches, Kravis and Lipsey, Ladd, LaFrance, and Morgan, but no agreement on the explicit relationship has been achieved.

Two simplifying assumptions can be employed that facilitate the estimation of equation (6) by turning it into a linear form. One assumption is that foods possess attributes in constant proportions, so $\partial X_j/\partial Q_i = x_{ij}$. For example, the amount of protein contained in an ounce of milk is the same whether the consumer drinks a glass or a gallon. The second assumption is that the marginal rate of substitution of income for an attribute is also assumed to be constant, or $\partial M/\partial X_j = \beta_j$. Since this rate of substitution is

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[5]The Ladd-Suvannunt model assumes that each good produces one attribute found in no other food. Thus, there are n unique attributes, one for each good. Letting X_i^* denote the ith unique attribute, their form of equation (6) is

$$P_i = \sum_{j=1}^{m} \frac{\partial X_j}{\partial Q_i} \frac{\partial M}{\partial X_j} + \frac{\partial X_i^*}{\partial Q_i}.$$

the ratio of the marginal utility of X_j to the marginal utility of income, this assumption has been considered equivalent to assuming constant marginal utilities of an attribute and income, or that each changes in such a way that the ratio remains constant. Together, the two assumptions lead to equation (7), which indicates the consumer alters purchases of goods, and thereby the X_j's obtained. The market price relationship has been simplified to where it is the sum of the constant implicit prices multiplied by the attribute proportions:

$$(7) \qquad P_i = \sum_{j=1}^{m} \beta_j x_{ij}.$$

The model can be adjusted from a representative consumer to one accommodating different consumer units. The form of the data used in this study is the household unit. Households pay different market prices for commodities, and they may have different marginal implicit valuations of attributes. The former is to account for price variations within and across shopping areas. The latter is assumed to be a result of socioeconomic factors that affect the utility derived by households from the attributes. If there are H different households, then equation (7) becomes

$$(8) \qquad P_i^h = \sum_{j=1}^{m} \beta_j^h x_{ij} \qquad \text{for } i=1,\ldots,n \text{ and } h=1,\ldots,H.$$

Notice that the x_{ij}'s are common to all households. That is, from the consumer's perspective the x_{ij}'s are exogenous. A household takes the physical attributes of a food item as given and decides how much Q_i to purchase in order to obtain X_j in maximizing utility. However, households' valuations of attributes could be different. The approach taken here is that households with a comparable set of characteristics have similar valuations of attributes. These do not vary with the level of food consumed, Q_j, due to the assumption of constant marginal implicit prices. But the valuations can differ across households. More precisely, the assumption is

$$(9) \qquad \beta_j^h = f(V),$$

where V is a vector of socioeconomic variables. Assume a linear relationship exists as an initial approximation:

$$(10) \qquad \beta_j^h = \sum_{k=1}^{K} \delta_k v_k,$$

where K is the number of socioeconomic variables.

Neither equation (9) nor equation (10) has been discussed in the characteristics model framework. They represent an extension of the more conventional analyses. Researchers have derived, instead, demand equations for nutrients in which the X_j's are functions of the β_j's and V.[6] These nutritional demand studies then focus on interpreting the effects of V on X_j. Often included in these approaches are participation in public assistance programs such as food stamps and school breakfasts and lunches.

The perspective provided by equation (9) is different. Here attention is drawn to the household valuations of nutrients as determined by V. Through an examination of the determinants of marginal implicit prices, insights regarding household valuations of nutrients can be obtained. They can also be used to forecast changes in the nutritional intakes of various segments of the population.

Data

The 1977-78 Nationwide Food Consumption Survey (NFCS) is a data set that is amenable to estimating equations (8) and (10). Food consumed away from home is not included, so it is assumed that food consumed at home is strongly separable from food consumed away from home. Such a view is consistent with a constant marginal rate of substitution of nutrients for income. Household-specific data on the quantities and cost of food used are provided, so the estimates of marginal implicit prices associated with equation (8) can be obtained. The detail available regarding the foods purchased and their nutritional content allows for specific foods to be used in the analysis. The price paid is the cost divided by the respective quantity. These computed prices are the observations of the dependent variable in equation (10).

Haneman and Ladd have both discussed the estimation procedures. The model assumes that each food is distinct, producing a specific bundle of nutrients. The assumption of constant marginal implicit prices leads to linear hedonic price functions that can be estimated. Results are then used in the household valuation of nutrients equation.

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[6]Examples of such research are Adrian and Daniel; Allen and Gadson; Chavas and Kepplinger; Davis and Neenan; Ladd and Suvannunt; Ladd and Zober; Lane; LaFrance; Price et al.; Searce and Jensen; and Terry.

Only the spring wave for the contiguous states is used. This is necessary to keep the number of observations manageable in an estimation step described below. Furthermore, it eliminates estimation problems associated with seasonal variations in market prices, availability of homegrown foods, and different seasonal life-styles and consequent nutritional needs. Another desirable feature is that a cross section of households was sampled, as opposed to more recent surveys of specific household types such as the elderly. This is important, given the present interest in a proposed methodology based on socioeconomic differences among households in the valuations of nutrients.

Although the spring wave contains observations on approximately 3,300 households, some are not included in the present analysis due to the following considerations: missing data, household incomes reported as being less than the yearly equivalents of food expenditures, and households purchasing few or no foods. Altogether, 1,138 households were eliminated, leaving a sample of 2,164. Food use data were for a one-week recall.

The nutritional contents for 14 nutrients by food item are included with the data.[7] Preliminary estimates of equation (8) were for all 14 nutrients, so, in order to have sufficient degrees of freedom, only households that purchased at least 20 food items were included. Fewer than 200 households of the 1,138 that were omitted altogether were eliminated in this step, so only a minimal sample selection bias was introduced here.

Multicollinearity among nutrients necessitated aggregation. In particular, a B-complex was generated by combining thiamin, riboflavin, niacin, and vitamins B6 and B12. Minerals were the combination of calcium, iron, magnesium, and phosphorus. These aggregations are consistent with the view that consumers assess broader groups of nutrients, as noted by Weimer. The aggregation also addresses the argument that many foods do not have nutritional labelling, so consumers are unaware of nutritional content. The perspective taken here is that the consumer is more likely to be cognizant of broader groups of nutrients and does make evaluations of foods on the basis of the market price and approximations of nutritional content as represented by the NFCS nutrient data.[8]

Another aggregate, food energy, was also considered. It is a combination of protein, fat, and carbohydrates, measured in calories. However, preliminary regressions indicated that including the variables separately provided a better statistical fit and enabled an examination of these nutrients individually. Further analyses, as a result, did not include food energy.

A final adjustment was made to account for the NFCS sampling biases. Over and under representation of subgroups of the population occurred. This

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[7]They are protein, fat, carbohydrates, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, and vitamin C.

[8]Given that so few households were eliminated by the 20-food-item criteria and that the estimation required a large amount of computer time, the decision was to continue the estimation with the 2,164 households.

necessitated the use of weighting factors in estimating equation (10). It was not necessary to use the weights in estimating equation (8) because these estimates were generated on a household by household basis.

The socioeconomic variables included in the vector V of equation (10) are listed in Table 1, along with descriptions of their measurement. Income determines the ability to pay for various attributes. As income increases, and assuming food is a necessity, the percent of income allocated to food expenditure declines. This may be reflected in declining implicit marginal valuations of nutrients. However, food demand is a derived demand. It may be that consumers' income elasticities for nutrients are different from those for food. Diets change with income, so that there are different income effects across nutrients.

Nutritional needs change with age, and this has been found to be a factor in the consumption of specific foods [e.g., Blaylock and Burbee]. In order

Table 1. Socioeconomic Variables Selected as Determinants of Imputed Marginal Prices of All Food for U.S. Households, Spring, 1977

Variable	Definition Based on 1977-78 NFCS
Income	1976 income after taxes, dollars.
Age distribution	Proportion of household members in selected stages of the life cycle. P1 = proportion less than or equal to age 2. P2 = proportion older than 2 but less than or equal to 12. P3 = proportion older than 12 but less than or equal to 19. P4 = proportion over 19 but less than 40. P6 = proportion over 64. The omitted category is the proportion between 40 and 64.
Education of meal planner	Educational attainment of the meal planner. ED1 = elementary school. ED2 = high school. ED3 = attended college. ED4 = college graduate. The omitted category is ED1.
Urbanization	Residential location is represented by nonmetropolitan, suburban, or central city. The omitted category is nonmetropolitan.
Region	Region of the country is Northeast, North Central, South, or West. The omitted category is West.
Race	Race of the respondent is white, black, or other. The omitted category is other.
Meal adjustment	The difference between the total number of meals served by a household and the number of family members multiplied by 21 (i.e., 21 = number of meals for 1 person for 1 week).
Food stamps	The bonus value of food stamps equals the face value minus the amount paid.
Employment status of homemaker	Person responsible for meal planning is employed outside the home: yes = 1 and no = 0.

to incorporate this into the analysis, the age distribution of household members is grouped into the cells identified in Table 1. The expectation is that, during the years of rapid physical growth and activity, the household valuations of nutrients are the highest.

Educational attainment of the meal planner is included [Adrian and Daniel; Searce and Jensen]. This is to reflect, in part, possible variations in the awareness of the meal planner with respect to the nutritional content of food items. It also is to account for an increased ability to process nutritional information about food. As educational attainment increases, the expectation is that the valuations of some nutrients will increase, especially protein and vitamins, while those of others decline, especially fat.

Urbanization may affect household valuations of nutrients [Burk]. Access to food stores offering wider varieties of commodities is more restricted in nonmetropolitan areas. Furthermore, there may be differences in lifestyles among rural, suburban, and central city locations. Also, the availability of nutritional information may be lower in nonmetropolitan areas.

Regional patterns of food consumed [Smallwood and Blaylock] may reflect regional valuations of nutrients. Consequently, to accommodate this possibility, regional dummy variables are incorporated into the analysis.

Ethnic backgrounds have also been found to affect attribute demand [Adrian and Daniel; Burk; Raunikar et al.]. Dummy variables for white, black, and other races are included in light of this research.

A meal adjustment variable is included to account for differences in the number of meals eaten at home. Some households may have consumed more food away from home. Or, households may have had guest, skipped, or free meals. One person normally eats 21 meals a week, so an adjustment was made for the household size and 21-meal standard. As the meal adjustment increases, the expectation is that the valuations of nutrients increase because the household is relying more heavily on at home meals for a balanced diet.

Participation in the food stamp program affects the relative price of food versus all other goods. It has an effect on nutrient demand [Chavas and Keplinger]. The extent of the effect on implicit marginal prices depends on the value of the bonus the stamps provide to the household. The larger the bonus, the greater the reliance on food stamps. Its impacts on the nutrient valuations would be similar to those of income.

The employment status of the meal planner is also included. This is to account for a more restrictive constraint on home production activities and an increase in food consumed away from home due to job-related activities. A consequence may be a decline in the valuations of nutrients of foods consumed at home, if the meals obtained elsewhere contain a balanced diet.

Results

Equation (8) was estimated for the nutrients protein, fat, carbohydrates, minerals, vitamin A, vitamin B-complex, and vitamin C. Separate estimates for each household in the sample that satisfied the selection criteria outlined above were derived. Since 2,164 households were included, there are far too many sets of β_j^h values to analyze individually or report. However, one can gain insight into the relationships associated with equation (8) by pooling the households and estimating this equation for the merged set. Thus, the per unit market prices paid by households were regressed on the nutritional attributes. Results obtained from this procedure should be interpreted as estimates of an average household's implicit prices.

Table 2 presents the results of the pooled regression. The estimates are for a no-intercept regression. This is consistent with the model that generated equation (8). Other regressions were computed using an intercept, and the results were analyzed. Comparisons of no-intercept regressions are somewhat complicated. Viewed from statistical perspective, two alternative hypotheses about the total, explained, and residual variations are involved, so measures of overall fit are not comparable [Brownlee]. The conventional t-test for the significance of the intercept was marginally significant, but some of the estimated coefficients of nutrients had significant negative coefficients, which contradicted the theory. Furthermore, it was not clear how to interpret an intercept because the household equations were estimated across food items. Finally, since there were too many equations to analyze household by household, the analyses of other regressions were restricted to the pooled

Table 2. Estimated Implicit Prices for Nutritional Attributes of All Food for U.S. Households, Spring, 1977[a]

Attributes	Implicit Prices	Standard Errors
	dollars per unit	dollars per unit
Protein (gm)	.00440*	.00011
Fat (gm)	.00248*	.00004
Carbohydrates (gm)	.00021*	.00002
Minerals (mg)	.00012*	.00000
Vitamin A (I.U.)	−.00001*	−.00000
B-complex vitamins (mg)	.02335*	.00015
Vitamin C (mg)	.00165*	.00003
R^2	.19[b]	

[a]For the pooled sample, a total of 101,649 food items were used.

[b]R^2-like value computed as the ratio of the sum of the predicted variations, $\Sigma(\hat{P}_i - \bar{P})^2$, to the sum of the total variations, $\Sigma(P_i - \bar{P})^2$.

*Significant at the .01 level.

data, and the pooling could be contributing to a marginally significant coefficient. These considerations, coupled with an interest in not being led by the data, prompted further work with the no-intercept form.

Positive estimates reflect positive valuations of the nutrients. Coefficients with negative signs are interpreted as the willingness to pay for the removal of an attribute. The representative household of the United States would be willing to pay $0.0044 for an additional gram of protein; the representative household is estimated to be willing to pay an additional $.001 for the removal of a 100 I.U. of vitamin A, etc.

Ladd and Suvannunt encountered similar negative results with their estimated coefficients for vitamin C and phosphorus. Their explanation was that vitamin C and phosphorus degrade or are proxies for characteristics that degrade taste, texture, or odor. However, such an explanation is not consistent with the separability assumption between nutrients and other attributes. The interpretation here is different. The positive coefficient for vitamin C could reflect increased consumer awareness of the importance of this vitamin and/or a different market basket of goods purchased since the Ladd and Suvannunt study. The incidence of vitamin A in foods is highly concentrated in fruits and vegetables, and a small serving of these foods provides all of a person's recommended daily allowance (RDA) [Pennington]. These observations lead to the possibility that consumers are relatively unconcerned about the presence of vitamin A in their diets, resulting in a negative coefficient.

An alternative way of summarizing the results of estimating equation (8) for 2,164 households is to present statistics on the distributions of the estimated coefficients. This is done in Table 3. Not surprisingly, the means are comparable to those obtained from the pooled sample (Table 2). Minimum estimated implicit marginal prices for all attributes are negative, while maximums are positive. The coefficients of variation are largest for carbohydrates, 4.78, and smallest (in absolute value) for fat, .69.

Examination of these distributions points out the importance and relevance of investigating the determinants of variation in household valuations of nutrients. Each nutrient received at least one negative estimated valuation from at least one household. On average, households' valuations of the nutrients are positive, with the exception of vitamin A. But even vitamin A has positive estimated valuations by some households. Overall, the inference is that if one is to understand the nutritional composition of household food consumption, it is appropriate to estimate equation (10) and interpret the results. The data also indicate that there is enough variation in household estimated implicit marginal valuations to permit such a regression analysis.

Several criteria were used in evaluating the estimates of equation (10). These included parameter values, signs of the estimated coefficients, significance of the estimated coefficients, and overall goodness-of-fit reflected in the R^2 and F values. Weighted least-squares regressions were computed in all cases. The weights were those provided on the NFCS tape to adjust for sampling biases. In the following discussion a 10 percent level of significance is used.

Table 3. Distribution of Estimated Implicit Marginal Prices for Nutritional Attributes of All Food for U.S. Households, Spring, 1977[a]

Attributes	Mean	Minimum	Maximum	Coefficient of Variation
Protein (gm)	.00301	−.05648	.058437	3.44
Fat (gm)	.00262	−.01248	.02184	.69
Carbohydrates (gm)	.00032	−.01805	.01222	4.78
Minerals (mg)	.00021	−.00118	.00229	1.33
Vitamin A (I.U.)	−.00002	−.00052	.00049	−2.98
B-complex vitamins (mg)	.02167	−.08982	.35821	1.07
Vitamin C (mg)	.00137	−.05224	.03986	2.64

[a]Summary data on estimated coefficients obtained from regressions for each of the 2,164 households drawn in the sampling procedure.

Various functional forms were estimated. Income and the bonus value of food stamps were included separately. However, the estimated coefficients proved to be not significantly different from zero. This led to adding the bonus value to income, forming the variable INCB, as had been done in expenditure studies [Blaylock and Burbee; Smallwood and Blaylock]. INCB, $INCB^2$, and income without the bonus were included in various regression equations to determine if there was a second-order relationship. None of these income measures had a significant coefficient, with the exception of $INCB^2$ in the fat equation, and in all cases the R^2 and F values suggested the equations presented below provided better statistical fits. The size of the household, SIZE, or its reciprocal [Blaylock and Burbee, Smallwood and Blaylock] was entered. Natural logs of INCB, SIZE, and 1/SIZE were also used. Log transformations of the dependent variables were not computed because of the presence of negative imputed prices, so eliminating these observations would have fostered a sample selection bias.

Table 4 presents the estimated equations that conform best to the criteria outlined above. The overall measures of goodness-of-fit, while low, are comparable to other cross-section studies of individual household behavior. Each of the computed F values is significantly different from zero.

There are several ways of viewing the results. One is that the estimated imputed values, the dependent variables obtained via equation (8), have

Table 4. Socioeconomic Determinants of Imputed Nutrient Prices (t-Values in Parentheses)

Variable	Protein[a]	Fat[a]	Carbo-hydrates[a]	Minerals[b]	Vitamin A[c]	B-Complex[b]	Vitamin C[b]
	gm	gm	gm	mg	IU	mg	mg
Intercept	.0016	2.974**	.2478	.2221**	−.0082	.0284**	2.3790**
	(1.03)	(10.87)	(1.09)	(5.21)	(1.05)	(7.69)	(4.83)
INCB	.0001	.0001**	.0001	.0001	−.0001	.0001*	.0001
	(1.25)	(2.30)	(.03)	(.20)	(.13)	(1.94)	(.41)
Location							
City	.0015**	−.0298	−.0593	.0124	.0016	−.4013	−.3044
	(2.50)	(.28)	(.68)	(.76)	(.55)	(.28)	(1.61)
Suburb	.0009*	.0110	.0611	.0251*	.0003	−3.1209*	−.3804**
	(1.66)	(.11)	(.76)	(1.66)	(.09)	(2.38)	(2.18)
Northeast	.0005	.3572**	.0054	.0459**	−.0083**	3.0333*	−.1958
	(.65)	(2.99)	(.05)	(2.47)	(2.43)	(1.88)	(.91)
North Central	−.0013*	.3025**	−.2043**	.0497**	−.0088**	.3682	−.0789
	(1.83)	(2.56)	(2.08)	(2.70)	(2.62)	(.23)	(.37)
South	−.0019**	.2168*	−.3750**	.0340*	−.0072**	4.1119**	−.2131
	(2.72)	(1.81)	(3.75)	(1.82)	(2.10)	(2.54)	(.99)
Net meals	.0005	−.1074*	−.0086	−.0098	−.0032*	−.3300	−.0786
	(1.56)	(1.86)	(1.8)	(1.08)	(1.95)	(.42)	(.75)
Education							
ED2	.0009	−.3199**	.0464	.0218	.0029	−1.5478	−.4680**
	(1.20)	(2.56)	(.45)	(1.12)	(.83)	(.92)	(2.08)
ED3	.0010	−.2653*	.2405*	.0057	.0008	−3.9163*	−.1646
	(1.12)	(1.73)	(1.88)	(.24)	(.18)	(1.89)	(.60)
ED4	.0010	−.1647	.2914**	−.0107	.0032	−3.2589	−.4428
	(1.02)	(.98)	(2.08)	(.41)	(.66)	(1.44)	(1.46)

Age distribution							
P1	.1040**	.5284	.7914**	-.2353**	.0250**	-25.9829**	1.0955
	(4.08)	(1.21)	(2.17)	(3.45)	(2.01)	(4.39)	(1.39)
P2	.0012	.6276**	.7889**	-.0157	-.0186**	-11.2294**	.2141
	(.75)	(2.22)	(3.36)	(.36)	(2.31)	(2.95)	(.42)
P3	.0003	.3083	.6157**	-.0145	-.0010	-7.7640*	.2445
	(.19)	(1.01)	(2.42)	(.31)	(.12)	(1.89)	(.45)
P4	.0018**	-.1834	.2688**	-.0561**	.0044	-1.0741	.6382**
	(2.07)	(1.25)	(2.19)	(2.44)	(1.06)	(.54)	(2.41)
P6	-.0017*	.0268	-.2250*	-.0311	-.0040	-.9175	-.5747**
	(1.83)	(.17)	(1.72)	(1.27)	(.89)	(.43)	(2.04)
Race							
White	-.0002	-.1201	.1864	0.0311	-.0048	-2.0787	-1.6733
	(.19)	(.57)	(1.05)	(.94)	(.80)	(.73)	(.44)
Black	.0030**	-.1509	.1107	-.1240**	-.0024	-4.8247	.4435
	(2.15)	(.63)	(.56)	(3.33)	(.36)	(1.50)	(1.03)
Homemaker Employed	-.0005	.0358	.0201	.0072	-.0001	1.6823	.1489
	(.92)	(.40)	(.27)	(.52)	(.04)	(1.41)	(.93)
Household Size (Log)	-.0004	-.5402**	-.2667**	-.0135	-.0018	-2.1058	-.4202*
	(.58)	(4.22)	(2.50)	(.68)	(.50)	(1.22)	(1.82)
R^2	.051	.024	.051	.039	.018	.050	.022
F	5.61**	2.53**	5.63**	4.22**	1.95**	5.51**	2.40**

[a]Coefficients measure the effect of the respective independent variable on the per gram imputed nutrient price.

[b]Coefficients measure the effect of the respective independent variable on the per 1,000 milligram imputed nutrient price.

[c]Coefficients measure the effect of the respective independent variable on the per 1,000 international units imputed vitamin A price.

*Significant at the .10 level.

**Significant at the .05 level.

relatively large stochastic components due to restrictions associated with the linear functional form. It could also be that functional form problems are also present with the estimation of equation (10). Another possibility is that the correct estimation procedures have been employed, and a fairly large stochastic component associated with consumer behavior is involved. Omitted variables that could affect tastes for attributes may also be a factor.

The following discussion is based on the assumptions that the correct procedures have been used and that all of the relevant socioeconomic variables have been incorporated. With respect to omitted variables, the perspective taken is that socioeconomic measures included in the analysis are highly correlated with tastes, resulting in a small omitted variable bias.

Interpretation of the intercept depends upon the omitted categorical variables. These are nonmetropolitan, the West region, an elementary school education at most, proportion of household members between 40 and 64 years old, race is other than black or white, and there is one person in the household. The intercept is positive and significant in the fat, minerals, B-complex, and vitamin C equations. It is not significant in the remaining three: protein, carbohydrates, and vitamin A. In the four instances where the intercept is positive and significant, the estimated values are small relative to their average imputed household prices (Table 2). This seems reasonable because the one-person household would have no income, including food stamps.

INCB is positive and significant in two instances, the fat and B-complex equations. An inference is that consumer's marginal valuations of nutritional attributes do not change with income with the exceptions of fat and B-complex vitamins, where increases in income lead to small increases in implicit valuations of these two nutrients. Given the role of nutrients as necessities, it is not surprising to observe this result. It suggests that the purchases of food items may change with income [e.g., Smallwood and Blaylock], but the underlying valuations of nutrients do not change with income, *ceteris paribus*.

Nutrient valuations are affected by the location of the household. Central city households tend to have higher valuations of protein, *ceteris paribus*. With respect to the other six nutrients, there appear to be no differences between nonmetropolitan and central city valuations. However, suburban households have significantly different valuations in four instances. These consumer units have significantly lower valuations, *ceteris paribus*, of the B-complex vitamin and vitamin C. Slightly higher implicit prices are found for suburban residents for minerals and protein.

Imputed prices also vary by region relative to the West. The Northeast has significant positive coefficients in the fat, minerals, and B-complex equations, and a significant negative coefficient in the vitamin A equation. North Central region households have a significantly higher imputed fat price and significantly lower valuations of protein, carbohydrates, and vitamin A. Positive significant coefficients for Southern households occur for fat, minerals, and the B-complex vitamin, while significant negative coefficients occur for protein, carbohydrates, and vitamin A. The South appears to be the most different from the other regions, since six of the seven price equations have their respective coefficients significantly different from zero.

The net amount of meals prepared at home has relatively small negative effects on the valuations of fat and vitamin A. The inference is that, for five nutrients, consumer valuations are not affected by the presence of guests or by skipped meals or meals eaten away from home.

Educational attainment has significant effects in 6 of the 21 instances. Significant negative coefficients are obtained for attending college in the B-complex vitamin equation, having at most an elementary education in the vitamin C equation, and either an elementary education at most or at least attending college in the fat equation. Positive significant coefficients for carbohydrates are found for at least attending college or beyond college. However, in general, educational attainment does not seem to have an effect on nutritional valuations.

Age distribution affects imputed prices. The percent of children two years old or younger has significant negative coefficients in the B-complex vitamin and minerals equations, and significant positive coefficients for protein, carbohydrates, and vitamin A. Children between 2 and 13 years old as a percent of the household are associated with significantly lower valuations of vitamin A and B-complex vitamin nutrients and significantly higher fat and carbohydrates imputed prices. The percent of teenage children in the household has a significant positive coefficient for carbohydrates and a significant negative coefficient for B-complex vitamin imputed prices. The percent of young adults in the consumer unit has significant positive effects on the imputed prices of protein, carbohydrates, and vitamin C, whereas a significant negative coefficient is obtained for minerals. Finally, older individuals as a percent of the household have significant negative coefficients for protein, carbohydrates, and vitamin C prices.

Race plays a relatively minor role in the determination of imputed prices of nutrients. White households do not have a significant coefficient in any of the equations. Black households have significantly lower inputed valuations of minerals and significantly higher valuations of protein than other race households.

The employment status of the homemaker is not significant in any equation. It suggests that this variable does not affect imputed prices. Thus, household valuations are not related to whether the homemaker works in the marketplace.

Household size has significant negative effects on the imputed prices of fat, carbohydrates, and vitamin C. It suggests, *ceteris paribus*, that in these instances increases in the number of people lead to lower valuations of these three nutrients, but the valuations of protein, minerals, B-complex vitamin, and vitamin A are not affected.

Conclusions

The characteristics model assumes the demand for a market good is derived from the attributes it contains. Such an approach to the analysis of consumer decision making leads to the hedonic price equation, which relates the price paid for a good to the attributes it possesses. Marginal implicit prices reflect the consumer's valuations of incremental units of the attributes. This model has been extended to relationships in which the marginal implicit prices are functions of socioeconomic variables.

The specific form of the characteristics model that has been applied is a new version that assumes market goods generate a common set of attributes and no unique attributes. It was applied to the food sector with specific attention directed toward nutritional attributes. A methodology for estimating the new relationship was outlined using the 1977-78 Nationwide Food Consumption Survey. Although this data set is not ideal, it did represent the most recent one available, which contained the necessary data for a wide range of households. Thus, preliminary estimates of the implicit price equations for households were obtained.

These initial results suggest that further work with the implicit price model is warranted. Estimation of the hedonic price equation obtained a significant overall fit and significant estimated marginal implicit prices. Similarly, estimation of the marginal implicit price equations obtained a significant overall fit and significant coefficients. The observed relationships were also consistent with the theoretical model.

However, the results must be tempered with the realization that limiting assumptions were made to arrive at the equations to be estimated. Of particular concern is the assumption of constant marginal utility. Relaxing this condition so that diminishing marginal utility could be incorporated introduces considerable theoretical and empirical complexities and was beyond the scope of the preliminary analysis. Another concern was the extent of implicit price variation observed across households. It suggests that an alternative functional form could provide better estimates of the implicit prices. Improved estimates could then lead to improved estimation of the relationships among the imputed prices and the socioeconomic determinants.

A final point is that more recent data sets need to be exploited as they become available. These newer sets should have measures of attributes that are of more recent concern and reflect more recent consumer attitudes.

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