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I am submitting herewith a dissertation written by Danny Edward Terry entitled "An Evaluation of Characteristic Theory: Implicit Prices and the Demand for Nutritional Attributes." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

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AN EVALUATION OF CHARACTERISTIC THEORY: IMPLICIT PRICES AND THE DEMAND FOR NUTRITIONAL ATTRIBUTES

A Dissertation

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ABSTRACT

The objectives of this study were: (1) to develop a theoretical and econometric model to estimate sets of household implicit price coefficients for nutritional attributes associated with foods consumed by households, (2) to estimate household demand functions for various dietary components of food, where the quantity of each nutritional attribute demanded by households was hypothesized to be related to the implicit prices of all nutritional attributes as well as geographic, demographic, and socioeconomic variables, and (3) to examine implications of the findings from objective one and two relative to current and future production, marketing, and consumption of foods.

Household utility was assumed to be a function of total quantities consumed of m product characteristics, as determined by n physical quanitities of goods consumed. The resulting hedonic price model stated that the price paid for each food product consumed was related to the quantities of attributes possessed by that product. By this price decomposition equation, each product price was expressed as a function of attribute prices. Allowing for preference structures to vary among households, demand for attributes would be affected by the prices of product attributes, income, and household characteristics.

Data from approximately 2,200 households located in the contiguous states of the United States were utilized to specify

household nutrient demand relationships. These data were separated by geographic location of the household to facilitate the estimation of nutrient demand relationships for households in the South, Northeast, North Central, and West regions of the United States. United States and regional household demand relationships were estimated for protein, fat, carbohydrates, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and vitamin C using multiple regression analysis. These nutrient demand relationships estimated the impact of implicit prices, income, and selected socioeconomic factors on household demand for the respective food nutrients.

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CHAPTER I

INTRODUCTION

> Webster's first definition of "quality" makes it synonymous with "characteristic". Quality meaning "superior quality" is a derived or secondary meaning. Quality, then, need not be ordinal-good, better, best. It may be only different.
>
> Herman M. Southworth[1]

During the past 20 years involvement by the United States government in the food system has expanded from basically farm related issues to include health and nutritional issues. Nonfarm groups with nutritional objectives have entered the policy making process at a rapidly increasing rate [Senauer, 1982, p. 1009].

Despite the availability of a plentiful and varied food supply, some Americans demand less than adequate quantities of food nutrients. Unequal distribution of economic and other resources in the United States has resulted in pockets of poverty and malnutrition. But, the incidence of malnutrition is not only a problem of the poor. It also affects some of the more affluent. Some of these individuals suffer nutritional excesses and/or imbalances. This could be due primarily to their affluent lifestyles.

In many cases, research emphasis has moved away from the quantities of food consumed, toward the qualities of foods consumed.

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[1] "Discussion: The Function of Grades in an Affluent Standardized-Quality Economy." Journal of Farm Economics 43 (1961): p. 1385.

The composition of diets in the United States has received considerable attention because of concerns about health consequences associated with levels of nutritional intake and sources of these nutrients. Nutritionists are becoming increasingly concerned with the nutritional consumption of various population subgroups [Gifft, Washbon, and Harrison, 1972; and Gibson, 1981]. Demographers expect changes to continue in the demographic composition of the United States population [Salathe, 1979; Sexauer, 1979; and Gibson, 1981]. Meanwhile, economists and sociologists have found that nutritional consumption is related to the changing composition of the population [Raunikar, Purcell, and Elrod, 1966; Adrian and Daniel, 1976; Price, Price, and West, 1980; Blanciforti, Green, and Lane, 1981 and Pao, 1981].

Because of both humanitarian and economic goals, professionals have been interested in trying to understand the decision-making process used by consumers and to identify and evaluate the important explanatory variables in the consumption function of any product. If consumer food purchasing behavior can be more completely understood, then policy recommendations for the food producers and food consumers can be more efficiently, and perhaps equitably, attained.

I. PROBLEM

Traditional consumer behavior and demand theory has, as its basic concept, the idea of a product, a good, or a service. Thus, the theory can be used to analyze consumer choice, given a collection of products and/or services, their respective prices, and a budget constraint. An alternative, characteristic theory, has as its basic

concept the idea of quality, characteristics, or attributes. Thus, characteristic theory views a product or service as a collection of attributes. This approach changes the basic arguments of the utility function. Instead of utility being a function of products, it becomes a function of the attributes provided by these products. That is, products are desired because of the utility that their attributes provide. Through the use of characteristic theory, product demand becomes a derived concept. Different products possess different proportions of attributes. Different proportions of the same attributes may be combined, resulting in different products. Also, the combination of different attributes result in different products [Ladd, 1982, p. 18].

Although he did not have a formal model, pioneer work on product attributes was accomplished in a study by Waugh [1928, 1929] more than a half century ago. He found that substantial portions of the variances of wholesale prices of vegetables were explained by quality-appearance characteristics.

From his work, Waugh concluded:

> There is a distinct tendency for market prices of many commodities to vary with certain physical characteristics which the consumer identifies with quality, and the relation of these characteristics to prices may in many cases be fairly accurately determined by statistical analysis. If this generalization is accepted as true, it opens up a field in the theory of prices which has been practically untouched [1929, p. 87].

According to the recently developed commodity characteristics theory of consumer demand, the price individuals are willing to pay

for a product reflects the value they place on commodity characteristics [Lancaster, 1966, 1971]. Thus, in terms of food nutrition, the price that an individual is willing to pay for a particular food item is a function of the relative implicit prices that the consumer is willing to pay for each of the nutritional attributes. However, Burk [1968, p. 95] noted that the relationships among the relative implicit prices for food nutrition are complicated by many nonnutritional factors. Both physiological and psychological factors affect consumers perceptions of inherent characteristics of products. Taste, color, texture, and form may affect the types and quantities of food consumed.

The development of "consumerism" and increased interest in nutritional levels has led to a greater need for a more complete understanding of buyer's purchasing behaviors with respect to food items. The characteristic model is of interest because it provides a different perspective on behavior. The price a consumer pays is related to attributes and their implicit prices. These implicit prices can be related to the market demand for a good. Ultimately, a manufacturer can relate the change in an attribute to market demand.

II. OBJECTIVES AND PROCEDURES

There has been a limited number of recent studies which have estimated relationships between prices paid for foods and their characteristics [Ladd and Suvannunt, 1976; and Morgan, Metzen, and Johnson, 1979]. The general purposes of this study were to evaluate the characteristic theory as applied to food products and to extend the empirical investigation of the relationship between price and

food attributes by identifying and estimating such relationships in food products. The investigation attempted to determine the implicit prices of the attributes of these products and the various factors affecting the demand for these attributes. Observing the factors affecting household purchases of foods is of interest not only to nutritionists, but also to producers, processors, and marketing agents. Based on hedonic hypotheses,[2] specific research objectives addressed in this study were:

1. Develop a theoretical and econometric model to be used to estimate sets of household implicit price coefficients for nutritional attributes associated with foods consumed by households.

2. Estimate a household demand function for various dietary components of food consumed. Each set of implicit price coefficients obtained from objective one, was included as a factor affecting the household demand for nutritional food attributes. The quantity of each nutritional attribute demanded by households was hypothesized to be related to the implicit prices of all nutritional attributes as well as geographic, demographic, and socioeconomic variables. Variables included were: income of the household, number of members in the household, race of the household, education of the homemaker, developmental stage of the family unit, meal adjustment, employment status of the homemaker, urbanization in which the household lives, and geographical area of the country in which the household lives.

---

[2]Court [1939] appears to be the first to use the term "hedonic" to describe price comparisons that recognize the potential contribution of a commodity's attributes to the welfare and happiness (utility) of the purchasers.

3. Examine implications of the findings from objectives one and two relative to current and future production, marketing, and consumption of foods.

The characteristic model may be a more accurate representation of consumer behavior than the traditional model. It should be noted, however, that this alternative approach to demand theory is relatively better suited for analysis of non-homogeneous products. Without product differentiation there would be no need for this approach. Thus, based on the hedonic concept, an empirical analysis was carried out. Briefly, the hedonic approach is based upon the idea of obtaining a set of variables that will explain differences in prices of products by way of attributes. This method requires the use of multiple regression equations, where the relevant product characteristics are regressed on product price. The partial derivatives of the multiple regression equations with respect to each attribute, represent the implicit prices of the product characteristics. Each of these coefficients is an estimate of the (marginal) implicit or imputed price that a consumer is willing to pay for an additional unit of that particular attribute.

The lowering of calorie intake and other nutritional consumption changes in recent years indicates an adjustment in atttitudes regarding health and dietary habits [Gifft, Washbon, and Harrison, 1972; Pao, 1981]. To estimate the household implicit price coefficients for nutrients, objective one, all food consumed by the household was included. When examining the hedonic relationships for

food nutrition, there is no theoretical basis for separating out specific food groups, since they all contain nutritional attributes important to consumers. Therefore, implicit prices for nutritional attributes were estimated for households, using all food consumed in a one week period. These estimates were then entered as independent variables along with household demographics, income, and other socio-economic variables, into the household demand for nutritional attributes equations.

Nutritional demand equations were initially estimated for all nutrients identified in the data. After examining the results, a reduced model combining closely related nutrients was used to re-estimate the nutritional demand equations. This model respecification was similar to the procedures used by Morgan [1977].

CHAPTER II

REVIEW OF LITERATURE

Research in the behavioral sciences usually begins with a hypothesis phrased in such a way that empirical evidence can be used to permit statistical testing and/or validation. Before entering into experimental research, or data collection, a scientist should perform a literature search in order to gain knowledge in the research area and to ascertain whether or not his hypothesis, or a similar one, has been evaluated previously. If a scientist proceeds with his research without investigating previously conducted relevant work, he runs the risk of duplicating previous mistakes and failing to confirm or extend the frontier of knowledge.

I. EARLY WORK

The initial work on product characteristics was accomplished by Waugh [1928, 1929]. He used linear regression techniques to estimate implicit prices of individual lots of cucumbers, asparagus, and tomatoes. He gathered data on characteristics such as size, shape, color, condition, and other physical characteristics which influenced the wholesale prices of locally grown vegetables in the Boston area market. From his analysis of asparagus, for example, he concluded that: an additional inch of green color per stalk was worth 38.45 cents per dozen bunches, each additional stalk per bunch reduced price by 4.6 cents, and each additional percentage variation

in the size of the stalks decreased price by .76 cents per dozen standard bunches in the Boston market in 1927 [Waugh, 1929]. Waugh used linear equations for asparagus and tomatoes, and a nonlinear equation for cucumbers.

A study that used an approach similar to that used by Waugh was conducted by Clarke and Bressler [1938]. They attempted to explain strawberry prices for two years in two different Connecticut auction markets. The independent variables were size, condition, uniformity, color, and variety. They concluded that the first three characteristics were significant in explaining variations in prices, with the premium for a given size declining as supply of that size increased.

Perregaux, Wright, and Bressler [1938] found that from 75.5 to 97.3 percent of variation in prices of lots of eggs at Connecticut markets were related to weight, grade, and color. Weight and grade were highly significant, but the importance of color as a quality factor explaining the price variance was slight. Premiums for large eggs declined as the supply of large eggs increased.

Harrington and Gislason [1956] studied the effects of quality-appearance factors on the retail quantities of fruit sold. They found that sales of peaches were affected positively by the percentage of peaches with extra color; apricot sales were affected positively by the percentages of apricots with extra color, and negatively by the percentage of hard apricots and the percentage of apricots having moderate defects; and the sales of cherries were affected positively by the percentage of ripe cherries.

Houthakker [1951-52] introduced a utility function with qualities as separate variables, in addition to traditional quantities. He assumed that a commodity could be described by two variables, physical quantity and quality. In his model, Houthakker stated that commodities with different characteristics were treated as the same good, but one with a variable quality. Consumers could choose the quality of the good explicitly and, by their choice of quality, they could determine its price.

II. LANCASTER'S "NEW" THEORY

A major impact on traditional consumer theory occurred when Lancaster [1966, 1971] criticized the traditional approach of treating bundles of products as the determinants of utility. He argued that conventional theory did not offer satisfactory accounts of why some products are more closely related in consumption than other products, or why some products are not purchased by the consumer.

Lancaster [1971, p. 7] developed two fundamental propositions. The first was that all products possess objective attributes relevant to the choices which individuals make among different collections of products. The relationship between a given quantity of a product and the characteristics which it possesses is essentially a technical relationship, depending on the objective properties of the product and the consumer's knowledge as to what the product can do and how the product can accomplish it. The second proposition was that

individuals differ in their reactions to different characteristics, rather than their assessment of the attribute content of various products. It is the characteristic in which individuals are interested. These individuals possess preferences for collections of characteristics, and preferences for products are indirect or derived in the sense that products are necessary only in providing the characteristics sought. Thus, the relationship between an individual and a product is a two-stage link. It is composed of the relationship between products and their objective and technical characteristics, and the relationship between characteristics and the individual preferences of people.

The consumer's utility function in this model is:

$$U(X_1, X_2, \ldots, X_m) \tag{1}$$

which is maximized by the consumer subject to:

$$\sum_{i=1}^{n} \chi_{ij} Q_i = X_j \quad (j = 1, \ldots, m) \tag{2a}$$

$$\sum_i P_i Q_i = I \tag{2b}$$

$$X_j \geq 0, \ \chi_{ij} \geq 0, \ Q_i \geq 0 \tag{2c}$$

where U is the consumer's utility, X_j is the total amount of the jth characteristic or attribute provided to a consumer by the consumption of all products, χ_{ij} is the quantity of the jth characteristic provided by one unit of the ith product, P_i is the price of the ith product, Q_i is the quantity of the ith product consumed, and I is the consumer's fixed income. An underlying assumption is that the magnitudes of the χ_{ij}'s are parameters to the consumer and are determined by producers.

III. LANCASTER'S THEORY OF ATTRIBUTE DEMAND: A SIMPLIFIED EXAMPLE

Lancaster [1966, 1971] suggested that traditional consumer theory might be enhanced by looking at bundles of characteristics rather than bundles of products. For a simple example of Lancaster's characteristic theory related to horticultural food products, assume six vegetables with completely divisible quantities available: broccoli (B), cauliflower (C), lettuce (L), okra (O), snap beans (SB), and spinach (S). Assume also that these vegetables constitute a closely related group of products supplying only two characteristics, protein (X_1) and iron (X_2). Using this simplistic view and the assumption that quantities of X_1 and X_2 are objectively measured by consumers, the hypothetical Table 1 was constructed.

If the consumer is rational and prefers more X_1 and X_2 to less, he will not purchase any okra. He can receive more of both attributes by purchasing either cauliflower or spinach, given a level of expenditure. Looking at snap beans, the consumer can obtain the same amount of X_1 per dollar as from cauliflower, but he can obtain one additional milligram of iron by purchasing cauliflower. Therefore, snap beans will not be purchased either.

As Figure 1 shows, each vegetable represents a vector from the origin showing the respective quantities of protein and iron obtainable from a given expenditure for that particular vegetable. With given prices per unit and homogeneous divisibility of the

TABLE 1. Hypothetical nutrient values in the edible portion of one pound of six selected vegetables, hypothetical prices of vegetables, and nutrients per dollar.

Vegetable	X_1 Protein	X_2 Iron	Price Per Pound	X_1 Per Dollar	X_2 Per Dollar
	grams	milligrams	dollars	grams	milligrams
Broccoli (B)	13	3	1.00	13	3
Cauliflower (C)	12	5	1.00	12	5
Lettuce (L)	2	5	.50	4	10
Okra (O)	9	6	1.50	6	4
Snap Beans (SB)	12	4	1.00	12	4
Spinach (S)	14	14	2.00	7	7

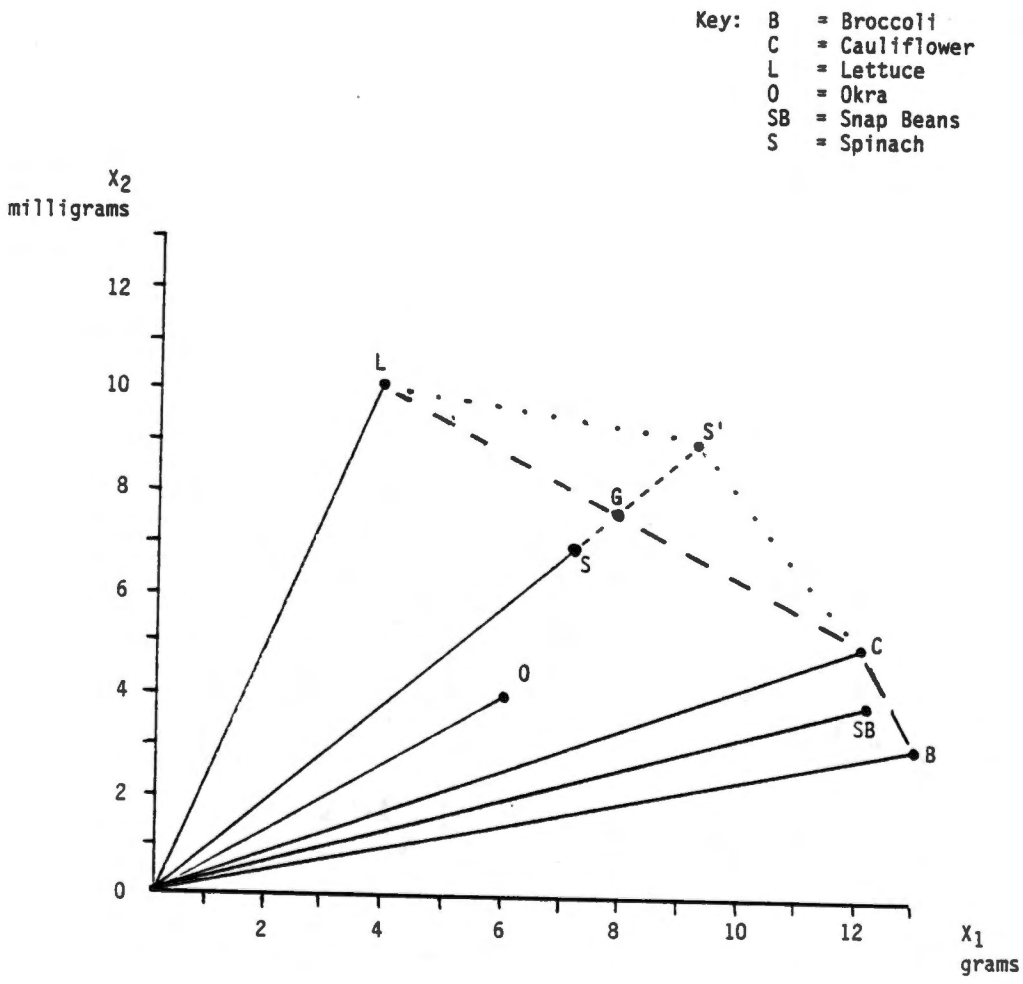

Figure 1. Hypothetical Characteristics Relationship for Selected Vegetables per Dollar Expenditure.

vegetables, the consumer can purchase anywhere along the efficiency frontier LCB. Spending one dollar on spinach will yield 7 units of X_1 and 7 units of X_2. However, spending 54 cents on lettuce and 46 cents on cauliflower yields total quantities of (2.2 + 5.5) X_1 and (5.4 + 2.3) X_2, identified as point G in Figure 1. Spinach is, therefore, added to the list of vegetables not considered for purchase, if utility is to be maximized.

If all consumers agree that the quantities of X_1 and X_2 per pound of edible portion of the vegetables are as shown in Table 1 and no other characteristics are observable, then there will be no purchase of spinach, snap beans, or okra. The purchase choice will be from lettuce, cauliflower, and broccoli, no matter how much is spent on vegetables. The consumer who spends two dollars on vegetables will have a frontier twice as far from the origin, but with exactly the same shape as LCB. This model explains why some products are not purchased. Over time, an excess supply of these products will lead to a lower price and products not purchased previously may again enter the efficiency frontier.

The shape of the frontier LCB depends on the price per unit of vegetables as well as the quantities of characteristics per unit. If the price of spinach was to decline, the quantities of X_1 and X_2 per dollar spent on spinach would increase and movement would be outward along its vector. If the price of spinach fell from $2.00 to $1.56 per pound, movement would be from S to S^1. Spinach would enter the efficiency frontier, such that the frontier would be LS'CB.

If the price of spinach continued to fall, then lettuce would be eliminated first from the efficiency frontier followed by cauliflower and broccoli. This price effect indicates that, at the individual household level, the derived demand for individual market goods is likely to be rather unstable and, at certain points, very sensitive to small changes in relative prices [Deaton and Muellbauer, 1980].

IV. CRITICIZED ASSUMPTIONS OF LANCASTER'S MODEL

With Lancaster's model, the actual purchase decision for products would be dependent on the individual's preferences for the obtainable attributes, as seen through the derived demand for products. Generally, one product will have more of some characteristics than another product, and less of other characteristics. If this occurs, the product of higher quality cannot be determined a priori, but will depend on the strength of the consumer's preferences for the various characteristics. By distinguishing between the objective characteristics of products and properties of consumer preferences for these products, Lancaster's model made it possible to judge an individual's success in maximizing his utility, without the knowledge of that individual's preferences or utility. But to accomplish this, he had to make three assumptions that have been severely criticized [Ladd and Zober, 1977, pp. 89-90]. These assumptions are: every characteristic has nonnegative marginal utility (NNMU), utility is independent of the distribution of characteristics among products (IDC), and there is a linear consumption technology (LCT).

Consider first the assumption of nonnegativity of marginal utility (NNMU). Assume there are two products, A and B, each having identical amounts of all characteristics, except for characteristic X_j. Assuming equal prices of the products, if product A had more of characteristic X_j, the consumer would never purchase product B. This is because product A is objectively more efficient, i.e., a larger amount of total characteristics for a given price. This argument relies on the assumption that the marginal utility of characteristics may never be negative. Hendler [1975] stated that the marginal utility of a product may be high and/or increasing, but some of its characteristics may convey disutility. If the NNMU assumption is violated, then it is impossible to judge a consumer's efficiency without knowing his preferences. Hendler argued that it was difficult to conceive of a product that does not possess characteristics with negative marginal utility while still yielding a net positive marginal utility to the consumer. Even characteristics of foods such as greater bulk and sweetness, typically yielding positive marginal utilities, can at some point lead to disutility. The point at which it becomes negative is subjective and depends on the consumer's preference function.

Lucas [1975] questioned Lancaster's assumption of a linear consumption technology (LCT). The LCT conveys that if Q_1 units of a product contains χ_{11} amount per unit of a certain characteristic and Q_2 units of another product contains χ_{21} amount per unit of the same characteristic, then the total amount of the characteristic obtained

is Q_1 times χ_{11} plus Q_2 times χ_{21}. However, the consumption technology may not be linear, i.e., twice as much Q_1 may not lead to twice as much χ_{11}. If the consumption technology is not linear, it is not possible to judge a consumer's efficiency without knowing the details of the consumption technology. This LCT assumption renders the model unsuitable for many potential applications. It is inappropriate when characteristics are measured on an ordinal scale (e.g., comfort, entertainment, etc.). But for food and food nutrition, these criticisms do not apply since the assumption of LCT is quite appropriate; i.e., a doubling of the quantity of a food product will lead to a doubling of the quantities of nutritional attributes obtained from that food product.

Both Hendler [1975] and Lucas [1975] challenged the assumption of utility's independence of the distribution of characteristics among products (IDC). If this assumption is violated, then Lancaster's analysis breaks down. The preference function of the consumer must then be known to evaluate his efficiency. According to the IDC, a consumer is indifferent between any number of ways of obtaining a characteristic. Assume, for example, peppers contain one unit of a characteristic j per pound, while apples contain one unit of the same characteristic per pound. In terms of obtaining, say 10 units of that characteristic, the IDC assumption is violated if an individual prefers to obtain most of that 10 units of characteristic from apples. If this occurs, then all the relevant characteristics are not being considered.

V. CONSUMER GOODS CHARACTERISTIC MODEL

Suvannunt [1973] and Ladd and Suvannunt [1976] developed a model similar to that of Lancaster's, but without the controversial assumptions of Lancaster's theory. They did not assume LCT nor NNMU. In one model they assumed IDC, while in another they did not. Their model, the Consumer Goods Characteristic Model (CGCM), yields two hypotheses: (1) for each product consumed, the price paid by a consumer equals the sum of the consumer's implicit marginal monetary values of the product's characteristics, where the marginal monetary value of each characteristic equals the quantity of the characteristic obtained from the marginal unit of the product consumed multiplied by the marginal implicit price of the characteristic; and (2) the consumer demand functions for products are affected by characteristics of the products [Ladd and Suvannunt, 1976, p. 504].

In the Houthakker model, commodities with different characteristics are treated as the same good but one with a variable quality; consumers choose the quality of this good explicitly and, by their choice of quality, they determine its price. Two assumptions are implicit in this formulation: (1) there is a continuum of quality levels; and (2) a consumer chooses only one quality level for each commodity. An individual, whose utility depends only on his own consumption, could not simultaneously demand both low and high-quality products, say wine. In the CGCM, commodities with different

characteristics are treated as separate goods, each with its own price and quality attributes. The consumer chooses quality implicitly by choosing an appropriate bundle of goods [Hanemann, 1982, p. 74].

The CGCM, therefore, is distinct from the Houthakker model. In the CGCM, goods having different χ_{ij}'s are distinct, so the χ_{ij}'s are parameters to the consumers. His only instruments for maximizing utility are the Q_i's. The solution to the CGCM relates market prices to characteristics and demands for characteristics to characteristic input-output coefficients.

Suvannunt [1973] assumed n products and m common attributes, with each of the common attributes being provided by several products. He also assumed that each product supplied a unique attribute that is not provided by other products. The utility function for a representative consumer was assumed to be as follows:

$$U(X_1, X_2, \ldots, X_m, X_{m+1}, X_{m+2}, \ldots, X_{m+n}) \qquad (3)$$

where X_j is the total quantity of the jth attribute obtained by a consumer from the consumption of all products, X_{m+i} is a consumer's total quantity of the unique attribute provided by the consumption of the ith product; and the consumer evaluates his taste and preferences in terms of the total product attributes obtained. The consumer's level of each attribute depends upon the quantities of products consumed and the exogenous attribute input-output coefficients associated with a unit of each product, the χ_{ij}:

$$X_j = f_j(Q_1, Q_2, \ldots, Q_n, x_{1j}, x_{2j}, \ldots, x_{nj}) \qquad (4)$$

$$X_{m+i} = f_{m+i}(Q_i, x_{im+i}) \qquad (5)$$

where X_j and X_{m+i} are endogenous. Substituting (4) and (5) into (3) yields the level of utility as a function of the input characteristics and quantities of market goods.

$$U(Q_1, Q_2, \ldots, Q_n, x_{11}, \ldots, x_{n1}, x_{22}, \ldots, x_{n2}, \ldots, x_{nm}, x_{1m+1}, \ldots x_{nm+n}) = U(\cdot) \quad . \qquad (6)$$

If it is assumed that the individual consumer has a limited and constant money income (I), then the budget constraint can be written as:

$$P_1Q_2 + P_2Q_2 \cdot \ldots, + P_nQ_n = \sum_{i=1}^{n} P_iQ_i = I \qquad (7)$$

where P_i ($i = 1, \ldots, n$) is the unit price of the ith product consumed, and Q_i ($i = 1, \ldots, n$) is desirable because x_{ij}'s generate utility. However, Suvannunt made no restrictions on the values of utility associated with each x_{ij}. Therefore, it is possible that a certain attribute in a specific product can lead to disutility. If the product is to be purchased, other attributes with positive utilities associated with them must at least be equal to the disutility.

The relationships among U, I, and vectors P, Q, and X in the general characteristic theory of consumer behavior can be expressed as follows:

$$\text{Maximize } U(\cdot) \qquad (8)$$

subject to:

$$\sum_{i=1}^{n} P_iQ_i = I \qquad (9)$$

where the objective function and the constraint function are assumed to be twice continuously differentiable.

First order conditions can be obtained from the Lagrangian expression associated with (8) and (9):

$$L = U(\cdot) + \lambda(I - \sum_{i-1}^{n} P_i Q_i) \tag{10}$$

with λ being a Lagrangian multiplier. Since the utility derived from the decision making is a consequence of the quantities purchased, the first order (necessary) conditions are obtained from the partial derivatives of L with respect to Q_i ($i = 1, \ldots, n$) and λ:

$$\frac{\partial L}{\partial \lambda} = I - \sum_{i=1}^{n} P_i Q_i = 0 \tag{11}$$

$$\frac{\partial L}{\partial Q_i} = \overline{U}_i - \lambda P_i = 0 \ (i = 1, \ldots, n) \tag{12}$$

where

$$\overline{U}_i = \frac{\partial U(\cdot)}{\partial Q_i} .$$

In light of (4), (5), and (6), the marginal utility of a change in Q_i is:

$$\overline{U}_i = \sum_{j=1}^{m} \frac{\partial U}{\partial X_j} \cdot \frac{\partial X_j}{\partial Q_i} + \frac{\partial U}{\partial X_{m+i}} \cdot \frac{\partial X_{m+i}}{\partial Q_i} \tag{13}$$

where ($i = 1, \ldots, n$). By rearranging (12) and substituting (13) into it, the following can be obtained:

$$P_i = \frac{1}{\lambda} \sum_{j=1}^{m} \frac{\partial U}{\partial X_j} \cdot \frac{\partial X_j}{\partial Q_i} + \frac{1}{\lambda} \cdot \frac{\partial U}{\partial X_{m+i}} \cdot \frac{\partial X_{m+i}}{\partial Q_i} . \tag{14}$$

Since $\lambda = \frac{\partial U}{\partial I}$, or the marginal utility of income, (14) can be expressed as (15):

$$P_i = \sum_{j=1}^{m} \left(\frac{\partial X_j}{\partial Q_i}\right)\left(\frac{\partial U}{\partial X_j} \cdot \frac{\partial I}{\partial U}\right) + \left(\frac{\partial X_{m+i}}{\partial Q_i}\right)\left(\frac{\partial U}{\partial X_{m+i}} \cdot \frac{\partial I}{\partial U}\right) \tag{15}$$

where $\frac{\partial U/\partial X_j}{\partial U/\partial I} = \frac{\partial U}{\partial X_j} \cdot \frac{\partial I}{\partial U}$ is the marginal rate of substitution of income for the jth attribute. It is the implicit price paid for the jth attribute, or the additional price a consumer is willing to pay for an additional unit of an attribute. For notational convenience define:

$$\frac{\partial I}{\partial X_j} = \frac{\partial U}{\partial X_j} \cdot \frac{\partial I}{\partial U} \tag{16}$$

$$\frac{\partial I}{\partial X_{m+i}} = \frac{\partial U}{\partial X_{m+i}} \cdot \frac{\partial I}{\partial U} \tag{17}$$

and assume that one unit of each product provides one unit of its own unique characteristic. Then

$$\frac{\partial X_{m+i}}{\partial Q_i} = 1$$

and equation (15) becomes

$$P_i = \sum_{j=1}^{m} \frac{\partial X_j}{\partial Q_i} \cdot \frac{\partial I}{\partial X_j} + \frac{\partial I}{\partial X_{m+i}} \qquad (i = 1, \ldots, n) \ . \tag{18}$$

Equation (18) is the hedonic price equation for the unit price of market good i. It expresses P_i, the price paid for a product by a consumer, as the sum of the marginal yields of various attributes provided by the product multiplied by the marginal implicit prices of the product's attributes. If the market price of a particular product exceeds the sum of the consumer's marginal valuations of

the product's characteristics, the consumer does not buy the product. Suvannunt turned (18) into an empirically estimable relationship where $\frac{\partial X_j}{\partial Q_i} = \chi_{ij}$ and $\frac{\partial I}{\partial X_j} = \beta_j$, or:

$$P_i = \sum_{j=1}^{n} \beta_j \chi_{ij} + \beta_{m+i} \quad . \tag{19}$$

One hypothesis that this particular model yields is that the marginal money values of the characteristics of a purchased product exhaust the price of the product. But this is not a testable hypothesis because the statistical estimation of equation (18) will produce residuals. It can be argued that the existence of residuals is evidence that equation (18) does not hold, or it could be that a residual, plus an intercept, measures the price of a product's unique attribute. Suvannunt [1973] and Ladd and Suvannunt [1976] included unique attributes in their model to get around a statistical problem of small degrees of freedom, and this had nothing to do with the anticipation of this argument [Ladd, 1982, p. 50]. However, equation (18) yields a second hypothesis, that product price is related to its characteristics. This hypothesis is testable [Ladd, 1982, p. 31].

The second order conditions for a maximum examined by Suvannunt require that the utility function be continuous and twice differentiable, the budget constraint be linear, and the bordered Hessian of the utility function be negative definite, i.e., the principal minors must alternate in sign, beginning with $\overline{H}_1 < 0$, $\overline{H}_2 > 0$, etc.

Identification of the other relevant market relationships can be outlined as follows. Since the first order conditions (11) and (12) contain prices and income, just as in traditional demand analysis, the demand equations can be readily seen to be functions of prices and income. The characteristics model has an additional set of exogenous variables, χ_{rs}, and Suvannunt [1973] has shown their role in demand equations. The effect of a change in χ_{rs} is derived through (6) and (12) such that:

$$-P_i \frac{\partial \lambda}{\partial \chi_{rs}} + \sum_{k=1}^{n} \frac{\partial \bar{U}_i}{\partial Q_k} \cdot \frac{\partial Q_k}{\partial \chi_{rs}} + \frac{\partial \bar{U}_i}{\partial \chi_{rs}} = 0 \ . \tag{20}$$

Solving for $\frac{\partial Q_i}{\partial \chi_{rs}}$

$$\frac{\partial Q_i}{\partial \chi_{rs}} = - \frac{1}{\lambda} \left(\sum_{k=1}^{n} \frac{\partial \bar{U}_k}{\partial \chi_{rs}} S_{ki} \right) \ . \tag{21}$$

S_{ki} is the Slutsky substitution term, having the general form indicated by Goldberger [1967, p. 8] as

$$S_{ki} = \lambda U^{-1} - \lambda \lambda_I^{-1} Q_I Q_I'$$

$$\lambda_I = \frac{\partial \lambda}{\partial I}$$

$$Q_I = \frac{\partial Q_i}{\partial I}$$

U^{-1} is the inverse of the Hessian of (6), and Suvannunt [1973, p. 43] has shown this to be

$$U_{ij} = \sum_{k=1}^{m+n} \frac{\partial \chi_{ik}}{\partial Q_j} \cdot \frac{\partial_U}{\partial \chi_k} + \sum_{k=1}^{m+n} \sum_{h=1}^{m+n} \chi_{ik} \chi_{jh} \frac{\partial^2 U}{\partial \chi_k \partial \chi_h} \ . \tag{22}$$

Taken together, (21) and (22) show that the effect of a change in an attribute has an effect on the quantities demanded. Thus, even

though prices and income remain constant, purchases of a product can vary if some producer varies at least one characteristic input-output coefficient.

The demand for attributes, therefore, depends upon prices, income, and product characteristics:

$$X_j = d_j\,(P_1, P_2, \ldots, P_n, I, x_{11}, x_{12}, \ldots, x_{1m+1}, x_{21}, x_{22}, \ldots, x_{2m+2}, \ldots, x_{n1}, x_{n2}, \ldots, x_{nm+n}) \tag{23}$$

By the price decomposition equation (hedonic price equation), each P_i can be expressed as a function of characteristics prices (β_j). Then the consumer's total demand for the jth characteristic can be expressed as

$$X_j = d_j\,(\beta_1, \beta_2, \ldots, \beta_m, \beta_{m+1}, \ldots, \beta_{m+n}, I, x_{11}, x_{12}, \ldots, x_{nm+n}) \ . \tag{24}$$

Equation (24) states that the consumer's total demand for an attribute is affected by the prices of product attributes, income, and attribute input-output coefficients [Ladd, 1978, 1982].

The IDC assumption has been maintained throughout, but could, with a modification, be dispensed with [Ladd, 1982, p. 33]. It follows that $X_j = \sum_i t_{ij}$ is the total quantity of the jth attribute obtained from the consumption of the ith product. The arguments of the utility function are now the X_j's and the ratios $\frac{X_j}{t_{ij}}$. But because the X_j's are functions of the t_{ij}'s, utility can be expressed

as a function of the t_{ij}'s. The resulting hedonic price equation (25) is similar to equation (18).

$$P_i = \sum_j \left(\frac{\sum_i t_{ij}}{\partial Q_i} \right) \left(\frac{\partial I}{\partial \sum_i X_j} \right) + \frac{\partial I}{\partial X_{m+i}} \quad . \tag{25}$$

Ladd and Suvannunt [1976] examined equations (18) and (19) by applying their model in the study of retail prices of 31 different meat, dairy, and poultry products. Using the linear function equation (19), they regressed 16 nutritional elements of foods on retail product prices and found that prices were significantly related to amounts of food energy, protein, carbohydrates, phosphorous, iron, potassium, riboflavin, and absorbic acid. Later analysis of their data showed that converting the linear function into a quadratic function resulted in a significant increase of R^2 [Ladd, 1978].

Both the Lancaster and Ladd and Suvannunt models state consumer utility as a function of characteristics possessed by products, where these characteristics are defined as objective, universal properties of the products. However, some researchers view utility as not depending upon characteristics so defined, but upon consumption services provided by characteristics. Ladd and Zober [1977] present a model that distinguishes between objective characteristics and consumption services. Their model yields the same hypothesis as the CGCM. However, it yields an additional hypothesis: for each product consumed, the price paid by the consumer equals the sum of the marginal monetary values of the product's contributions to various consumption services.

Two studies have been conducted with respect to equation (24). King [1976] assumed the consumer's utility function to be weakly separable, reflecting a utility tree in which housing is one branch. The housing characteristics he studied were structural features, interior and exterior quality, interior space, and site. Each of these is a composite of specific features. For example, structural features combine insulation, number of garages and baths, and laundry facilities. The price variables in his demand functions are prices of these four characteristics.

Adrian and Daniel [1976] related household consumption of protein, carbohydrate, fat, vitamin A, calcium, iron, thiamin, and vitamin C to family income, family size, place of residence, race, education of homemaker, and stage of household in the family life cycle. All F ratios were highly significant. But the consumption equations for nutrition did not contain implicit prices of nutrients or prices of foods containing these nutrients, nor did they base their estimated equations on an explicit theoretical model.

VI. OTHER HEDONIC STUDIES

The distinction between characteristics and consumption services is similar to the distinction that Ohta and Griliches [1975] draw between a car's physical characteristics (e.g., horsepower, weight, and length) and performance variables such as acceleration, handling, ride, and frequency of repair. Instead of regressing automobile prices upon physical characteristics, Otha and Griliches

regressed automobile prices on measures of performance.

Other studies that focused on the explanation of automobile prices as a combination of characteristics or specifications were Court [1939], Griliches [1961], Cagen [1965], Dhrymes [1967, 1971], and Triplett [1969]. Refrigerator prices as a function of cubic footage capacity, height, weight, cubic footage freezer capacity, and other specifications were analyzed by Dhyrmes [1967, 1971]. Farm tractor prices, as related to types of engine and horsepower, were analyzed by Fettig [1963], and Cowling and Raymer [1970], while the relationship between diesel engine prices and horsepower, displacement, revolutions per minute, and weight were examined by Kravis and Lipsey [1969]. The prices of houses as relating to various characteristics have been studied by Bailey, Muth, and Nourse [1963], Brown [1964], and Musgrave [1969]. Rent determination was examined by Gillingham and Lund [1970].

There have been other studies relating to the hedonic approach. Morgan, Metzen, and Johnson [1979] studied prices paid by state purchasing agents for cereals. They found that these prices were related to the cereal's nutritional composition, other product characteristics, and market factors. The market factors were included as statistical controls for differences in conditions under which cereals were purchased, namely the amount of imperfect competition in the market place for cereals. Naumann, Jaenke, Rhodes, Kiehl, and Brady [1959] investigated retail sales of shank-portion smoked hams, rib-end loin roasts, and center-cut ham slices to determine

effect of leanness of a cut on market share of the cut. Johnson [1976] studied rail transportation of grain from Michigan grain elevators. He concluded that the quantity of railroad services demanded by an elevator is influenced by the delay in delivery of rail cars, damage by railroad shipment, and promotional efforts by trucking firms as well as by characteristics of the elevator. He also concluded that the ratio of rail shipments to truck shipments by an elevator is related to truck equipment delay and railroad speed, as well as to characteristics of the elevator.

Both nutritional and dietary evaluation studies reflect the fact that nutritional quality is related to economic status, level of education, and other factors. Characteristic theory is important to the extent that it can provide a more accurate representation of consumer behavior. It was used to examine the effects of various factors on food nutrition consumed and the implicit prices of food characteristics. Additional information was derived by the application of statistical analysis of the hedonic hypotheses to specific relationships between various factors and the implicit prices of food product attributes.

CHAPTER III

SOURCES AND EVALUATION OF DATA

Procedures appropriate for examining the objectives of this study require large amounts of specific data. Due to costs associated with a primary survey, in terms of both time and financial requirements, a search was instituted to obtain appropriate data from secondary sources. The purpose of this chapter is to review alternative sets of data and to discuss the set selected for use in this study.[3]

I. COMPREHENSIVE AGGREGATE SOURCE

The annual estimates of expenditures by the U. S. civilian population for farm-produced foods is prepared by the Economic Research Service (ERS) of the United States Department of Agriculture (USDA). The ERS estimates start with production data adjusted for imports, exports, and noncivilian use. The base data are converted to a civilian expenditure basis using consumer price indexes from the Department of Labor and the Agricultural Marketing Service. The annual consumer level estimates are prepared in 15 broad categories. For seven groupings, representing combinations of these 15, a split

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[3]For a more complete review of available data sets see: Pearl, Robert B. 1977. "Data Systems on Food Demand and Consumption: Properties, Uses, Future Prospects." In Food Demand and Consumption Behavior. Edited by Robert Raunikar. Athens, Georgia. Agricultural Experiment Station. University of Georgia.

is provided between food expenditures for home use and meals purchased away from home.

The data are of limited detail but are available on a continuous basis from ERS, which provides the only available information on consumption of specific food products combining both the content of meals at home and the ingredients of those purchased outside the home. However, a serious limitation for its use in this study is the absence of geographic, demographic, and socioeconomic detail, as well as specific food expenditure data.

II. DISTRIBUTION SOURCE

As applicable to this study, probably the most relevant type of distribution data source is represented by the information on warehouse shipments to supermarkets and other food stores as compiled by Selling Areas Marketing, Inc. (SAMI). These statistics are assembled in 33 metropolitan areas. At four week intervals, shipment data are compiled for each area for more than 300 dry, frozen, and packaged food products. Fresh meat and perishables such as milk and bread are not covered.

The omission of some rather important food items and the lack of data on the characteristics of the purchasers are among the more evident limitations for this analysis. The validity of national projections based on 33 metropolitan areas also creates some additional uncertainty.

III. CONSUMER PANELS WITH LIMITED PRODUCT COVERAGE

Consumer panels in the commercial field usually cover a limited range of products, those for which they have immediate or prospective clients. An example of a commercial operation is the National Consumer Panel conducted by the Market Research Corporation of America (MRCA).

The primary objective of the MRCA panel is to serve the interests of manufacturers and distributors in measuring the size and composition of their market and in studying market trends. Major interest is focused on the proportion of sales occurring in various kinds of outlets, and in changes in product and brand preferences over time and among different population groups. However, the restricted product coverage of even the most comprehensive panels limits the value of the data for this study.

IV. CONSUMER PANELS WITH COMPREHENSIVE PRODUCT COVERAGE

The second kind of consumer panel is found primarily in the academic or nonprofit field. Examples are the small localized consumer panels operated in Lansing by Michigan State University in the 1950's, covering all food products. Similar operations were conducted by the University of Georgia in Atlanta from 1958-1962.

The Lansing panel averaged under 300 households who completed and mailed in weekly diaries covering all food products. The diaries were over 30 pages in length and itemized some 500 or more detailed

products. However, the consumer panel dropout rate was high. Also due to the cost and difficulty of maintaining a comprehensive panel of this type, widespread use of this method was never achieved.

V. CONSUMER EXPENDITURE SURVEYS

Consumer expenditure or family budget surveys were initially introduced primarily to study the standard of living of poor and disadvantaged persons. The main emphasis today is on providing the underpinning for construction and maintenance of consumer-price indexes.

Comprehensive consumer expenditure surveys have been conducted at roughly 10-year intervals. The last available survey (1972-73), by the U. S. Department of Labor, used a substantially different methodology from that employed by the Bureau of Labor Statistics (BLS), which conducted the surveys previously. In the prior surveys, the procedure followed was an "annual recall" method. There was an attempt to determine both large and small family expenditures for the entire preceding calendar year. A modified procedure was followed for food expenditures, where questions were asked about expenditures for specific food products in the week preceding the "annual recall" interview. At the tabulation stage, the detailed food expenditures derived in this manner were forced into agreement with the overall annual totals, which were used as control figures.

The U. S. Department of Labor's new approach, used in the 1972-73 survey, attempted to take account of the experience in other

survey undertakings aimed at controlling response errors. Diaries were the primary focus for deriving food expenditures both in the aggregate and in detail. The diary operation consisted of 200-250 households per week. Each household was asked to maintain a record of all expenditures for the subsequent two-week period. Also, a wide range of demographic, socioeconomic, and other background information was obtained.

The data appeared to be relatively complete for the more costly products such as meat and poultry and for those products purchased and consumed on a frequent basis. On the other hand, data deficiencies were prevalent for staple food products that were purchased infrequently [Pearl, 1977, p. 130]. Also, the consumer expenditure surveys relate to purchases, rather than consumption, and there would be serious problems associated with converting the data to the nutrient consumption basis required for this study.

VI. FOOD CONSUMPTION SURVEYS[4]

Another major government data system is the Food Consumption Survey of the U. S. Department of Agriculture. Like the expenditure surveys, these have been conducted at roughly 10-year intervals, with

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[4]For a more complete review of the Food Consumption Surveys see: U. S. Department of Agriculture. 1982. Consumer Nutrition Center, Human Nutrition Information Service. Food Consumption; Households in the United States, Spring 1977. Nationwide Food Consumption Survey 1977-78, Report No. H-1. U. S. Government Printing Office, Washington, D. C.

the most recent survey being in 1977-78. The principal conceptual difference between the expenditure and consumption surveys is that the former relates to purchases during a specified period and the latter to use or consumption of food. These two measures should be approximately equal in the long run, or for a sufficiently large grouping of persons. However, for specific households, and for limited periods such as a week or two, which both systems use, a considerable difference is possible. While use, or consumption, may vary only within moderate limits, considerable fluctuations in purchases may occur from week to week. These fluctuations depend on buying habits, storage capacity, and special inducements such as sales. Since one of the main objectives of the Food Consumption Survey is the conversion of the survey data to a nutrient basis for individual families, the use or consumption concept would be the more appropriate and less variable approach.

The prominent feature of the food consumption surveys has been the exhaustive detail provided on food useage. Early studies of household food consumption were small-scale, intensive investigations and sometimes involved relatively few respondents. Since the 1930's, however, the USDA has conducted six household food consumption surveys on a national scale: 1936, 1942, 1948 (urban only), 1955, 1965-66, and 1977-78. The 1965-66 survey was expanded to include all four seasons. Information was obtained from about 7,500 sample households in the spring and about 2,500 households in each of the three subsequent quarters to provide indicators of seasonal consumption patterns.

The higher concentration in the first quarter was designed to permit more valid trend comparisons with the previous 1955 survey, which was carried out entirely in the spring period. The 1977-78 survey was carried out over 12 months, with approximately 3,750 sample households surveyed during each 3-month period.

In addition to household food consumption, some members of the sample households reported their intakes of food and beverages for a day in the spring of 1965. This was the first national survey of food intakes of individuals to be undertaken. In 1977-78, the individual food intake phase of the study was expanded to cover the entire year, and intakes were obtained for 3-day periods.

For the two latest surveys, households were selected to represent the universe of households in each of four Census regions, Figure 2, [U. S. Department of Agriculture, 1972, p. 216; and U. S. Department of Agriculture, 1983, pp. 304-305]. Households were also selected to represent three urbanization categories during each of four seasons. Information was collected from about 15,000 households in the 48 conterminous states.

The data on food used in a surveyed household were collected in an interview with the person identified as most responsible for food planning and preparation. Trained interviewers recorded the kind, form, quantity and cost, if purchased, of each food or beverage used in the household during the 7 days before the interview. Respondents also gave information on home food production and preservation, the number of meals eaten at home and away by household members, and

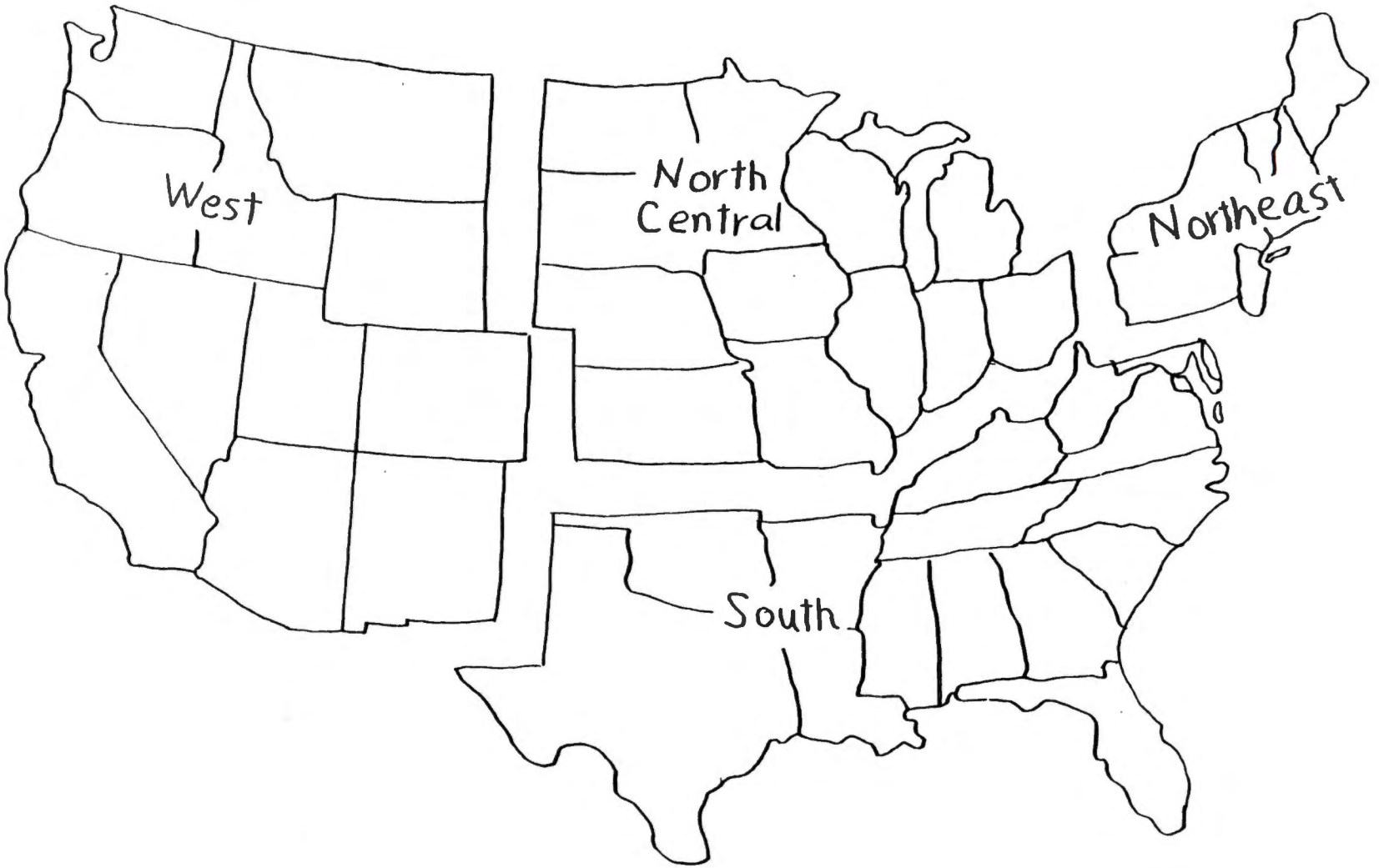

Figure 2. Census Regions of the United States.

meals and snacks eaten by guests. Respondents also provided other data, such as income, participation in food programs, age, education, and employment.

The methodology used to obtain household food consumption in the 1977-78 survey was the same as that used in 1965-66, with few exceptions. Both surveys measured food consumption at the level at which the foods come into the kitchen. The data should be interpreted as consumption in an economic rather than a physiological context. This is because some food was discarded in the kitchen and at the table. Thus, the household consumption of attributes could be over-estimated. On the other hand, nutrient supplements (vitamins, etc.) were not included is the survey so some households could have consumed larger quantities of some nutrients. Before the food consumption values were applied to the food quantities, estimated losses of nutritional attrubutes due to cooking were deducted [U. S. Department of Agriculture, 1982].

Household food consumption included food and beverages from the household food supplies "used" during the seven days before the data of the survey interview, whether bought or received without direct expense (home produced and/or received as a gift or a substitute for payment). This included food and beverages eaten at home, carried from the home in packed meals, thrown away, or fed to pets. Food fed to animals raised for commercial purposes and commercial "pet" food were omitted. Food was considered home produced if it was raised for home use or was obtained by hunting, fishing, and gathering from the wild [U. S. Department of Agriculture, 1982].

Food received without direct expense was valued at the average price per pound paid for comparable food by survey households in the same region. Any food from the household that was given away for use outside the home, such as food donated to church suppers, and food given to household help to take home, was not considered as food used by the household.

Although methods were generally the same for both surveys, changes were made in the 1977-78 survey that affect comparability. In 1965-66, the households were interviewed at the initial contact. But in 1977-78, households were contacted at least 7 days prior to the interview and asked to keep grocery receipts, shopping lists, menus, package labels or other aids to help them recall the food consumed in the 7-day period. In 1977-78, data were collected from all types of households. In the earlier survey data were collected from "housekeeping" households only (households in which one person had 10 or more meals at home).

Income data for 1977-78 included the income of all household members age 14 and older (except roomers, boarders, and employees). In 1965-66, income data included only related persons living in the household whom the respondent considered as part of the family's financial matters. Also, in 1977-78, specific income data were collected. In 1965-66, respondents indicated which one of 14 income classes corresponded most closely to their family's income after taxes.

Information on certain factors that was not collected in the 1965-66 survey, was collected in 1977-78. Education and employment

of the male head of the household and occupation of both the male and female household heads was acquired.

The food consumption survey provided the best raw data available to permit statistical analysis of the equations specified in the economic model constructed to satisfy the objectives of this study. Because of financial and time constraints, as well as problems with comparability, only a portion of the data from the Nationwide Food Consumption Survey 1977-78[5] was used in this study. Approximately 3,300 households were surveyed in the contiguous states of the United States in the spring of 1977.

The utilization of data which has been collected for other purposes can present problems for the researcher. For this study, a part of the original spring data was discarded because of the lack of applicability to the present study. Information on such things as shopping frequency and distance to the store, dollar amount of utilities paid per month, and cars and trucks owned by household members were deleted.

Data from approximately 1,075 households were eliminated from the original spring survey to form the sample utilized for this study. These households were excluded because data elements were missing. If, for example, households with relatively high income typically did not report their income, these households would be deleted. Thus,

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[5]The original survey was conducted by the Consumer Nutrition Center, Human Nutrition Information Service (formerly Human Nutrition, Science and Education Administration), United States Department of Agriculture (USDA). National Analysts, Inc., under contract with USDA, designed the sample and collected the data. Tabulation of the data was accomplished by the Federal Prison Industries, also under USDA contract [U. S. Department of Agriculture, 1982, p. I].

the results could be biased. After adjusting the sample for these occurrences, 2,218 households were included in the United States samples utilized for this study. The South, Northeast, North Central, and West regions had 727, 490, 600, and 401 households per region, respectively. Distribution of these households among the respective race and urbanization categories is shown in Table 2.

TABLE 2. Distribution of households in the sample for race and urbanization categories, the United States and regions of the United States, Spring 1977.

Category	United States[a]	South[b]	Northeast[c]	North Central[d]	West[e]
Race					
White	1898	558	431	549	360
Black	247	151	39	37	20
Other	73	18	20	14	21
Urbanization					
Nonmetropolitan	687	208	163	176	140
Suburban	738	189	196	184	169
Central City	793	330	131	240	92

[a]The United States sample was composed of 2218 households.

[b]The South region sample was composed of 727 households.

[c]The Northeast region sample was composed of 490 households.

[d]The North Central region sample was composed of 600 households.

[e]The West region sample was composed of 401 households.

CHAPTER IV

THEORETICAL FRAMEWORK

The primary purpose of this chapter is to examine a framework of the process of choice, derive the characteristic model used in this study, and to evaluate the factors which may have had an impact on the demand for product attributes. These factors were integrated into the theoretical model, designed to permit estimation of the implicit prices of various attributes and the demand for these attributes.

I. BURK'S PROCESS OF CHOICE[6]

A conceptual framework for studying the process of choice has been developed by Burk [1968, pp. 131-134]. Figure 3 identifies four sets of factors operating through the psychological process of the individual consumer by affecting motivation and perception. Market situation and activity (Box A) included supplies, prices, and attributes of products offered on the market, including potential substitutes and complements.

Physiological or biogenic needs (Box B_2) include hunger, thirst, and sex. They are affected by such things as one's age, size, and health (Box B_1). Socioeconomic needs (Box C_1) include

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[6]The context of this presentation is from Burk, Marquerite C. 1968. Consumption Economics: A Multidisciplinary Approach. New York: John Wiley and Sons, Inc.

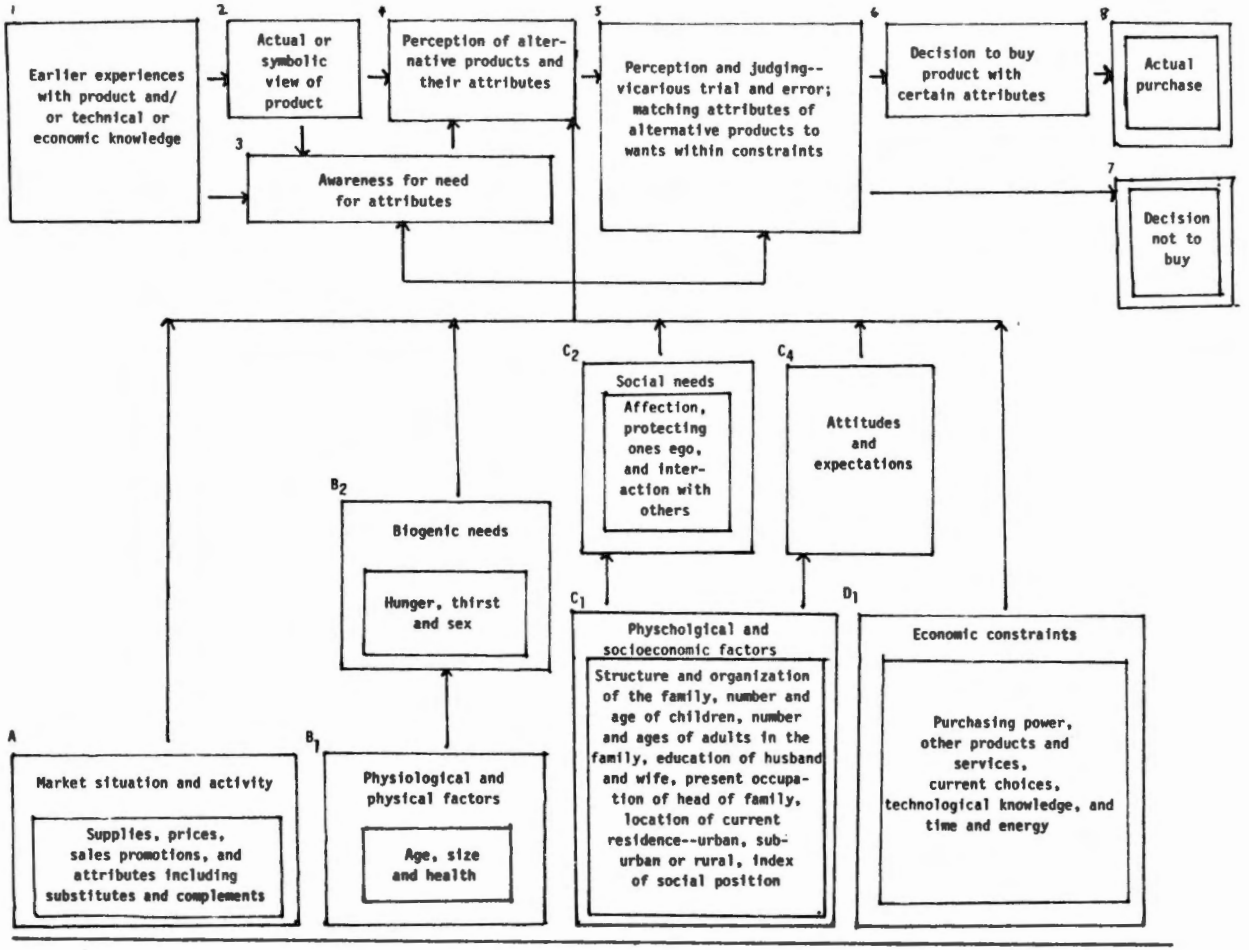

Figure 3. The Process of Choice.

Source: Marguerite C. Burk. 1968. Consumption Economics: A Multidisciplinary Approach. New York: John Wiley and Sons, pp. 131-134.

the structure and organization of the family--the number of children and their ages, and the number and ages of the adults in the family; the education of the husband and wife, and their present occupation; location of current residence--urban, suburban, or nonmetropolitan; and an index of social position.

A consumer begins each process of choosing products that will supply the desired attributes with an accumulation of knowledge learned from past experience (Box 1), attitudes (Box C_3), psychological and socioeconomic factors (Box C_1), technical knowledge, purchasing power, other products and services, and time (Box D). Concurrently, the cognitive process of perception may be influenced by his view of the product (Box 2) and possible sales promotions (Box A), which help to convert his awareness of needs into awareness of wants and desires for particular attributes (Box 4) and how they are affected by past experiences, attitudes, biogenic and sociogenic needs, technical knowledge, purchasing power, time, and other products and services.

Based on perceptions, the consumer goes through cognitive processes of evaluation. Because foods are experience goods, the consumer may use a trial and error method to match attributes of various products to his wants within the constraints set by his budget, his supply of substitutes and complementary goods, his technical knowledge, and his time and energy (Box 5). The consumer will then decide to buy a product with certain attributes (Box 6). He may purchase a product familiar to him, or seek a product that

will more closely approximate the attributes demanded (Box 8). Or, at least for the time, the consumer may decide to not buy the product (Box 7). The framework presented in Figure 3 provides for all of the ideas underlying the usual economic analysis of choice. It includes the price of the product in question and the prices of related products and services in Box A. Current purchases and inventories of related purchases are among the constraints in Box D, as well as purchasing power in the form of income. Past experiences enter through Box C_1. Tastes and preferences enter both in phase 1 and through sociogenic needs, attributes, and expectations in the cognitive phases 4 and 5.

Throughout the conceptual framework, Burk repeatedly referred to the purchase of products to supply the attributes which the consumer desires. The products which a consumer purchases generate utility because of the attributes which the products possess. A question growing from the framework is the extent to which product attributes or characteristics and the conditions related to the purchasing of products are reflected in expenditures.

This study is designed in such a way as to provide an application of the concepts presented in Boxes 3, 4, and 5 of Burk's conceptual framework for study of the process of choice, i.e., the awareness of need for attributes, the perception of alternative goods and their attributes, and the perception, judging, and matching of attributes of alternative products to wants within certain constraints contained in Box D. Factors A, B_1, C_1, i.e., market

situation and activity, physiological and physical factors, and psychological and socioeconomic factors, will be integrated into the investigation.

II. MODEL DEVELOPMENT

Suvannunt [1973] and Ladd and Suvannunt [1976] included a unique attribute for each product in their models to get around a statistical problem of small degrees of freedom. According to Lancaster [1971], all products possess objective attributes relevant to the choices which individuals make among different collections of products. The relationship among a given quantity of a product and the characteristics which it possesses is essentially a technical relationship, depending on the objective properties of the product and the consumer's knowledge of these properties and what they can do. Individuals differ in their reactions to different characteristics, rather than their assessment of the attribute content of various products. If all relevant attributes are common to the products consumed, then there is no basis to include a variable to represent a unique attribute for each product. Due to this, the unique attribute term for each product is dropped from this model.

Assume n products and m common attributes, and the utility function for a representative consumer is as follows:

$$U(X_1, X_2, \ldots, X_m) \tag{26}$$

where X_j is the total quantity of the jth attribute obtained by the

consumer from the consumption of all products, and the consumer evaluates his taste and preferences in terms of the total product attributes obtained. The consumer's level of each attribute depends upon the quantities of products consumed and the exogenous attribute input-output coefficients associated with a unit of each product, the χ_{ij}:

$$X_j = f_j(Q_1, Q_2, \ldots, Q_n, \chi_{1j}, \chi_{2j}, \ldots, \chi_{nj}) \qquad (27)$$

where X_j is endogenous. Substituting (27) into (26) yields the level of utility as a function of the input characteristics and quantities of market goods

$$U(Q_1, Q_2, \ldots, Q_n, \chi_{11}, \ldots, \chi_{nm}) = U(\cdot) \quad . \qquad (28)$$

If it is assumed that the individual consumer has a limited and constant money income (I), then the budget can be written as:

$$P_1Q_1 + P_2Q_2 + \ldots + P_nQ_n = \sum_{i=1}^{n} P_iQ_i = I \qquad (29)$$

where P_i $(i = 1, \ldots, n)$ is the unit price of the ith product consumed, and Q_i $(i = 1, \ldots, n)$ is desirable because the χ_{ij}'s generate utility. However, there are no restrictions on the values of utility associated with each χ_{ij}. Therefore, it is possible that a certain attribute in a specific product can lead to disutility. If the product is to be purchased, other attributes with positive utilities associated with them must at least be equal to the disutility.

The relationships among U, I, and vectors P, Q, and X for the consumer can be expressed as follows:

$$\text{Maximize } U = U(\cdot) \tag{30}$$

subject to:

$$\sum_{i=1}^{n} P_i Q_i = I \tag{31}$$

where the objective function and the constraint function are assumed to be twice continuously differentiable.

First order conditions can be obtained from the Lagrangian expression associated with (30) and (31):

$$L = U(\cdot) + \lambda \left(I - \sum_{i=1}^{n} P_i Q_i\right) \tag{32}$$

with λ being a Lagrangian multiplier. Since the utility derived from the decision making is a consequence of the quantities purchased, the first order (necessary) conditions are obtained from the partial derivatives of L with respect to Q_i ($i = 1, \ldots, n$) and λ:

$$\frac{\partial L}{\partial \lambda} = I - \sum_{i=1}^{n} P_i Q_i = 0 \tag{33}$$

$$\frac{\partial L}{\partial Q_i} = \overline{U}_i - \lambda P_i = 0 \quad (i = 1, \ldots, n) \tag{34}$$

where

$$\overline{U}_i = \frac{\partial U(\cdot)}{\partial Q_i} .$$

In light of (27) and (28), the marginal utility of a change in Q_i for the consumer is:

$$\overline{U}_i = \sum_{j=1}^{m} \frac{\partial U}{\partial X_j} \cdot \frac{\partial X_j}{\partial Q_i} \tag{35}$$

where ($i = 1, \ldots, n$). By rearranging (34) and substituting (35) into it, the following can be obtained:

$$P_i = \frac{1}{\lambda} \sum_{j=1}^{m} \frac{\partial U}{\partial X_j} \cdot \frac{\partial X_j}{\partial Q_i} \quad . \tag{36}$$

Since $\lambda = \frac{\partial U}{\partial I}$, or the marginal utility of money, (36) can be expressed as (37):

$$P_i = \sum_{j=1}^{m} \left(\frac{\partial X_j}{\partial Q_i}\right) \left(\frac{\partial U}{\partial X_j} \cdot \frac{\partial I}{\partial U}\right) \tag{37}$$

where $\frac{\partial U/\partial X_j}{\partial U/\partial I} = \frac{\partial U}{\partial X_j} \cdot \frac{\partial I}{\partial U}$ is the marginal rate of substitution of income for the jth attribute. It is the implicit price paid for the jth attribute, or the additional price the consumer is willing to pay for an additional unit of an attribute. For notational convenience define:

$$\frac{\partial I}{\partial X_j} = \frac{\partial U}{\partial X_j} \cdot \frac{\partial I}{\partial U} \tag{38}$$

then (37) can be rewritten as

$$P_i = \sum_{j=1}^{m} \frac{\partial X_j}{\partial Q_i} \cdot \frac{\partial I}{\partial X_j} \quad (i = 1, \ldots, n) \tag{39}$$

Equation (39) is different from equation (18) in that there is no unique attribute term for the ith product. Equation (39) is the hedonic price equation for the unit price of market good i, for which two hypotheses can be derived. One hypothesis is that the marginal money values of the characteristics of a purchased product exhaust the price of the product. But this is not a testable hypothesis because the statistical estimation of equation (39) will produce residuals. However, equation (39) yields a second hypothesis, that

the product price is related to its characteristics. This hypothesis is testable [Ladd, 1982, p. 31]. The relationships in (39) can be converted into an empirically estimable form, assuming LCT, where $\frac{\partial X_j}{\partial Q_i} = \chi_{ij}$ and $\frac{\partial I}{\partial X_j} = \beta_j$, or:

$$P_i = \beta_1 \chi_{i1} + \beta_2 \chi_{i2} + \ldots + \beta_m \chi_{im} \quad . \tag{40}$$

Let a particular household be represented by h. Allowing for h (h = 1, . . . , H) different households, equation (40) becomes

$$P_i^h = \sum_{j=1}^{m} \beta_j^h \chi_{ij} \tag{41}$$

where P_i^h is the price per unit of the ith product paid by a household and β_j^h is the implicit price which the household is willing to pay for an additional unit of attribute j from the products. With respect to objective one, equation (41) was used to determine the relationships between prices and quantities of attributes for food products consumed by a particular household. Due to the particular hypotheses to be tested and the nature of the data, the problem of households with zero purchases of some food items must be noted. A weakness of this model is the assumption of an interior solution. According to Hanemann [1982] it is very difficult to find models which are manageable and still make an allowance for the presence of corner solutions. He calls it the "single most challenging problem in this branch of consumer demand theory" [Hanemann, 1982, p. 61]. Also, the number of different foods consumed by a household, during a one week period, must be substantially larger than the number of

coefficients to be estimated to avoid the problems associated with small degrees of freedom. It was expected that some households would consume fewer numbers of different foods than necessary to perform a regression analysis. The deletion of these households could have biased the results.

To fulfill objective two, demand for attribute equations had to be estimated. Since the first order conditions (33) and (34) contain prices and income, just as in traditional demand analysis, the demand equation can be readily seen to be functions of prices and income. The characteristic model has an additional set of exogenous variables, χ_{rs}, that have a role in demand equations. The effect of a change in χ_{rs} is derived through (28) and (34) such that:

$$-P_i \frac{\partial \lambda}{\partial \chi_{rs}} + \sum_{k=1}^{n} \frac{\partial \bar{U}_i}{\partial Q_k} \cdot \frac{\partial Q_k}{\partial \chi_{rs}} + \frac{\partial \bar{U}_i}{\partial \chi_{rs}} = 0. \qquad (42)$$

Solving for $\frac{\partial Q_i}{\partial \chi_{rs}}$

$$\frac{\partial Q_i}{\partial \chi_{rs}} = -\frac{1}{\lambda}\left(\sum_{k=1}^{n} \frac{\partial \bar{U}_k}{\partial \chi_{rs}} S_{ki}\right) . \qquad (43)$$

S_{ki} is the Slutsky substitution term, having the general form indicated by Goldberger [1967, p. 8] as

$$S_{ki} = \lambda U^{-1} - \lambda \lambda_I^{-1} Q_I Q_I'$$

$$\lambda_I = -\frac{\partial \lambda}{\partial I}$$

$$Q_I = \frac{\partial Q_i}{\partial I}$$

U^{-1} is the inverse of the Hessian of (28) and Suvannunt [1973, p. 43] has shown this to be

$$U_{ij} = \sum_{k=1}^{m} \frac{\partial x_{ik}}{\partial Q_j} \cdot \frac{\partial U}{\partial X_k} + \sum_{k=1}^{m} \sum_{h=1}^{m} x_{ik} x_{jh} \frac{\partial^2 U}{\partial X_k \partial X_h} \quad . \quad (44)$$

Taken together, (43) and (44) show that a change in an attribute has an effect on the quantities demanded. Thus, even though prices and income remain constant, household purchases of a product can vary if some producer varies at least one characteristic input-output coefficient. Household demands for attributes depend upon prices, income, and product characteristics:

$$X_j = d_j(P_1, P_2, \ldots, P_n, I, x_{11}, x_{12}, \ldots, x_{1m}, x_{21}, x_{22}, \ldots, x_{2m}, \ldots, x_{n1}, x_{n2}, \ldots, x_{nm}). \quad (45)$$

By the price decomposition equation (hedonic price equation), each P_i can be expressed as a function of characteristic prices (β_j). Then the household's total demand for the jth attribute can be expressed as

$$X_j = d_j(\beta_1, \beta_2, \ldots, \beta_m, I, x_{11}, x_{12}, \ldots, x_{nm}). \quad (46)$$

Equation (46) states that the household's total demand for an attribute is affected by the prices of product attributes, income, and attribute input-output coefficients.

Assume that producers do not vary characteristic input-output coefficients over the relevant time period. Then equation (46) becomes

$$X_j = d_j(\beta_1, \beta_2, \ldots, \beta_m, I) \quad (47)$$

Equation (47) can be converted into an empirically estimable relationship and expressed as follows:

$$X_j = a_o + \delta_1\hat{\beta}_1 + \delta_2\hat{\beta}_2 + \ldots + \delta_m\hat{\beta}_m + \delta_I I \qquad (48)$$

where X_j is the total quantity of attribute j consumed by household h from numerous products, $\hat{\beta}_j$ is household h's previously estimated implicit price for attribute j, and δ's are the parameters to be estimated.[7] Equation (48) states that the household's total demand for an attribute is affected by the implicit prices of all attributes as well as income.

By integrating Burk's framework into the attribute demand equation, the theory for a representative household h, can be modified to allow for variations among households. By allowing for preference structures to vary by household characteristics (see section IV for more detail), equation (48) can be expanded to:

$$X_j = a_o + \delta_1\hat{\beta}_1 + \delta_2\hat{\beta}_2 + \ldots + \delta_m\hat{\beta}_m + \delta_I I + \delta_S S \qquad (49)$$

where S represents one or more socioeconomic, demographic, or geographic variables relating to household h. Equation (49) was used to fulfill objective two, that is, to estimate household demand for attributes.

III. MODEL SPECIFICATION

The basic hedonic model for attributes common to food products consumed by a household, equation (40) was specified such that the

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[7] Estimated implicit prices for attributes are stochastic in nature, and these regressors violate the assumption of nonstochastic independent variables. The seriousness of this problem depends on the correlation between the stochastic independent variables and their respective error terms.

x_{ij} is the quantity of the jth nutritional attribute (j = 1, . . . , 14) provided by one unit of the ith food product where:

j = 1 = protein	j = 8 = vitamin A
j = 2 = fat	j = 9 = thiamin
j = 3 = carbohydrates	j = 10 = riboflavin
j = 4 = calcium	j = 11 = niacin
j = 5 = iron	j = 12 = vitamin B_6
j = 6 = magnesium	j = 13 = vitamin B_{12}
j = 7 = phosphorus	j = 14 = vitamin C

The demand for a particular nutritional attribute, equation (49), was specified as follows:

$$X_{jv} = a_o + \delta_1\hat{\beta}_1 + \delta_2\hat{\beta}_2 + \ldots + \delta_{14}\hat{\beta}_{14} + \delta_I I + \delta_N N + \delta_R R + \delta_E E + \delta_D D + \delta_M M + \delta_W W + \delta_U U \qquad (50)$$

where X_{jv} = the quantity of the jth nutritional attribute (j = 1 . . . 14) consumed by household h, located in the Vth region (v = 1 . . . 5) with

V = 1 = United States

V = 2 = Southern region

V = 3 = Northeast

V = 4 = North Central

V = 5 = West

δ_π = parameters to be estimated.

$\hat{\beta}_j$ = household h's previously estimated implicit price for attribute j.

I = income of household h.

N = number of members in household h.

R = race of household h.

E = education of the homemaker of household h.

D = developmental stage of the family unit (presence of the female head of the household, childbearing ability of the female head, and the presence and average age of children) of household h.

M = meal adjustment {total number of meals consumed by household members and guests during a week - (21)(number of family members)} for household h.

W = employment status of the homemaker of household h.

U = urbanization in which household h lives.

IV. SOCIOECONOMIC, DEMOGRAPHIC, AND GEOGRAPHIC CONCEPTS

Through the allocation of dollars to various food products, consumers purchase food attributes. In allocating their food dollars, homemakers often make decisions which reflect their desire to have and maintain a balanced and adequate diet [Murray, 1978]. Although there are exceptions, homemakers usually try to obtain products that will supply at least minimal quantities of the basic nutrients necessary for life. The household was the basic consuming unit utilized in this study.[8] There are several advantages of this approach that a per capita analysis does not have. Per capita analysis assumes

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[8]A household is defined as consisting of all persons who occupy a house, an apartment, or other group of rooms or a room that consisted of a housing unit [U. S. Department of Agriculture, 1982, p. 291].

that everyone is the same. Expenditure per household allows for some accommodation of differences in consumption. A number of empirical considerations such as the problem of assigning parts of family income and expenditures to individuals within the family, lead most economic analysts to use households as the basic consumer unit [Burk, 1968, p. 100]. If the household collectively pools consumption and income, then it is the appropriate unit of study. Since food is generally purchased on a household basis, the per capita approach would entail some method for the distribution of the household food supply among individual members of the household. Also, most households are family units, and the inclusion of the family in the consumer unit forces recognition of the problems of family decision making. However, by using households as the basic consumer unit, inferences cannot be developed with respect to individual members of the household.

Just as in traditional theory, socioeconomic variables, such as family size, race, age, religion, education, and stage in family life cycle, can be explicitly postulated to affect utility surfaces and, consequently, food expenditure patterns. There is substantial evidence supporting the idea that socioeconomic characteristics are important determinants of food expenditures and nutritional status.

Residential location was found to have a significant impact on nutritional status [Adrian and Daniel, 1976; and Johnson, Burt, and Morgan, 1981]. Race was found to be significantly related to nutritional status [Adrian and Daniel, 1976], as well as the general

educational level of the homemaker [Adrian and Daniel, 1976; and Searce and Jenson, 1979]. Household size was found to have a significant positive impact on aggregate household food expenditures [Smallwood and Blaylock, 1981]. Also, factors such as rural-urban location, life-cycle stage, and age-race-sex composition were found to exert significant impacts on food expenditures [Davis, 1982].

Income of the Household

Income is considered to be a factor affecting household nutrient demand. Income elasticity of demand measures the percentage change in the quantity of a product, or attribute, purchased relative to the percentage change in income, ceteris paribus. Income elasticities can be greater than, equal to, or less than unity. Products or attributes with negative income elasticities are considered inferior. Products, such as potatoes or dried beans, are found to be negatively affected by increasing consumer incomes; i.e., they are traditional examples of inferior products.

Characteristic theory states that the availability of income affects the quantities of various attributes consumed, as seen through the influences of the food bundle obtained by the household, i.e., income affects the relative position of the efficiency frontier. As income increased, it was hypothesized that the consumption of all food nutrients would increase--have positive income elasticities--except for fat and carbohydrates (hypothesized because of previous results obtained by Adrian and Daniel [1976]). With increasing incomes, the demand for fat was expected to fall; i.e., fat was expected to have

a negative income elasticity. Also, the consumption of carbohydrates and high carbohydrate foods was expected to be negatively related to rising incomes. Income was, therefore, expected to have a positive effect on the quantity of protein, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and vitamin C consumed per household.

Number of Members in the Household

Variations in food nutrient demand among households could also be explained by differences in household size. Generally, a household should increase consumption of nutritional attributes as household size increases, so as to maintain a relative nutrient balance. If nutrient demand per household did not increase with an increase in household size, the available nutrients would have to be reallocated among all household members.

Race of the Household

Different races possess ethnic backgrounds that can influence utility, and consequently, food and food attribute demands. The isolation of these influences can be complicated by the possible concurrent relationships of race with other economic and social factors and accumulated consumption habits [Burk, 1961; and Rauniker, Purcell, and Elrod, 1966]. However, based on the results of previous research conducted by Adrian and Daniel [1976], it was hypothesized that white households consume significantly more protein and carbohydrates, while black households consume more fat and vitamin A.

Education of the Homemaker

Higher education levels of individuals generally reflect higher ability, desires, and resourcefulness. The acquisition of education should improve the individual's ability to relate the consumption of food products to their nutritional content [Searce and Jenson, 1979; and Adrian and Daniel, 1976]. Thus, education of the homemaker was expected to be related to variations in nutrient demands among those purchasing and preparing food. In accordance with previous research, education was hypothesized to have a positive effect on the demand for all nutritional attributes, except fat and carbohydrates. The quantity of fat and carbohydrates consumed was expected to fall as educational level of the homemaker rose, due to greater health concerns.

Developmental Stage of the Family Unit

Changes occur in people's attitudes and behaviors as they grow older. However, many of these changes may be associated with the influence of age upon the individual's family membership rather than of the biological process of aging. Thus, changes in the developmental stage of families were expected to be important in explaining household demand for product attributes. The problem is to ascertain when these stages of family development occur [Lansing and Kish, 1957].

Adrian [1974] developed a family life cycle framework reflecting the sequence of stages through which the family unit passes,

in an attempt to explain the consumption of food nutrients. His basic criterial for developing the discrete stages were: the presence of the female head of the household, the female head of the household's capacity for childbirth, and the presence and average age of children. The same criteria were used for this demand study.

The presence of a female head of the household (whether or not there is a male head of household) was considered an important influence on nutrient demand and consumption because of the primary control exercised over the purchase and preparation of food. A female head of household is expected to have a better knowledge of food nutrition than a male head of household. Generally, if there is more than one member but no female head of the household present, a situation occurs where the male head must assume this responsibility.

The capacity of the female head of the household to bear children is represented by her age. A stage in which the female is under 40 years of age could reflect a state wherein the family has the capacity to change size. A situation in which she is 40 or older and has no children at home represents a stage where change is limited. Since the age of children generally represents activity levels, the presence of a female had and the average age of children was included also to serve as partitions for life cycle stages.

The criterion resulted in seven distinct household life cycle classes: (1) the female head, under 40 years of age was present and there were no children in the household, (2) the female head was present and the average age of the children was under 6 years,

(3) the female head was present and the average age of the children ranged from 6 to less than 12 years, (4) the female head was present and the average age of the children ranged from 12 to less than 19 years, (5) the female head was present and the average age of the children was 19 years or older, (6) the female head, 40 years old or older was present and there were no children in the household, and (7) all households not falling within one of the other six classes. The seventh class was composed primarily of households with the female head absent. Single person households fell into one of three categories, i.e., a female under 40 years of age fell in category one, a female over 40 years of age fell in category six, and a male fell in category seven.

Households having a female head and children whose average age ranged from 12 to less than 19 were hypothesized to demand more of each nutrient than other classes because of the greater physiological demands for nutrients in the adolescent age range. Households with the female head 40 years or older and no children were hypothesized to demand the least of each of the nutrients, due to lower physiological requirements.

Meal Adjustment

Total meals consumed by the household will influence the demand for attributes. Total meals consumed can be expressed by accounting for the number of at home, away from home, guest, skipped, and free meals consumed. An increase in either home or guest meals would result in an increase in the demand for nutritional attributes.

An increase in either skipped or away meals would have an opposite effect because of lower household attribute consumption. Intuitively, household members could not skip a large number of meals and still maintain their health. Thus, the overall impact of this variable was hypothesized, *a priori*, to be positive.

Employment Status of the Homemaker

The employment status of the homemaker was expected to influence the demand for food attributes. Although household income may be higher, a working homemaker may face a more restrictive time constraint for home activities. This may lead to a greater consumption of processed food containing larger portions of fat and carbohydrates and lower quantities of other nutrients. Therefore, it was hypothesized that fat and carbohydrates demand would be greater for households in which the homemaker is employed outside the house, and the consumption of other nutrients would be lower.

Urbanization

Food expenditure patterns by degree of urbanization are influenced by: (1) the potential for home production, (2) accessibility to particular types of food stores, and (3) economic, social, and cultural factors such as prices of nonfood products and services, educational and occupational opportunities, and information availability [Burk, 1961, p. 54]. It was hypothesized that rural families would demand larger quantities of all nutrients. This follows from the fact that rural families, farm operators for

example, have greater physiological needs for all nutrients, especially food energy (proteins, fats, and carbohydrates). Also, rural areas have a lower cost for home food production, making for a convenient source of nutrients.

Region

Attribute demand for spatially distinct regional markets was expected to differ. Households are classified into four geographical categories, as seen in Figure 2, page 38. Geographic location could reflect differences in natural resource availability, climate, topography, and regional price variations [Price, Price, and West, 1980]. Each of these elements can affect expenditures and the demand for nutritional attributes as well as occupation, education, urbanization, and the level of living. Therefore, regional effects are hypothesized to be important. Due to lack of information, inferences are extremely limited, a priori.

CHAPTER V

SPECIFICATION OF THE STATISTICAL MODEL

This chapter presents the statistical equations used to estimate and evaluate a household's implicit prices associated with nutritional attributes of food products, and household demand for these attributes. The statistical equations presented in the third and fourth sections are preceded by a discussion of the functional form and other statistical considerations as related to development and implementation of the regression analysis.

I. FUNCTIONAL FORM OF THE EXPENDITURE AND ATTRIBUTE DEMAND EQUATIONS

The choice of functional form used to estimate hedonic price and demand equations should take into consideration the following interrelated factors: (1) theoretical plausibility, (2) cost, simplicity, and convenience of estimation and interpretation; (3) ability to test alternative hypotheses; and (4) validity and fit of the function over the range of data [Smallwood and Blaylock, 1981, p. 3].

Kravis and Lipsey [1969] presented a discussion as to which is the best functional form to be used when dealing with hedonic models. They analyze the use of linear, semilog, inverse semilog, and double log regressions as possible fits. However, they do not arrive at any firm conclusions as to which functional form is best

for relating price and quality. Griliches [1971, p. 10] stated that most investigators, after some experimentation, settle for a semi-logarithmic relationship between prices and attributes. However, Ladd and Suvannunt [1976] examined the relationship between prices and characteristics of meat, dairy, and poultry items using a linear function.

Morgan [1977] examined four functional forms of the regression equations used to identify price and attribute relationships for breakfast cereals. They were: (1) linear in the dependent variable and in the explanatory variables; (2) logarithmic in the dependent variable and linear in the explanatory variables; (3) linear in the dependent variable and polynomial in the explanatory variables; and (4) logarithmic in the dependent variable and polynomial in the explanatory variables. The R^2 values for each form were fairly similar. However, coefficients were relatively sensitive to the form. Therefore, the linear functional form was chosen because interpretation of the results from use of this form is most easily understood [Morgan, 1977, p. 134]. Also, Adrian [1974] used a linear functional form for testing the relationships between socioeconomic variables and the consumption of food nutrients.

Looking at the Houthakker version of the hedonic model, Freeman [1979, p. 156] states that if the hedonic equation is linear in the characteristics, then the implicit prices are constants for households. But if the hedonic equation is nonlinear, then the implicit price of an additional unit of a characteristic depends on

the quantity of the characteristic being purchased and, depending on the functional form, perhaps on the quantities of other characteristics as well.

Ladd and Suvannunt [1976] stated that regressing product prices upon product attributes (as measured by χ_{ij}) provides a test of the hypothesis that P_i is linearly related to the χ_{ij}'s. If the marginal implicit prices are not believed constant, one might use a polynomial equation. Hedonic price researchers generally have used logarithmic equations or semilogarithmic equations to relate product prices to product characteristics. Ladd and Suvannunt [1976, p. 507] said that neither of these forms were consistent with the CGCM hedonic price equation (18); "they cannot be interpreted as relating product price to the sum of the products of marginal yields of characteristics and marginal implicit prices."

It can be argued that there is an identification problem when trying to estimate demand functions using the Houthakker model, where both the χ_{ij}'s and the Q_i's are determined by the consumer, if the supply of products at a given price is not perfectly elastic for the consumer. This would also be true of the CGCM, where only Q_i's are determined by the consumer. However, this identification problem is "exactly the same as that which arises in the standard neoclassical demand model, and it can be resolved in exactly the same way" [Hanemann, 1982, p. 93]. Another identification problem arises if the hedonic price functions are nonlinear. The problem is discussed by Rosen [1974] who suggests a way of solving it. But, the problem can be avoided entirely by estimating demand functions whose

arguments are the parameters of the hedonic price functions [Hanemann, 1982].

It was assumed that, for households, the supplies of food products with given bundles of nutritional attributes were perfectly elastic at the observed prices. If household marginal implicit prices of attributes are diminishing, a multiple regression of observed levels of an attribute against the observed household implicit prices obtained from a nonlinear equation, income, and other socioeconomic characteristics of households should identify the demand for that attribute. But, if the marginal implicit prices are constant over the relevant range, a linear implicit price function would be appropriate.

In this study, it was assumed that implicit prices of nutritional attributes for each household were constant, with larger quantities of attributes being consumed. To achieve the objectives of this study, the linear function was used to estimate implicit prices of nutritional attributes for various households. To maintain simplicity, interaction terms for the explanatory variables were not included. To examine the household demand for nutritional attributes, a linear functional form was also used.

II. STATISTICAL REVIEW

Economic theory is mainly concerned with causal relations among variables. Econometrics is concerned with testing the theoretical propositions embodied in these relations and with estimating the parameters involved. Before beginning the investigation,

however, several statistical considerations of the multiple regression analysis should be mentioned.

Dummy Variables

Qualitative facts, for which no cardinal or ordinal numerical measures exist, require the researcher to create two or more categories to assign the observations. Often, these qualitative facts refer to either-or (dichotomous) situations and are expressed in numerical terms by use of appropriate dummy variables. These qualitative facts can encompass qualitative groupings (e.g., male or female), qualitative shifts over space (e.g., industrialized or developing country), the aggregation of quantitative facts into qualitative facts (e.g., rich or poor, rather than the quantitative level of income), and seasonal factors [Intriligator, 1978, p. 58; and Maddala, 1977, p. 132-141]. The dummy variable customarily assumes a value of zero or one, one usually referring to the occurrence of an event or the presence of a characteristic and zero referring to the nonoccurrence of the event or the absence of the characteristic. One assumption of the dummy variable method can be that the regression equations for the different groups differ only in the intercept term but have the same slope coefficients. If there is a constant term in the regression equation, the number of dummies defined should always be one less than the number of groupings by that category. The constant term is the intercept for the base group and the coefficients of the dummy variables measure differences from that base group [Maddala, 1977, p. 134]. Another possibility

is to allow for changes in the estimated slope of the equation through the interaction of the variable, which allows both the intercept value and the coefficient of the explanatory variable being examined to change. For simplicity and convenience of estimation and interpretation, this study is based on the assumption that the equations for the different groups differ only in the intercept term and have the same slope coefficients.

If both the constant term and all dichotomous variables are included without the deletion of one of them, perfect multicollinearity, or singularity of the X'X matrix, will occur. Therefore, the elimination of one dummy variable in each category is necessary. Statistical significance of each dummy variable is measured relative to the omitted variable using the t-test. Signs of the dummy variable coefficients are dependent upon which category is omitted.

Statistical Criteria

The adequacy of statistical models are generally evaluated on such criteria as: (1) the coefficient of multiple determination (R^2), (2) the number of significant variables, and (3) the number of coefficients with proper signs. The coefficient of multiple determination reflects the percentage of the variability in the dependent variable that can be explained by variations in the independent variables. This measure generally reflects the "goodness of fit" of a model [Johnson, 1972].

Statistical significance of the various coefficients of the independent variables may be judged by using the t-test. Choice of

the level of significance to use as a criterion for rejection of the null hypothesis that the coefficient is not different from zero is based upon the degree of precision desired. For this study, the null hypothesis was rejected at the .10 level. Probabilities at the .05 and .01 levels are presented in the tables. Unless stated otherwise, all references to significance in the text refer to the .10 level.

Analysis of proper signs primarily involves the consideration of relevant economic and sociological theory. The adequacy of the estimated models in reflecting implicit price and nutrient demand patterns of households were examined statistically using these criteria.

Multicollinearity

Multicollinearity refers to strong interrelationships among the independent variables. It becomes difficult to disentangle their separate effects on the dependent variable [Maddala, 1977, p. 183]. Economic data, by their nature, tend to move together (Intriligator, 1978, p. 152]. Therefore, multicollinearity becomes a question of degree, and most data exhibit some--though not perfect--multicollinearity [Kmenta, 1971, pp. 380, 387]. The higher the degree of multicollinearity, the larger the variance and the covariance of the estimates. Because of the large variances, a high degree of multicollinearity is harmful in the sense that the estimates of the regression coefficients are highly imprecise. The acceptance region for the hypothesis that a given regression is zero will be wide. However, there are only some rules of thumb by which to decide

whether multicollinearity is serious or not [Maddala, 1977, p. 186; and Kmenta, 1971, pp. 388-391].

There are two basic ways of determining which explanatory variables are collinear in nature. One is to analyze the correlation coefficients and partial correlation coefficients, but this may not be a sufficient indicator [Johnson, 1972, p. 163; and Intriligator, 1978, p. 155]. The possibility exists to have a set of variables which may have very low pair-wise correlations among themselves and yet form a perfectly collinear set. The second, and a more reliable guide, is to regress each independent variable on all other independent variables, and observe the coefficient of multiple determination, R^2 [Johnston, 1972, p. 163].

Several solutions have been suggested to handle the problem of multicollinearity. These approaches include: (1) augmenting the data, (2) reducing the model, and (3) living with the problem [Intriligator, 1978, p. 155; and Maddala, 1977, p. 190]. The first approach is to obtain additional sample data or other extraneous information to facilitate the estimation of the model as specified. If additional data or information cannot be obtained, multicollinearity might be reduced by simplifying the model. This can be done by dropping some of the explanatory variables or by averaging or by aggregating certain groups of variables. However, if the model as specified is based on a well-developed underlying theory, then there is no justification for changing the specification. A specification error would then be induced due to the omission of a relevant

variable. This specification error could lead to more problems, such that the "cure" might be worse than the disease [Intriligator, 1978, p. 155].

Various nutritional attributes may be interrelated. Also, economic and sociological variables may be related to each other or to other variables included in the models. Multicollinearity could be a serious problem in the statistical models developed. Therefore, care must be taken to examine the models for multicollinearity and the possible alternatives available. Since additional data are not available, if serious multicollinearity occurs, the models will be simplified and the possible resulting theoretical and statistical ramifications noted.

III. HEDONIC PRICE EQUATION

Two theoretical equations from one model were developed in Chapter IV. The first equation represented the relationship between attributes per unit of various food products consumed in a one-week period by the household and the price paid per unit. The following statistical equation, the hedonic price equation, was developed from the relationships suggested by equation (40) in Chapter IV.

$$P_i^h = \beta_1^h X_{i1} + \beta_2^h X_{i2} + \beta_3^h X_{i3} + \beta_4^h X_{i4} + \beta_5^h X_{i5} + \beta_6^h X_{i6} + \beta_7^h X_{i7} + \beta_8^h X_{i8} + \beta_9^h X_{i9} + \beta_{10}^h X_{i10} + \beta_{11}^h X_{i11} + \beta_{13}^h X_{i13} + \beta_{14}^h X_{i14} + \varepsilon \quad . \tag{51}$$

The dependent variable (P_i^h) is the price per pound paid by household h for food item i consumed during a one-week period in the spring of 1977. The independent variables are as follows:

X_{i1}-X_{i14} = the quantity of the jth nutritional attribute obtained from a pound of food product i by household h in a one-week period. (Due to data limitations, only 14 nutritional attributes are considered.) Attributes are defined in Section IV of Chapter IV.

β_j^h = the parameters to be estimated.

ε = error term.

Ladd and Suvannunt [1976] accomplished their research by including constant terms in their regressions to measure marginal implicit prices of unique product attributes. Certain food product attributes such as taste, small, and other omitted variables may be relevant but not objectively measureable. If this is true, then a non-zero constant term may represent attributes not measured in equation (51). The assumption employed here is that the set of included attributes contains all of the relevant characteristics. In other words, the nutritional attributes comprise an exhaustive set of the food characteristics, and all are objectively and correctly measureable by households. Hence, the model used to derive equation (51) suggests the absence of a constant term; i.e., the regression hyperplane should go through the origin. For statistical purposes one might argue that an intercept term should be included in the estimation procedure. However, the intercept, measuring unknown characteristics for differentiated food products over various households, could not be clearly interpreted.

If one assumes that all of the nutritional attributes of the purchased products are desired, at least over some positive range of quantities of the attributes, households would be expected to prefer to purchase and consume more of each attribute rather than less, ceteris paribus. Based on this assumption, implicit prices associated with the nutritional attributes were hypothesized to be positive for each household; i.e., β_1-β_{14} for each household were all expected to be greater than zero.

However, it should be noted that Ladd and Suvannunt [1976, p. 509] found that two of the nutritional attributes associated with meat, dairy, and poultry products, had negative signs. They gave two possible explanations of why the signs for phosphorus and ascorbic acid (vitamin C) were not positive. These two explanations were (1) phosphorus and ascorbic acid import an unpleasant taste, texture, or odor, and (2) they are proxies for some characteristics that degrade taste, texture, or odor. While it was not consistent with Lancaster's characteristics model, negative marginal implicit prices are consistent with the Consumer Goods Characteristics Model (GGCM) used in this study.

IV. ATTRIBUTE DEMAND EQUATION

The second set of equations developed in Chapter IV, represented the impact of the estimated household implicit prices of the attributes, along with household socioeconomic and demographic factors, on the quantity demanded of nutritional attributes by a

household. The following statistical equation, the attribute demand equation, was developed from the relationships suggested by equation (50) in Chapter IV.

$$X_j = a + \sum_{j=1}^{14} \delta_j \hat{\beta}_j + \delta_{15} I + \delta_{16} N + \delta_{17} R_1 + \delta_{18} R_2 + \delta_{19} E_1 +$$

$$\delta_{20} E_2 + \delta_{21} E_3 + \delta_{22} D_1 + \delta_{23} D_2 + \delta_{24} D_3 + \delta_{25} D_4 + \delta_{26} D_5 +$$

$$\delta_{27} D_6 + \delta_{28} M + \delta_{29} W + \delta_{30} U_1 + \delta_{31} U_2 + \varepsilon \quad . \qquad (52)$$

The dependent variable, X_j, is the weekly aggregate consumption of a particular nutrient ($j = 1, \ldots 14$) obtained from all foods. Equation (52) is estimated for each of 14 attributes and observations are households.

X_1 = grams of protein consumed per household per week.

X_2 = grams of fat consumed per household per week.

X_3 = grams of carbohydrates consumed per household per week.

X_4 = milligrams of calcium consumed per household per week.

X_5 = milligrams of iron consumed per household per week.

X_6 = milligrams of magnesium consumed per household per week.

X_7 = milligrams of phosphorus consumed per household per week.

X_8 = international units (I.U.) of vitamin A consumed per household per week.

X_9 = milligrams of thiamin consumed per household per week.

X_{10} = milligrams of riboflavin consumed per household per week.

X_{11} = milligrams of niacin consumed per household per week.

X_{12} = milligrams of vitamin B_6 consumed per household per week.

X_{13} = micrograms of vitamin B_{12} consumed per household per week.

X_{14} = milligrams of vitamin C consumed per household per week.

The independent variables are defined as follows:

$\hat{\beta}_1 - - - \hat{\beta}_{14}$ = households' previously estimated implicit prices for each of 14 nutrient attributes.

I = net disposable income per household after taxes.

N = the number of members in the household who depend on a common pool of income for their livelihood.

R_0-R_2 = race of the household members. Race classes were coded using the zero-one analysis of covariance (dummy variable):

R_0 = white;

R_1 = 1 if black and = 0 otherwise;

R_2 = 1 if other races and = 0 otherwise.

The white classification (R_0) was omitted to prevent singularity.

E_0-E_3 = level of education attained by the homemaker. The zero-one dummary variable technique was used to represent the data as follows:

E_0 = elementary school;

E_1 = 1 if high school and = 0 otherwise;

E_2 = 1 if some college and = 0 otherwise;

E_3 = 1 if college graduate and = 0 otherwise.

The elementary school classification (E_0) was omitted to avoid singularity.

D_0-D_6 = stage of the household in the family life cycle. The seven discrete family life cycle stages were represented using the zero-one dummy variable format as follows:

D_0 = no children were present and the female head was under 40 years of age (stage 1);

D_1 = 1 if the female head was present and the average age of the children was under six years (stage 2) and 0 otherwise;

D_2 = 1 if the female head was present and the average age of the children ranged from six to less than 12 years (stage 3) and = 0 otherwise;

D_3 = 1 if the female head was present and the average age of the children ranged from 12 to less than 19 years (stage 4) and = 0 otherwise;

D_4 = 1 if the female head was present and the average age of children was 19 years or older (stage 5) and = 0 otherwise;

D_5 = 1 if no children were present and the female head was over 40 years of age or older (stage 6) and = 0 otherwise.

D_6 = 1 if the female head was absent (stage 7) and = 0 otherwise.

Stage 1 (D_0) was omitted to avoid singularity.

M = meal adjustment computed as the difference between the total number of meals each household reported serving and the number of family members multiplied by 21. The 21 represented meal equivalents per week for one household member.

W = employment status of the homemaker as represented by: W = 1 if employed and = 0 if not employed.

U_0-U_2 = urbanization in which the household lives as categorized into one of three groups. The zero-one dummy variable technique was used to represent the data as follows:

U_0 = nonmetropolitan;

U_1 = 1 if suburban and = 0 otherwise;

U_2 = 1 if central city and = 0 otherwise.

The nonmetropolitan category (U_0) was omitted to avoid singularity.[9]

ε = error term.

V. EXPECTED SIGNS OF ATTRIBUTE DEMAND COEFFICIENTS

With the aid of consumer characteristic theory, knowledge of socioeconomic and demographic relationships, and information developed in Chapter IV and from other sources, hypotheses concerning the signs of the coefficients of these independent variables are formulated.

Attributes

As stated in Chapter IV, the quantity of each nutritional attribute of equation (52) should be negatively related to its own price. The quantity demanded of each attribute was expected to be positively related to the implicit prices of substitute attributes, and negatively related to the implicit prices of complementary attributes. The more difficult problem is one of hypothesizing cross-price elasticities between attributes. Since protein, fat,

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[9]The data are examined using an urbanization stratification; central city, suburban, and nonmetropolitan. They are defined as follows: central city--population of 50,000 or more main or core city within the standard metropolitan statistical area (SMSA). Suburban--generally within the boundaries of the SMSA, but not within legal limits of the central city SMSA. Nonmetropolitan--all U. S. areas not within an SMSA [U. S. Department of Agriculture, 1982, p. 290].

and carbohydrates are forms of food energy, they were considered to be substitutes. Thiamin, riboflavin, niacin, vitamin B_6, and vitamin B_{12} are all fat soluble members of the B complex and were, therefore, expected to be substitutes. However, the relationships between many of the remaining nutritional components and implicit prices were not clear.

Income of the Household

As stated previously, the demands for all nutritional attributes, except fat and carbohydrates, were expected to be positively related to income. Therefore, a priori, the signs of the coefficients were hypothesized to be positive for all attributes, except fat and carbohydrates; i.e., $\delta_{15}>0$.

With increasing incomes, the demands for fat and carbohydrates were expected to fall. Thus, the signs of the coefficients were expected to be negative for fat and carbohydrates; i.e., $\delta_{15}<0$.

Number of Members in the Household

As stated beforehand, households were expected to increase their demands for all nutritional attributes associated with food products, as the size of the household increases. Therefore, the coefficient representing the impact of family size (δ_{16}) was expected to be positive in each attribute demand equation.

Race of the Household

Households were classified into one of three mutually exclusive race groups: white, black, and other races. Therefore the

zero-one dummy variable analyses were required. This necessitated the exclusion of one group to avoid singularity. The white group was deleted. As advanced earlier, white households were expected to consume greater quantities of protein and carbohydrates. Since the white group was deleted, δ_{17} and δ_{18} were hypothesized to be negative for protein and carbohydrates. Black households are expected to consume more fat and vitamin A, therefore δ_{17} was expected to be positive for these nutrients.

Education of the Homemaker

Educational attainment of the homemaker was categorized into one of four classes: (1) elementary school, (2) high school, (3) some college, and (4) college graduate. The zero-one format necessitated the deletion of one class. The elementary school class was deleted to prevent singularity. Increased education was previously hypothesized to have a positive effect on demand for all nutritional attributes except fat and carbohydrates. Since the signs and magnitudes of the education coefficients are based on the omitted class, high school (δ_{19}), some college (δ_{20}), and college graduate (δ_{21}) were expected to be negative for fat and carbohydrates, and positive for other nutrients.

Development Stage of the Family Unit

Changes in the development of households should, as explained in Chapter IV, be important in explaining the demand for product attributes. Thus, groups representing various household stages were

integrated into the model. The class representing the earliest stage of family development (stage 1--no children and the female head of the household under 40 years of age) was deleted. The magnitude and sign of the remaining stages would be viewed relative to stage 1, due to the zero-one variable analysis. As seen earlier, the primary criterion used to evaluate the signs of the family life cycle stages were based mainly on the children's average age. The average age reflected the expected level of activity and growth of the children which should have in turn affected attribute demand.

Households with children (stages 2-5) were hypothesized to have positive coefficients for nutritional demand, while stage 6 (no children and the female head of the household is 40 years of age or older) was hypothesized to have a negative coefficient for nutritional demand, due to lower nutritonal demands in the later years of life. The coefficient sign for households without a female head, stage 7, was not hypothesized, a priori. Thus, the signs in the nutritional attribute equations were hypothesized to be positive for δ_{22}-δ_{25}, and negative for δ_{26}. The δ_{27} coefficient could have been $\gtrless 0$.

Meal Adjustment

As presented in the last chapter, meal adjustment is the variable used to measure the composite impact of the number of home, guest, away, and skipped meals on nutrient consumption. The mean of the meal adjustment variable equal to zero would indicate that

the family ate no meals away from home, had no guests, and skipped no meals or served as many guest meals at home as the family members ate away from home and skipped. A negative mean value would indicate that consumption of a larger number of meals away from home or skipped meals than guest meals served at home. A positive mean would indicate more guest meals were served at home than meals eaten away from home or skipped.

Since an increase in either home or guest meals would increase nutrient consumption and an opposite affect on household nutrient consumption would occur for away or skipped meals, the coefficient of the meal adjustment variable (δ_{28}) was hypothesized to be positive.

Employment Status of the Homemaker

The expected sign of the employment status of the homemaker was deemed important in Chapter IV. An employed homemaker could have less time to plan, purchase, and prepare food. These households could purchase more convenience foods, eat away from home more often, or choose among other alternatives. Thus, the coefficient for the employment status of the homemaker was judged to be negative for all nutrients except fat and carbohydrates; i.e., $\delta_{29}<0$. For fat and carbohydrates, δ_{29} was expected to be positive.

Urbanization

As discussed earlier, the degree of urbanization variable was expected to pick up variations in the demand for nutritional attributes. The degree of urbanization was categorized into one of three groups: nonmetropolitan, suburban, and central city. The zero-one format necessitated the deletion of one category. The nonmetropolitan category was deleted to prevent singularity. In Chapter IV, it was hypothesized that rural families would demand larger quantities of all nutrients. Therefore, it was expected that suburban (δ_{30}) and central city (δ_{31}) would be negative; i.e., δ_{30} and $\delta_{31}<0$.

CHAPTER VI

STATISTICAL RESULTS

This chapter presents the results of the tested theoretical model. Estimated implicit price relationships and the estimated nutrient demand relationships for the United States and four regions of the United States were analyzed using the statistical criteria discussed in Chapter V. The four regions of the United States are the South, Northeast, North Central, and West. United States and regional estimates of implicit price relationships, equation (51), for protein, fat, carbohydrates, calcium, iron, magnesium, phosphorus, vitamin A, thiamin (vitamin B_1), riboflavin (vitamin B_2), niacin, vitamin B_6, vitamin B_{12}, and vitamin C (ascorbic acid) are evaluated in the first section of this chapter. United States and regional estimations of household demand relationships, equation (52), for protein, fat, carbohydrates, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and vitamin C are evaluated in the second section of this chapter. United States and regional models representing implicit price relationships and household demand relationships, using a reduced linear hedonic price equation, are evaluated in the third and fourth sections, respectively.

Primary emphasis in each of the four sections is devoted to analyzing the uniformity of the estimated relationships and the <u>a priori</u> relationships hypothesized in Chapter V. The statistical

significance of the various coefficients, estimated for the independent variables are evaluated using the Student's t distribution. Variables are judged at the .01, .05, and .10 significance levels to determine whether the coefficients are significantly different from zero in the case of continuous variables or to determine whether the coefficients are significantly different from the omitted or base class in the case of dummy variables. Unless otherwise specified, the .10 level of significance will be used, with the .05 and .01 levels provided for information.

I. IMPLICIT PRICES USING THE FULL LINEAR MODEL: POOLED-SAMPLE

Implicit prices for all nutritional attributes, for pooled households were hypothesized to be positive. The food nutrients obtained from per unit foods consumed by each household in a one-week period in the Spring of 1977 were combined or pooled for all households in the sample, in the United States and the four regions, and regressed on respective per unit market price to obtain the implicit prices for each nutrient. In this way, estimated implicit prices for representative households in the United States and four regions can be generated.

Table 3 shows the estimated coefficients, standard errors, and level of probability for rejecting the null hypotheses for the full linear hedonic price equation for pooled households. Examination of Table 3 reveals an R^2 of .36 for the United States implicit price

TABLE 3. Estimated implicit prices, in dollars per unit, for nutritional attributes of food for pooled households, using full linear hedonic price equation, for the United States and regions, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors
Protein (gm)	.0096472***	.0001143	.0095651***	.0002089	.01156947***	.0002374	.0086202***	.0002137	.0091709***	.0002657
Fat (gm)	.0021951***	.0000321	.0021941***	.0000529	.0023039***	.0000679	.0021600***	.0000633	.0021761***	.0000772
Carbohydrates (gm)	.0011207***	.0000235	.0012737***	.0000425	.0015432***	.0000497	.0009380***	.0000443	.0010338***	.0000554
Calcium (mg)	.0001255***	.0000036	.0001301***	.0000057	.0001503***	.0000079	.0001088***	.0000008	.0001042***	.0000080
Iron (mg)	-.0017731***	.0002051	.0000530	.0003581	.0014005***	.0004196	-.0037531***	.0003799	-.0035009***	.0005436
Magnesium (mg)	.0011450***	.0000178	.0010977***	.0000335	.0010833***	.0000381	.0011858***	.0000334	.0011549***	.0000390
Phosphorus (mg)	-.0001360***	.0000067	-.0001775***	.0000123	-.0001653***	.0000154	-.0000883***	.0000123	-.0001174***	.0000149
Vitamin A (I. U.)	-.0000034***	.0000005	-.0000051***	.0000009	-.0000012	.0000010	-.0000033***	0000010	-.0000030***	.0000011
Thiamin (mg)	-.3040142***	.0041024	-.4278606***	.0091469	-.03876933***	.0100446	-.2733756***	.0070947	-.2266099***	.0077496
Riboflavin (mg)	.1138138***	.0029426	.1290731***	.0050013	.0669153***	.0061580	.1465962***	.0059183	.1384703***	.0068757
Niacin (mg)	.0220054***	.0002820	.0236146***	.0005132	.0219382***	.0005818	.0221545***	.0005445	.0196864***	.0006424
Vitamin B_6 (mg)	-.0881966***	.0033998	-.0486902***	.0062903	-.0267360***	.0072723	-.1146791***	.0063092	-.1294311***	.0079138
Vitamin$_{12}$ (mcg)	-.0031794***	.0004106	-.0049950***	.0007508	-.0024927***	.0007856	-.0058293***	.0008474	-.0006189	.0009490
Vitamin C (mg)	.0021240***	.0000257	.0025556***	.0000436	.0018508***	.0000600	.0020500***	.0000469	.0019084***	.0000603
R^2	.36		.44		.34		.37		.31	

[a] N = 104,178.

[b] N = 31,277.

[c] N = 24,837.

[d] N = 28,269.

[e] N = 19,795

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

equation. Other coefficients of multiple determination are similar for the regional equations. Therefore, over a third of the price variability in market prices can be explained by variations in the 14 nutritional attributes. Inspecting the estimated coefficients for the United States and all regions, five of the attributes had negative coefficients, i.e., the coefficients for phosphorus, vitamin A, thiamin, vitamin B_6, and vitamin B_{12} were negative. Also, iron had negative coefficients for the United States and two regions, the North Central and the West. For the South, iron was positive but not significantly different from zero at the .10 level, while in the Northeast iron was positive and significant at the .01 level. Vitamin A for the Northeast region was negative but not significantly different from zero at the .10 level, as was vitamin B_{12} for the West region. For the United States and all regions, protein, fat, carbohydrates, calcium, magnesium, riboflavin, niacin, and vitamin C, were positive and significant at the .01 level.

The implicit price coefficients can be readily interpreted. Examining the representative household of the United States, the household would be willing to pay \$0.0096 for an additional gram of protein, or \$0.96 for an additional hectogram (100 grams) of protein in foods. For calcium, the household would be willing to pay an additional \$0.10 for an additional gram of calcium. Coefficients with negative signs are interpreted as the willingness to pay for the removal of an attribute. Thus, the household would be willing to pay an additional \$0.30 for the removal of a milligram of thiamin,

according to the estimates of the representative household in the United States. As stated in Chapter V, Ladd and Suvannunt [1976] found their estimated coefficients for phosphorus and vitamin C to be negative. Their explanations were that phosphorus and vitamin C degrade, or are proxies for characteristics that degrade taste, texture, or odor.

However, Ratchford [1979, p. 78] offered another explanation. He said that regressions estimated with relatively few observations and/or collinear sets of attributes will result in some estimates of negative implicit characteristics prices. He felt that it might be more reasonable to interpret negative (or wrong) signs on the limitations of regression procedures rather than on violation of the stated hypotheses.

Since there were ample observations, the possibility of highly collinear attributes was examined. Remembering that the possibility exists of having a set of variables which may have very low pair-wise correlations among themselves and yet form a highly collinear set, the simple correlation coefficients of the nutritional attributes, Table 4, are provided. For each of the attributes with estimated negative implicit prices, there was relatively high collinearity among other attributes. For example, relatively high pair-wise correlations exist for phosphorus and protein (.56), phosphorus and calcium (.59), vitamin A and vitamin B_{12} (.55), thiamin and riboflavin (.64), thiamin and niacin (.48), iron and thiamin (.50), vitamin B_6 and riboflavin (.58), vitamin B_6 and niacin (.47), thiamin and vitamin B_6 (.68),

TABLE 4. Simple correlation coefficients of the independent variables of the hedonic price equation, full model, fourteen food nutritional attributes, United States, Spring 1977, N = 104178.

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	1.00	.15	-.04	.20	.20	.11	.56	-.00	.26	.24	.19	.26	.20	-.14
X_2		1.00	-.24	.00	-.06	-.06	.06	.04	-.07	-.08	-.07	-.06	.01	-.15
X_3			1.00	.06	.27	.17	.11	-.01	.43	.22	.21	.24	-.04	.04
X_4				1.00	.10	.07	.59	.01	.01	.08	.00	-.02	.02	-.01
X_5					1.00	.24	.26	.15	.50	.41	.43	.38	.12	.05
X_6						1.00	.37	-.01	.16	.34	.75	.13	-.00	-.03
X_7							1.00	.02	.26	.31	.30	.19	.12	-.09
X_8								1.00	.18	.34	.12	.31	.55	.15
X_9									1.00	.64	.48	.68	.08	.15
X_{10}										1.00	.62	.58	.34	.07
X_{11}											1.00	.47	.12	.04
X_{12}												1.00	.23	.17

TABLE 4. (Continued)

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_{13}													1.00	.02
X_{14}														1.00

X_1 = Protein.

X_2 = Fat.

X_3 = Carbohydrates.

X_4 = Calcium.

X_5 = Iron.

X_6 = Magnesium.

X_7 = Phosphorus.

X_8 = Vitamin A.

X_9 = Thiamin.

X_{10} = Riboflavin.

X_{11} = Niacin.

X_{12} = Vitamin B_6.

X_{13} = Vitamin B_{12}.

X_{14} = Vitamin C.

niacin and magnesium (.75), and niacin and riboflavin (.62). Thus, there is some concern as to the limitations of the regression procedure for the full set of attributes.

At any given time, food price schedules for spatially distinct region and urbanization markets are known to differ. Households paying relatively high prices for food are assumed to buy relatively low quantities of food (holding attributes fixed). Of course, this depends on household preferences. It could be that households might reduce purchases of other products while maintaining food purchases. Since the household implicit price coefficients are estimated using the market price per unit the household pays as a function of the attributes obtained from a unit of the food product, households purchasing relatively high priced foods would be expected to have relatively high implicit prices. Thus, relatively high implicit prices should lead to relatively low quantities of attributes demanded, ceteris paribus.

Implicit prices for the 14 nutritional attributes were estimated for each household. The number of observations associated with each household were determined by the number of different foods consumed during a one week period in the Spring of 1977. Table 5 shows the means, standard deviations, extremes, and coefficients of variation for the estimated implicit price coefficients for 2,218 households. The food nutrients obtained from foods consumed by each household in a one week period in the Spring of 1977 were regressed on the respective per unit market price to obtain the implicit prices for

TABLE 5. Means, standard deviations, minimum and maximum values, and coefficients of variation for estimated implicit price coefficients for nutritional attributes of food for households, using full linear hedonic price equation, for the United States, Spring 1977.

Variables	Number of Households	Mean	Deviation	Minimum	Maximum	Coefficient of Variation
Protein (gm)	2218	.0097912	.0176998	-.1596600	.1628600	1.0877253
Fat (gm)	2218	.0022820	.0030680	-.0642790	.0477500	1.3444347
Carbohydrates (gm)	2218	.0010450	.0021463	-.0329200	.0218920	2.0538756
Calcium (mg)	2218	.0001800	.0011779	-.0377390	.0113640	6.5438889
Iron (mg)	2218	.0168584	.0696697	-.7357600	1.1901000	4.1326401
Magnesium (mg)	2218	.0012566	.0039033	-.0252130	.1170900	3.1062391
Phosphorus (mg)	2218	-.0002206	.0013207	-.0130450	.0211980	5.9868540
Vitamin A (I. U.)	2218	-.0000011	.0000591	-.0009062	.0007510	53.7272730
Thiamin (mg)	2218	-.3017839	.6100590	-6.5777000	12.3830000	2.0215094
Riboflavin (mg)	2218	.1063643	.6368950	-3.9127000	12.6450000	5.9878643
Niacin (mg)	2218	.0092830	.0573645	-1.7153000	.5306600	6.1795217
Vitamin B_6 (mg)	2218	-.0018223	.4776099	-3.0921000	8.0075000	262.0918105
Vitamin B_{12} (mcg)	2218	.0111146	.1399232	-1.3384000	.9901100	12.5891350
Vitamin C (mg)	2218	.0019070	.0075372	-.2796900	.0696240	3.9523859

each nutrient, for each of the 2,218 households. The mean estimates for phosphorus, vitamin A, thiamin, and vitamin B_6 were negative, while mean estimates for other nutritional attributes were positive. Minimum implicit prices for all attributes were negative, while maximums were positive. Coefficients of variation were relatively large for vitamin A and vitamin B_6, 53.73 and 262.09, respectively, Table 5. The smallest coefficient of variation was for fat, 1.34.

To estimate household demand functions for attributes (if they are something other than zero slope), there should be considerable variations in household implicit price coefficients for these attributes. Results from the aggregated first equation (Table 3) and the individual households (summarized in Table 5) indicate that it is reasonable to estimate the second equation, the household attribute demand functions.

II. FOOD NUTRIENT DEMAND

The quantities of food nutrients demanded by each household are hypothesized to be affected by implicit prices for protein, fat, carbohydrates, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and vitamin C (see equation 52). Characteristics of the household hypothesized to affect the demand for food nutrients were income, family size, race, stage in the family life cycle, urbanization, and family eating habits (i.e., the meal adjustment variable, page 62). Characteristics of the homemaker (male or female) hypothesized to influence the

demand for food nutrients were educational attainment and employment status. These characteristics of the household and homemaker were included, along with implicit prices, as independent variables in the respective food nutrient demand equations for the United States and the four regions of the United States.

Estimated coefficients and standard errors of these respective coefficients were presented in Tables 6 through 19. Also, the percentage of variability in the demand for each respective nutrient explained by variations in the independent variables was represented by the respective R^2's in Tables 6 through 19.

In all United States and regional food nutrient demand equations, the implicit prices and the selected characteristics of the household and homemaker explained a significant amount of the variation in demand and quantity demanded for each food nutrient. The explained variation for all nutrients except vitamin A, vitamin B_{12}, and vitamin C for the United States and regional equations was greater than 50 percent, Tables 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, and 17. The percentages of variation in household demands for vitamins A, B_{12}, and C, explained by variations of the independent variables in these equations, were not as large, Tables 13, 18, and 19. Coefficients of determination (R^2's) were .34, .23, and .36 for the United States equations representing vitamin A, vitamin B_{12}, and vitamin C demand, respectively. Similar results were obtained in the regional equations.

TABLE 6. Estimates of United States and regional demand relationships for protein in grams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	166.16*	97.08	355.34**	175.59	-21.28	266.51	51.93	201.42	301.23	228.06
Implicit Prices										
Protein	-5956.15**	2870.78	-3759.30	5827.51	-5074.29	6043.13	-8341.20	6257.96	-8095.06	6456.68
Fat	2165.75	6148.19	2371.30	10300.43	1374.39	20983.66	1069.31	11283.84	-9229.62	15221.88
Carbohydrates	-4948.27	12031.55	26626.25	23771.03	-27865.75	28602.23	-6188.06	26379.23	-30684.99	25784.57
Calcium	-26140.61	35899.32	-39913.10	20621.79	-21768.69	72676.95	-7086.49	75129.15	-124208.20	100450.64
Iron	-1014.00*	582.74	-497.13	1248.67	-163.45	1344.39	1254.04	1295.75	-1877.48	1176.94
Magnesium	-26948.10***	9977.22	-36139.99*	18970.02	21851.47	23318.74	31005.25	24715.83	-46566.63**	21012.10
Phosphorus	-96602.04**	43571.51	-120734.79	85786.77	-31030.45	88533.56	-86903.06	96930.18	-192283.76*	102829.06
Vitamin A	9500.90	312674.26	-46481.95	563347.49	416493.47	611756.21	-248551.95	787493.54	-41240.79	882572.73
Thiamin	11.55	65.96	89.33	141.88	43.54	149.55	-4.45	150.04	-4.26	122.36
Riboflavin	-69.59	68.85	-10.46	136.07	63.58	151.83	-98.99	144.24	-188.35	150.49
Niacin	-1243.46	774.05	-586.14	1539.87	-96.87	1874.33	-2229.61	1831.89	-1491.77	1389.34
Vitamin B_6	-149.20***	55.63	-146.84	102.02	-111.62	121.80	-199.79	127.05	-188.54	116.36
Vitamin B_{12}	245.31	195.22	199.75	383.37	-443.40	404.42	-291.53	417.91	-686.36	453.62
Vitamin C	-1146.44	3797.48	-9003.61	7547.07	16120.36	14166.22	-432.60	9396.64	-716.64	8478.04
Income ($100)	1.44***	.32	1.79***	.59	.44	.49	1.61***	.41	1.31***	.24
Family Size	620.66***	16.38	536.23***	30.27	609.95***	37.84	732.19***	30.39	560.89***	37.53
Race										
White[f]										
Black	145.45***	55.90	137.87*	82.58	-59.33	146.76	172.14	144.40	526.42***	161.51
Other	-149.94*	92.99	-260.07	196.60	-58.62	190.29	-96.01	218.95	-137.15	159.35
Education										
Elementary school[f]										
High school	117.69**	50.14	119.39	81.74	145.35	119.51	62.49	105.21	282.83**	124.71
Some college	38.52	61.86	-72.15	113.69	134.48	151.49	7.88	123.10	210.22	138.42
College graduate	-25.80	67.04	-175.61	127.99	100.55	149.91	70.77	142.21	47.71	148.02
Life Cycle[g]										
Stage 1[f]										
Stage 2	-359.31***	73.01	-288.56**	139.81	-215.45	158.46	-512.79***	142.22	-291.88*	152.64
Stage 3	-186.56**	78.92	-81.94	149.42	24.84	171.32	-369.19**	159.63	-152.09	163.01
Stage 4	107.61	76.77	197.55	144.17	358.60**	172.83	3.32	150.51	-108.45	157.84
Stage 5	70.08	79.16	89.14	146.86	304.39*	166.30	46.38	158.54	19.44	179.58
Stage 6	-83.07	61.83	-53.01	122.07	-13.99	127.03	-55.18	126.59	-166.32	124.70
Stage 7	97.42	78.20	3.56	150.83	64.81	162.75	319.65*	168.52	91.45	153.79

TABLE 6. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	584.21***	24.69	596.70***	43.84	494.10***	58.05	648.74***	48.66	503.91***	51.78
Homemaker Employed	31.88	35.89	81.89	66.19	-67.37	149.91	128.20*	69.47	-102.34	75.29
Urbanization										
Nonmetropolitan[f]										
Suburban	119.56***	39.73	11.93	74.52	244.55**	90.08	104.78	78.64	178.14**	90.01
Central city	116.11***	42.06	163.53**	78.08	183.25*	98.53	32.69	83.80	183.38**	94.74
R^2	.65		.58		.67		.73		.67	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 7. Estimates of United States and regional demand relationships for fat in grams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	338.67**	152.86	418.65	291.93	89.12	331.50	47.18	302.39	623.28*	372.54
Implicit Prices										
Protein	-2698.97	4520.27	5999.11	9688.72	-2378.49	8844.06	-8518.45	9395.12	-155.49	10547.22
Fat	-5297.46	9680.80	-11486.36	17125.31	-2668.75	30709.34	1987.70	16940.50	-1030.05	24865.49
Carbohydrates	-16679.55	18944.61	43376.90	39521.30	-55861.17	41859.02	-13504.17	39603.33	-55957.36	42120.02
Calcium	-17296.27	56526.27	-4014.05	117414.55	13667.79	106361.82	4617.30	142791.92	-155459.99	164089.71
Iron	-558.32	917.57	1263.84	2076.02	219.42	1967.49	-767.59	1945.31	-605.11	1922.56
Magnesium	-29802.78*	15709.92	-10440.49	31539.22	19911.17	34126.69	-50800.03	37106.05	-52013.98	34324.01
Phosphorus	-75015.08	68606.74	-27162.50	142627.58	5076.76	129567.77	-85106.60	145521.96	-138047.92	167974.96
Vitamin A	-58999.01	492329.95	-721970.99	936611.55	402453.03	895297.63	-495693.89	1182269.51	480359.91	1441714.16
Thiamin	49.89	103.86	246.76	235.88	-24.72	218.87	98.76	225.25	125.05	199.87
Riboflavin	27.24	108.40	203.03	226.24	212.54	222.20	-15.90	216.55	31.47	245.87
Niacin	-1177.89	1218.80	1105.33	2560.16	-1477.89	2743.06	-3287.13	2750.23	-615.64	2269.54
Vitamin B_6	-121.99	87.59	-5.84	169.61	-164.17	178.26	-220.23	190.75	-99.56	190.08
Vitamin B_{12}	172.75	307.39	1036.13	637.38	-172.67	591.87	-147.73	627.42	-4.76	741.00
Vitamin C	5629.87	5979.43	2513.3	12547.63	21522.51	20732.09	8418.09	14107.24	-776.44	13849.18
Income ($100)	1.57***	.34	1.61**	.78	.06	.86	2.21***	.51	1.85***	.71
Family Size	845.59***	25.79	813.38***	50.33	833.52***	55.39	997.79***	45.63	660.82***	61.31
Race										
White[f]										
Black	196.85**	88.02	9.85	137.30	-106.68	214.78	518.43**	216.79	812.49***	263.84
Other	-427.12***	146.42	-669.17**	326.87	13.09	278.49	-160.84	328.71	-646.27***	260.31
Education										
Elementary school[f]										
High school	130.10*	78.94	142.51	135.89	88.65	174.91	62.90	157.95	411.15**	203.73
Some college	-18.54	97.41	-78.43	189.02	-78.35	221.71	-63.26	184.82	288.57	226.11
College graduate	-197.97*	105.57	-188.98	212.80	-166.58	219.40	-177.84	213.51	-11.56	241.80
Life Cycle[g]										
Stage 1[f]										
Stage 2	-458.09***	114.97	-455.58**	232.45	-275.25	231.91	-752.19***	213.52	-109.99	249.35
Stage 3	-197.21	124.27	-226.11	248.43	109.13	250.73	-612.09***	239.66	194.07	266.28
Stage 4	104.54	120.88	209.58	239.70	145.48	252.94	-156.61	225.97	300.43	257.84
Stage 5	74.15	124.64	38.14	244.16	441.20*	243.38	-90.76	238.02	165.40	293.35
Stage 6	156.59	97.35	-89.20	202.96	-94.50	185.91	-142.76	190.06	-183.16	203.70
Stage 7	145.89	123.14	-34.86	250.76	36.22	238.19	544.48**	252.99	181.97	251.23

TABLE 7. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	796.08***	38.88	795.19***	72.88	687.66***	84.97	837.96***	73.05	784.28***	84.59
Homemaker Employed	52.20	56.51	25.88	110.04	22.41	118.45	207.44**	104.30	-145.95	122.99
Urbanization										
Nonmetropolitan[f]										
Suburban	75.65	62.55	-93.51	123.89	464.62***	131.84	-.80	118.06	49.62	147.03
Central city	84.42	66.22	297.06**	129.81	219.67	144.20	-109.99	125.81	22.05	154.75
R^2	.58		.51		.64		.68		.59	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 8. Estimates of United States and regional demand relationships for carbohydrates in grams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	1046.96**	349.08	1896.18***	638.95	-358.82	723.27	-192.10	734.14	994.31	906.68
Implicit Prices										
Protein	-28699.39***	10322.96	-22975.11	21205.87	-26898.47	19295.93	-44929.87**	22809.38	-23035.94	25669.74
Fat	16197.64	22108.10	-13928.73	37842.46	-31769.66	67001.50	-35252.10	41127.97	-3835.08	60517.43
Carbohydrates	-92516.93**	43263.91	20996.66	86500.93	-179120.46**	91327.84	-96239.27	96148.50	-175932.77*	102511.36
Calcium	-117021.82	129089.32	-68909.76	256987.19	219256.39	232059.76	-227691.88	273834.90	-444840.08	399360.19
Iron	-6831.40***	2095.47	-5043.64	4543.82	-8422.55**	4292.68	-8335.22	4722.81	-7030.47	4679.13
Magnesium	-107329.33***	35876.81	-58726.63	69030.43	-59971.29	74457.47	-155733.37*	90085.63	-159927.36*	93357.52
Phosphorus	-389367.52***	156677.55	-358876.48	312171.37	-215039.36	282690.42	-570089.92	353296.49	-512233.82	408816.07
Vitamin A	-506579.36	1124336.37	-630213.10	2049977.42	1454509.95	1953356.55	-1931366.03	2870300.05	-1646816.55	3508832.03
Thiamin	-653.53***	237.19	-381.21	516.28	-847.65*	477.52	-681.49	546.86	-571.95	486.45
Riboflavin	-332.71	247.57	-19.10	495.18	80.84	484.80	-749.64	525.75	-599.24	598.34
Niacin	-6627.55**	2783.99	-479.29	5603.47	-9851.01*	5984.81	-8988.50	6676.98	-6607.76	5523.58
Vitamin B_6	-733.24***	200.04	-547.23	371.24	-682.45*	388.93	-990.33**	463.10	-615.19	462.62
Vitamin B_{12}	-155.32	701.99	797.98	1395.04	210.84	1291.33	-1532.73	1523.24	-1242.83	1803.44
Vitamin C	-19595.75	13655.26	-26515.35	27463.21	-44.09	45233.19	39632.23	34249.39	-10126.83	33706.03
Income ($100)	.18	.78	1.27	1.71	-4.42**	1.88	1.39	1.23	.94	1.75
Family Size	2135.39***	58.89	1959.38***	110.16	1969.16***	120.85	2591.19***	110.79	1893.95***	149.22
Race										
White[f]										
Black	-193.75	201.02	-281.95	300.51	-1070.73**	468.61	-244.38	526.37	957.05	642.14
Other	-385.80	334.39	-660.63	715.42	-277.95	607.62	60.37	798.04	-428.63	633.54
Education										
Elementary school[f]										
High school	-63.81	180.29	-331.87	297.43	209.77	381.62	-158.49	383.48	901.45	495.84
Some college	-343.32	222.46	-1083.32***	413.71	48.56	483.72	-39.49	448.71	620.86	550.32
College graduate	-349.76	241.09	-1017.55**	465.77	177.25	478.69	124.96	518.35	300.64	588.49
Life Cycle[g]										
Stage 1[f]										
Stage 2	-958.95***	262.55	-625.42	508.77	-107.65	505.97	-1731.86***	518.37	-805.20	606.87
Stage 3	-368.14	283.80	-191.10	543.74	906.19*	547.04	-1577.36***	581.83	29.96	648.07
Stage 4	224.72	276.07	591.54	524.62	874.50	551.87	-386.90	548.62	-25.87	627.53
Stage 5	323.16	284.64	-373.22	534.39	548.77	531.01	-773.09	577.87	-191.10	713.95
Stage 6	-204.99	222.33	-491.15	444.21	409.30	409.63	43.61	461.43	-318.38	495.78
Stage 7	410.21	281.21	-56.05	548.85	1058.74**	519.69	854.65	614.22	300.18	611.46

TABLE 8. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	1688.05***	88.78	1851.84***	159.53	1438.86***	185.38	1674.97***	177.34	1509.89***	205.90
Homemaker Employed	53.73	129.05	64.99	240.85	239.96	258.45	208.97	253.22	438.24	299.35
Urbanization										
Nonmetropolitan[f]										
Suburban	-59.33	142.85	-550.39**	271.16	379.69	287.64	303.43	286.63	73.18	357.86
Central city	-119.48	151.24	-48.99	284.13	134.96	314.63	123.30	305.44	-60.23	376.64
R^2	.61		.57		.66		.69		.60	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 9. Estimates of United States and regional demand relations for calcium in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	1106.95	1261.57	3143.99	2124.28	-2368.78	2662.84	-2718.89	2799.53	5778.20*	3257.10
Implicit Prices										
Protein	-127752.31***	37807.10	-71204.10	70502.47	-96060.65	71040.71	-178045.85**	86980.61	-221504.75**	92214.16
Fat	-80455.58	79898.51	-30793.48	124616.76	108471.36	246675.52	-138413.51	156836.22	-260633.86	217398.54
Carbohydrates	-160168.87	156355.42	168510.44	287586.91	-397943.03	336236.37	-218180.48	366649.93	-215675.45	368254.58
Calcium	-1180854.67***	466527.78	1007330.44	854397.23	-551036.44	854360.90	-1293108.06	1044234.14	-2874005.39**	1434633.28
Iron	-21983.59***	7573.03	11025.03	15106.69	-13548.77	15804.09	-34751.88**	18009.82	-31126.44*	16808.98
Magnesium	-470856.80***	129658.52	-400182.64*	229503.29	-55208.19	274125.75	-636704.63	343529.94	-766960.00***	300094.26
Phosphorus	-2061503.27***	566231.43	-1438944.46	1037866.32	-1647541.74	1040764.84	-2215176.21*	1347250.69	-3948074.81***	1468601.92
Vitamin A	-2284355.17	406342.66	-1242330.19	6815495.27	-1106387.05	7191559.01	-4617160.05	10945519.70	-12100524.67	12604879.97
Thiamin	-1401.71*	857.20	-1224.13	1716.44	-643.04	1758.06	-2218.41	2085.37	-948.15	1747.49
Riboflavin	-2350.99***	894.70	-1515.39	1646.31	-959.40	1784.87	-2689.77	2004.88	-4973.48**	2149.43
Niacin	-23967.09**	10059.13	-12936.43	18629.68	-10000.30	22033.89	-33723.14	25461.79	-39989.71**	19843.54
Vitamin B_6	-2725.49***	722.93	-1820.38	1234.27	-3445.31**	1431.91	-2626.71	1765.97	-3342.39**	4661.89
Vitamin B_{12}	-6381.79***	2537.00	694.42	4638.03	-8393.38*	4754.22	-8535.28	5808.67	-15858.89***	6478.57
Vitamin C	-84507.32*	49349.99	-147363.37	91306.07	-140107.84	166532.38	153750.38	130605.64	36719.99	121083.14
Income ($100)	7.49***	2.80	13.19**	5.68	6.16	6.94	8.63*	4.73	11.31*	6.29
Family Size	7646.65***	212.84	6355.60***	366.26	7491.73***	444.93	9411.47***	422.47	6859.95***	536.04
Race										
White[f]										
Black	-3932.68***	726.49	-2921.70***	999.08	-5567.54***	1725.27	-4494.40**	2007.08	-3325.76	2306.76
Other	-4990.43***	1208.47	-4566.65*	2358.55	-3474.14	2237.04	-2929.38	3043.24	-8810.01	2275.88
Education										
Elementary school[f]										
High school	701.87	651.57	-414.39	988.86	3213.74**	1405.00	365.71	1462.35	2591.00	1781.20
Some college	1155.25	803.96	-2214.43	1375.46	3484.81**	1780.88	2044.04	1711.11	3365.93*	1976.93
College graduate	366.88	871.28	-2329.08	1548.54	3943.10**	1762.35	721.21	1976.65	1083.18	2114.05
Life Cycle[g]										
Stage 1[f]										
Stage 2	-3456.44***	948.87	-1510.47	1691.49	-366.31	1862.81	-6625.92***	1976.73	-4133.64*	2180.08
Stage 3	-3884.54***	1025.66	-1532.92	1807.74	-1825.90	2014.01	-8651.54***	2218.74	-1790.26	2328.09
Stage 4	455.18	997.69	1983.17	1744.20	3749.16*	2031.79	-2779.99	2092.08	-470.99	2254.29
Stage 5	-759.89	1028.68	1351.80	1776.68	2099.64	1955.00	-4249.02**	2203.62	-818.31	2564.75
Stage 6	-472.89	803.50	863.43	1476.86	704.26	1493.40	-607.03	1759.61	-2949.55*	1781.00
Stage 7	2074.43**	1016.29	800.91	1824.74	4210.23**	1913.33	4147.52*	2342.25	1582.32	2196.55

TABLE 9. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	4792.95***	320.87	5215.11***	530.38	4551.20***	682.51	3849.51***	676.27	4967.37***	739.65
Homemaker Employed	806.24*	466.39	1632.65**	800.74	418.04	951.50	2074.56**	965.64	-2203.47***	1075.37
Urbanization										
Nonmetropolitan[f]										
Suburban	1168.73**	516.25	-837.87	901.51	780.70	1058.99	1970.09*	1093.04	3197.26***	1285.54
Central city	915.14*	546.57	416.10	944.63	1425.64	1158.34	694.82	1164.75	1963.02	1353.01
R^2	.60		.53		.67		.66		.61	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

**Significant at .01 level.

TABLE 10. Estimates of United States and regional demand relationships for iron in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	58.67***	20.58	86.55**	37.61	1.54	46.12	6.27	42.65	70.95	49.90
Implicit Prices										
Protein	-1496.15***	608.62	-929.22	1248.11	-1692.82	1230.49	-2223.10*	1324.99	-982.68	1412.90
Fat	39.19	1303.44	457.94	2206.10	2460.68	4272.64	-1443.00	2389.13	-2074.16	3330.97
Carbohydrates	-3117.67	2550.73	3518.37	5091.16	-6890.39	5823.91	611.05	5585.28	-12098.76**	5642.38
Calcium	-6823.41	7610.79	-5791.01	15125.44	3376.84	14798.29	536.74	15907.10	-35129.69	21981.39
Iron	-366.99***	123.54	-250.15	267.43	-442.05	273.74	-336.84	274.34	-443.33*	257.54
Magnesium	-6138.19***	2115.21	-6928.55*	5062.91	-810.34	4748.10	-3066.49	5233.09	-10418.70**	4598.03
Phosphorus	-23369.21***	9237.32	-27014.40	1837.41	-12092.78	18026.97	-16344.54	20523.04	-40193.66*	22501.85
Vitamin A	-14447.68	66288.08	25815.61	120655.14	63648.77	124564.15	-42023.20	166736.15	-59663.71	193131.41
Thiamin	-12.33	13.98	10.74	30.39	-25.34	30.45	5.09	31.77	-18.06	26.77
Riboflavin	-17.24	14.60	4.70	26.14	-2.85	30.92	-18.82	30.54	-50.39	32.93
Niacin	-256.11	164.10	42.57	329.80	-284.27	381.65	-290.03	387.87	-94.93	304.02
Vitamin B_6	-35.45***	11.79	-30.07	21.85	-23.74	24.80	-41.91	26.90	-35.70	25.46
Vitamin B_{12}	-28.92	41.39	34.43	82.10	-31.71	82.34	-64.49	88.49	-121.08	99.26
Vitamin C	-818.58	805.08	-1357.89	1616.40	2581.15	2884.49	179.55	1989.55	-1100.88	1855.23
Income ($100)	.15***	.05	.20**	.10	.15	.12	.24***	.07	.13	.10
Family Size	126.13***	3.47	117.59***	6.48	123.84***	7.71	144.33***	6.43	115.25***	8.21
Race										
White[f]										
Black	20.51*	11.85	6.27	17.69	-34.42	29.88	24.93	30.57	126.52***	35.34
Other	-5.99	19.71	-1.54	42.11	9.08	38.75	-7.37	46.36	-12.97	34.87
Education										
Elementary school[f]										
High school	6.57	10.63	-2.15	17.51	39.17	24.34	-11.16	22.28	58.96**	27.29
Some college	-9.47	13.11	-15.96	24.34	28.34	30.84	-35.31	26.07	38.47	30.29
College graduate	-20.47	14.21	-57.21**	27.41	26.47	30.53	7.62	30.11	8.37	32.39
Life Cycle[g]										
Stage 1[f]										
Stage 2	-38.62***	15.48	-35.36	29.94	2.76	32.27	-55.31*	30.11	-45.91	33.40
Stage 3	-22.75	16.73	-25.37	32.00	16.83	34.88	-56.44*	33.80	14.27	35.67
Stage 4	10.23	16.27	37.17	30.87	17.21	35.19	3.97	31.87	-24.12	34.54
Stage 5	-6.05	16.78	-4.69	31.45	20.71	33.86	-4.21	33.57	-5.46	39.30
Stage 6	-8.22	13.10	-8.25	26.14	3.27	25.87	8.35	26.80	-16.82	27.29
Stage 7	23.19	16.57	.98	32.30	20.42	33.14	69.99**	35.68	23.76	33.66

TABLE 10. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	113.14***	5.23	109.26***	9.39	98.45***	11.82	122.37***	10.30	113.08***	11.33
Homemaker Employed	-7.67	7.61	-7.73	14.18	-7.69	16.48	7.39	14.71	-29.58*	16.48
Urbanization										
Nonmetropolitan[f]										
Suburban	7.35	8.42	-21.10	15.95	48.22***	18.34	14.66	16.65	17.90	19.69
Central city	15.62*	8.92	35.70**	16.72	35.15*	20.06	5.84	17.74	20.86	20.73
R^2	.62		.57		.65		.69		.65	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 11. Estimates of United States and regional demand relationships for magnesium in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	1617.15***	403.90	2074.33***	726.41	790.01	905.90	525.67	823.80	3721.80***	1042.56
Implicit Prices										
Protein	-46632.52***	11944.09	-29266.28	24108.62	-43013.68*	24168.05	-69358.11***	25595.11	-86148.01***	29516.70
Fat	-22704.92	25579.99	-23072.65	42613.24	-10827.19	83919.01	-40217.23	46150.98	-25550.37	69586.79
Carbohydrates	-71605.10	50058.14	97648.26	98341.58	-194139.38*	114387.61	-120742.87	107891.22	-134065.33	117874.08
Calcium	-100528.40	149361.71	100222.08	292164.80	85087.73	290653.56	-213267.91	307278.66	-743934.29	459209.71
Iron	-8800.09***	2424.55	-5329.95	5165.74	-7702.01	5376.55	-12866.45**	5299.61	-14187.78***	5380.36
Magnesium	-206804.72***	41510.97	-160157.05**	78429.64	-90252.11	93257.57	-256612.49***	101087.89	-372762.05***	96056.74
Phosphorus	-650572.23***	181282.44	-485466.53	354902.85	-509853.71	354068.18	-839849.48**	396444.99	11451175.99***	470082.68
Vitamin A	3274.17	1300903.93	-2597.96	2330587.89	2313345.23	2446568.23	-2049049.96	3220853.03	-1776902.62	4034677.96
Thiamin	-460.04*	274.44	90.93	586.95	-441.04	598.09	-920.61	613.64	-696.46	559.35
Riboflavin	-421.16	286.44	100.88	562.96	-2.75	607.21	919.78	589.96	-1272.07*	688.01
Niacin	-10202.64***	3220.49	-2602.72	6370.50	-7952.29	7495.93	-15729.18**	7492.44	-16898.92***	6351.37
Vitamin B_6	-1194.77***	231.45	-915.53**	422.06	-1178.32**	487.14	-1370.93***	519.66	-1649.74***	531.95
Vitamin B_{12}	-996.37	812.24	730.05	1585.99	-1776.08	1617.39	-1526.56	1709.27	-5041.24**	2073.71
Vitamin C	-40336.25***	15799.70	-50761.26*	31222.50	24571.94	56654.31	-61675.83	38432.30	-16707.72	38757.33
Income ($100)	3.99***	.89	6.63***	1.94	1.59	2.36	3.53***	1.39	4.00**	2.01
Family Size	2404.96***	68.14	2081.75***	125.24	2349.88***	151.36	2866.77***	124.31	2091.84***	171.58
Race										
White[f]										
Black	-730.47***	232.59	-680.22**	241.64	-1279.97**	586.94	-1147.44**	590.61	908.74	738.37
Other	-772.18**	386.90	-73.36	831.35	-904.85	761.04	-29.97	895.51	-1752.26**	728.48
Education										
Elementary school[f]										
High school	226.54	208.60	157.16	338.15	621.54	477.98	-70.29	430.31	517.03	570.14
Some college	98.99	257.39	-493.59	470.35	791.29	605.86	-115.65	503.51	335.19	632.79
College graduate	-195.04	278.94	-937.07*	529.53	434.93	599.55	-57.54	581.65	-71.81	676.68
Life Cycle[g]										
Stage 1[f]										
Stage 2	-1482.02***	303.79	-1140.02**	578.41	-636.18	633.73	-1868.60***	581.68	-1685.55**	697.82
Stage 3	-662.99**	328.37	-502.16	618.17	575.71	685.16	-1159.37*	652.89	-599.89	745.19
Stage 4	16.69	319.42	415.39	596.44	656.28	691.21	-232.19	615.62	-616.05	721.57
Stage 5	161.87	329.34	316.34	607.54	1038.74	665.09	-9.84	648.44	55.70	820.95
Stage 6	-109.09	257.24	8.22	505.02	208.42	508.05	135.82	517.79	-455.97	570.08
Stage 7	375.51	325.37	223.35	623.98	999.68	650.91	816.66	689.24	-460.56	703.09

TABLE 11. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	2099.71***	102.73	2168.30***	181.37	2155.92***	232.19	2026.71***	199.00	1889.78***	236.75
Homemaker Employed	81.24	149.32	15.19	273.82	-40.88	323.70	680.85***	284.15	-551.66	344.21
Urbanization										
Nonmetropolitan[f]										
Suburban	430.83***	165.28	-146.18	308.28	705.75***	360.27	671.23***	321.64	459.15	411.49
Central city	427.11***	174.99	694.01**	323.02	386.28	394.07	485.93	342.74	393.17	433.08
R^2	.60		.54		.65		.70		.59	

[a] $N = 2218$.

[b] $N = 727$.

[c] $N = 490$.

[d] $N = 600$.

[e] $N = 401$.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 12. Estimates of United States and regional demand relationships for phosphorus in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	4665.37***	1692.08	7083.51***	3212.51	626.99	3594.47	-1481.39	3484.54	9821.76***	3987.59
Implicit Prices										
Protein	-156895.45***	50038.21	-73002.32	106619.59	-148530.75	95895.24	-227318.01**	108263.88	-243586.16**	112895.30
Fat	-57134.35	107164.04	-22043.46	188455.62	72610.27	332978.22	-115204.93	195212.44	-193602.04	266155.13
Carbohydrates	-231884.60	209712.01	-379375.54	434912.39	-629112.25	453873.12	-211143.42	456365.42	-527646.24	450844.07
Calcium	-811332.24	625731.31	-391286.37	1292089.14	-518218.07	1153270.37	-576600.15	1299747.56	-2691803.84	1756382.50
Iron	-28759.49***	10157.34	-12697.44	22845.57	-19765.51	21333.36	-40305.27*	22416.64	-45433.34**	20578.78
Magnesium	-661110.43***	173904.75	-616812.03*	347073.59	17204.15	370032.27	-753727.76*	427588.21	-1076660.96***	367397.24
Phosphorus	-2501485.28***	759459.02	-2023063.46	1569546.06	-1885076.85	1404890.19	-2536061.23	1676909.17	-4689540.33***	1797969.38
Vitamin A	-367319.79	5449966.37	2123280.31	10306947.61	3869550.97	9707621.21	-6164850.44	13623776.99	-7653486.36	15431811.67
Thiamin	-1019.65	1149.71	787.36	2595.75	-592.09	2373.14	-1601.14	2595.63	-1065.11	2139.40
Riboflavin	-1946.47*	1200.01	365.07	2489.68	-687.85	2409.32	-2937.52	2495.45	-4747.26*	2631.49
Niacin	-31477.58**	13491.83	-4904.98	28173.32	-15712.45	29742.74	-46708.41	31692.03	-48781.56**	24292.69
Vitamin B_6	-3946.49***	969.63	-2881.18	1866.56	-3850.07**	1932.89	-4668.08**	2198.08	-4670.13**	2034.60
Vitamin B_{12}	-5809.24*	3402.76	3996.04	7014.01	-11280.98*	6417.55	-9147.51	7229.99	-17264.66**	7931.53
Vitamin C	-81069.55	66190.77	-148126.65	138080.49	83747.05	224795.94	-152149.05	162563.50	808.28	148238.80
Income ($100)	16.64***	3.76	23.74***	8.59	-.65	9.37	18.29**	5.88	22.09***	7.70
Family Size	10990.99***	285.47	9778.54***	553.88	10429.35***	600.59	13256.51***	525.84	9506.63***	656.25
Race										
White[f]										
Black	-1192.36	974.41	-957.66	1510.89	-4457.39*	2328.87	-2233.22	2498.19	3393.67	2824.10
Other	-5132.92***	1620.86	-5317.33	3597.03	-3634.11	3019.69	-2740.21	3787.89	-7514.04***	2786.29
Education										
Elementary school[f]										
High school	1328.82	873.91	848.55	1495.44	3090.36*	1896.56	723.05	1820.17	4162.01*	2180.68
Some college	659.48	1078.32	-2655.34	2080.09	3821.91	2403.95	1098.03	2129.81	3422.10	2420.30
College graduate	-688.87	1168.60	-4195.40*	2341.83	3217.31	2378.93	1203.11	2460.32	536.16	2588.17
Life Cycle[g]										
Stage 1[f]										
Stage 2	-5399.41***	1272.67	-3718.53	2558.01	-1589.86	2514.54	-8476.81***	2460.42	-5217.39**	2669.01
Stage 3	-3452.38***	1375.67	-1959.40	2733.81	1249.35	2718.63	-7800.69***	2761.65	-1557.03	2850.22
Stage 4	1414.74	1338.16	3842.74	2637.72	5756.81**	2742.65	-1505.49	2603.99	-1487.89	2759.86
Stage 5	459.00	1379.72	1502.47	2686.84	4735.06*	2638.98	-1278.97	2742.82	401.22	3139.96
Stage 6	-1230.62	1077.69	-224.68	2233.43	500.81	2015.88	-327.86	2190.17	-3779.16*	2180.43
Stage 7	2147.63	1363.09	758.26	2759.51	3413.00	2582.73	5992.08**	2915.38	706.12	2689.17

TABLE 12. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	9364.99***	430.36	10056.08***	802.08	8379.99***	921.29	9062.93***	841.75	8513.03***	905.53
Homemaker Employed	850.09	625.54	1253.45	1210.94	-59.64	1284.39	2908.42**	1201.91	2062.67	1316.54
Urbanization										
Nonmetropolitan[f]										
Suburban	1468.71**	692.42	913.21	1363.34	3104.78**	1429.50	2539.30*	1360.49	2815.29*	1573.85
Central city	1370.88*	733.09	1627.69	1428.55	2608.18*	1563.60	1175.95	1449.76	2770.27*	1656.45
R^2	.65		.57		.70		.73		.63	

[a] N = 2218

[b] N = 727

[c] N = 490

[d] N = 600

[e] N = 401

[f] Omitted to avoid singularity

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 13. Estimates of United States and regional demand relationships for vitamin A in International Units, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	25141.51**	12189.01	27890.69	21511.64	68999.13**	28403.08	-10514.39	25111.90	38565.43	32047.80
Implicit Prices										
Protein	-987067.38***	360453.02	-739546.08	713946.49	-1631620.33**	757752.10	-1027643.50	780219.27	-1403576.80	907313.13
Fat	-929848.30	771962.05	-484642.57	1261937.22	-3509730.13	2631151.95	54312.30	1406826.58	-3360254.29	2139026.59
Carbohydrates	-2018380.14	1510672.02	-1142985.23	2912261.84	-3306710.36	3586448.21	-2085435.09	3288863.20	-4687426.26	3623328.44
Calcium	-4490900.68	4507489.99	-3790864.67	8652092.05	-3680192.20	9112997.16	-1829385.59	9366818.18	-22670730.37	14115635.80
Iron	-255578.03***	73168.96	-220362.72	152978.56	-336259.39**	168573.54	-274578.50*	161548.74	-446790.26***	165386.85
Magnesium	-2287052.73*	1252732.43	-2868701.13	2324075.42	-705739.74	2823948.35	-1535144.42	3081476.05	-5592682.45*	2952685.81
Phosphorus	-15351193.99***	5470804.95	-18649825.24*	10510000.12	-15970401.95	11101265.32	-10644010.42	12084887.68	-32626340.53**	14449859.90
Vitamin A	-60089419.18	39259133.24	-102719167.06	69017420.37	187993.23	76708399.36	-9693781.27	98181709.45	-168678025.77	124021865.28
Thiamin	-21965.77***	8282.06	-10817.81	17381.64	-27801.40	18752.28	-37384.34**	18705.80	-24999.73	17193.88
Riboflavin	-24302.84***	8644.38	-15476.89	16671.42	-31087.10*	19038.17	-20577.79	17983.82	-56089.66***	21148.68
Niacin	-170317.67*	97189.15	-33792.24	188654.32	-402273.06*	235023.41	-102457.96	228393.18	-204623.92	195234.64
Vitamin B_6	-25653.68***	6984.79	-36876.18***	12498.84	-14038.75	15273.43	-18176.64	15840.78	-36011.94**	16351.63
Vitamin B_{12}	-67650.25***	24511.97	-68644.30	46967.26	-82571.64*	50710.66	-37579.36	52103.96	-154682.64**	63743.88
Vitamin C	-1205788.58***	476808.84	-1854501.63**	924615.05	149672.34	1776309.22	-2138060.83*	1171537.30	-1104110.63	1191360.60
Income ($100)	69.28***	27.09	62.43	57.52	-49.74	74.03	135.23***	42.40	40.70	61.88
Family Size	42276.03***	2056.39	41237.79***	3708.90	33342.21***	4745.78	47558.44***	3789.54	43694.90***	5274.17
Race										
White[f]										
Black	38241.62***	7019.22	26433.49***	10117.23	27678.05	18402.47	78160.92***	18003.60	63946.52***	22696.66
Other	-15020.85	11675.97	-17873.75	24086.44	-35496.90	23861.23	27424.88	27297.96	-21202.07	22392.80
Education										
Elementary school[f]										
High school	2386.85	6295.27	954.38	10013.76	-1815.76	14986.37	6193.40	13117.34	13246.64	17525.65
Some college	8668.01	7767.71	-10041.61	13928.68	12494.14	18995.69	12242.73	15348.75	31242.33	19451.40
College graduate	7068.99	8418.10	-14881.61	15681.34	22371.98	18798.03	15644.45	17730.66	8307.61	20800.50
Life Cycle[g]										
Stage 1[f]										
Stage 2	-23596.64***	9167.74	-16923.06	17128.97	-11625.26	19869.55	-35384.69**	17731.38	-26273.61	21450.20
Stage 3	-15032.86	9909.74	-16683.40	18306.18	9928.09	21482.30	-21688.89	19902.19	-19050.72	22906.56
Stage 4	278.35	9639.55	4148.03	17662.72	21858.52	21672.03	-1607.71	18766.08	-9845.46	22180.35
Stage 5	4907.45	9938.91	-5185.36	17991.63	28695.81	20852.91	2594.19	19766.58	29705.08	25235.14
Stage 6	8247.21	7753.23	13312.52	14955.49	6741.38	15929.27	10540.12	15783.80	12781.94	17523.62
Stage 7	-845.39	9819.15	-1645.88	18478.27	-16317.76	20408.41	15719.46	21010.10	4776.09	21612.28

TABLE 13. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	35458.29***	3100.15	32876.59***	5370.90	31601.05***	7279.91	36182.56	6066.19	32386.73***	7277.57
Homemaker Employed	-6207.87	4506.16	6409.49	8108.70	-6818.68	10149.15	-7893.37	8661.79	-24570.04**	10580.78
Urbanization										
Nonmetropolitan[f]										
Suburban	14271.94***	4987.88	-4321.49	9129.18	16773.54	11295.75	20844.23**	9804.61	24131.27*	12648.65
Central city	22915.01***	5280.82	25766.32***	9565.88	18705.91	12355.34	14342.31	10447.88	39429.92***	13312.50
R^2	.34		.32		.31		.44		.38	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For evaluation of stages, see page 60.

* Significant at .10 level.

** Significant at .05 level.

*** Significant at .01 level.

TABLE 14. Estimates of United States and regional demand relationships for thiamin in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	5.03***	2.03	7.95**	3.71	1.83	4.37	-1.36	4.28	3.17	5.08
Implicit Prices										
Protein	-131.25**	60.20	-26.86	122.97	-181.10	116.80	-206.79	133.01	-43.43	243.71
Fat	-62.64	128.94	-5.13	217.36	61.08	405.58	-165.94	239.83	8.40	338.71
Carbohydrates	-403.18	252.33	322.51	501.61	-957.85*	552.83	-392.29	560.68	-676.60	573.89
Calcium	-1024.72	752.92	-1005.40	1490.23	-306.20	1404.73	-596.99	1596.85	-1936.68	2235.76
Iron	-34.89***	12.22	-9.12	26.35	-42.85*	25.98	-50.11*	27.54	-32.59	26.19
Magnesium	-730.76***	209.25	-748.13*	400.29	-48.55	450.71	-641.62	525.32	-1059.99**	467.67
Phosphorus	-2409.13***	918.83	-2285.25	1810.24	-1867.43	1711.21	-1792.52	2060.22	-2593.44	2288.69
Vitamin A	-6550.59	6557.75	-7138.88	11887.51	6409.13	11824.28	-12471.96	16738.00	-1639.02	19643.68
Thiamin	-1.21	1.38	2.27	2.99	-2.66	2.89	-2.40	3.18	.49	2.73
Riboflavin	-2.21	1.44	.01	2.87	-1.55	2.93	-3.35	3.06	-2.09	3.35
Niacin	-27.86*	16.23	9.22	32.49	-27.62	36.22	-34.55	38.93	-19.13	30.92
Vitamin B_6	-3.74***	1.16	-2.83	2.15	-3.23	2.35	-3.95	2.70	-3.67	2.59
Vitamin B_{12}	-4.93	4.09	3.72	8.08	-10.29	7.81	-6.94	8.88	-9.75	10.09
Vitamin C	-105.59	79.64	-132.34	159.25	33.99	273.81	-188.51	199.72	-120.76	188.69
Income ($100)	.01	.00	.01	.00	-.02*	.01	.02**	.01	.00	.00
Family Size	12.69***	.34	11.62***	.63	11.39***	.73	15.55***	.64	11.45***	.83
Race										
White[f]										
Black	1.92*	1.17	1.88	1.74	-3.54	2.83	1.28	3.06	6.77*	3.59
Other	-2.67	1.95	-4.27	4.14	-2.60	3.67	-1.55	4.25	-1.99	3.54
Education										
Elementary school[f]										
High school	.04	1.05	-1.20	1.72	3.75	2.31	-1.80	2.23	5.13*	2.77
Some college	-1.06	1.29	-4.51*	2.39	4.11	2.92	-1.74	2.61	4.76	3.08
College graduate	-2.06	1.40	-5.70**	2.70	3.34	3.89	-.63	3.02	2.03	3.29
Life Cycle[g]										
Stage 1[f]										
Stage 2	-5.73***	1.53	-3.26	2.95	-1.20	3.06	-10.59***	3.02	-5.30	3.39
Stage 3	-2.00	1.65	-1.22	3.15	6.41**	3.31	-9.30***	3.39	1.14	3.62
Stage 4	2.09	1.61	4.83	3.04	5.47*	3.34	-1.09	3.19	.50	3.51
Stage 5	-.54	1.66	-.27	3.09	3.59	3.21	-1.05	3.36	-.36	3.99
Stage 6	-.24	1.29	.11	2.57	1.64	2.45	.77	2.69	-1.38	2.77
Stage 7	3.13*	1.64	1.38	3.18	3.85	3.14	8.18**	3.58	2.94	3.42

TABLE 14. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	10.24***	.51	10.40***	.92	8.56***	1.12	10.78***	1.03	10.17***	1.15
Homemaker Employed	-.33	.75	.48	1.39	-1.28	1.56	.75	1.47	-2.68	1.68
Urbanization										
Nonmetropolitan[f]										
Suburban	.45	.83	-1.59	1.57	3.01*	1.74	1.12	1.67	2.44	2.00
Central city	.31	.88	.84	1.64	2.10	1.90	-.14	1.78	2.83	2.10
R^2	.61		.57		.65		.70		.63	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 15. Estimates of United States and regional demand relationships for riboflavin in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	2.79	2.67	9.16**	4.70	-2.13	6.13	-7.17	5.57	6.29	6.50
Implicit Prices										
Protein	-239.96***	79.09	-188.32	156.25	-215.73	163.74	-338.05*	173.09	-253.60	184.14
Fat	-76.54	169.39	1.85	276.19	228.99	568.57	-243.53	312.11	-293.89	434.12
Carbohydrates	-465.33	331.49	243.26	637.39	-1055.26	775.00	-258.96	729.65	-852.41	735.37
Calcium	-2001.81**	989.09	-2085.88	1893.64	-1315.68	1969.25	-998.36	2078.09	-4110.88	2864.85
Iron	-52.34***	16.05	-36.49	33.48	-47.75	36.42	-76.22**	35.84	-72.18**	33.56
Magnesium	-883.92***	274.89	-1186.52**	508.66	11.39	631.84	-874.62	683.64	-1515.29***	599.26
Phosphorus	-4000.24***	1200.47	-4413.13*	2300.28	-2958.37	2398.90	-3253.05	2681.11	-6121.72**	2932.69
Vitamin A	-7867.77	8614.73	-393.02	15105.55	4846.30	16576.14	-20715.06	21782.26	-26238.64	25171.03
Thiamin	-3.36*	1.81	-.82	3.80	-4.77	4.05	-4.68	4.15	-2.31	3.48
Riboflavin	-5.32***	1.89	-4.16	3.64	-4.51	4.11	-5.47	3.98	-7.90*	4.29
Niacin	-45.99**	21.32	-24.78	41.28	-19.41	50.78	-62.42	50.67	-45.97	39.64
Vitamin B_6	-5.58***	1.53	-5.47**	2.73	-3.78	3.30	-7.61**	3.51	-6.71**	3.31
Vitamin B_{12}	-13.71***	5.37	-5.87	10.27	-20.47*	10.95	-15.71	11.55	-26.61**	12.93
Vitamin C	-171.64*	104.62	-199.09	202.36	-148.13	383.84	-300.11	259.91	-36.71	241.79
Income ($100)	.02***	.01	.03***	.01	.02	.02	.02***	.01	.01	.01
Family Size	17.32***	.45	14.39***	.81	16.60***	1.02	21.80***	.84	15.11***	1.07
Race										
White[f]										
Black	-1.34	1.54	-1.58	2.21	-8.11**	3.97	-.08	3.99	7.91*	4.60
Other	-8.21***	2.56	-9.47*	5.27	-8.15*	5.15	-4.59	6.05	-9.26**	4.54
Education										
Elementary school[f]										
High school	2.37*	1.38	.31	2.19	6.44**	8.23	1.88	2.91	7.61**	3.55
Some college	1.77	1.70	-3.61	3.04	5.00	4.10	2.65	3.40	8.06**	3.94
College graduate	-.60	1.84	-7.16**	3.43	5.18	4.06	3.23	3.93	2.90	4.22
Life Cycle[g]										
Stage 1[f]										
Stage 2	-6.59***	2.01	-2.79	3.74	1.46	4.29	-15.33***	3.93	-5.04	4.35
Stage 3	-4.43**	2.17	.64	4.00	2.28	4.64	-15.33***	4.41	.30	4.64
Stage 4	3.82*	2.11	7.37*	3.86	9.42**	4.68	-2.97	4.16	3.50	4.50
Stage 5	-1.08	2.18	.38	3.93	5.01	4.50	-4.67	4.38	1.45	5.13
Stage 6	.17	1.70	2.27	3.27	1.34	3.44	.69	3.50	-2.59	3.55
Stage 7	5.14**	2.15	2.50	4.04	7.06	4.41	11.81***	4.66	4.14	4.38

TABLE 15. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	12.84***	.68	12.55***	1.17	11.52***	1.57	13.30***	1.34	12.44***	1.47
Homemaker Employed	.30	.98	1.92	1.77	-.92	2.19	2.49	1.92	-4.67**	2.14
Urbanization										
Nonmetropolitan[f]										
Suburban	2.42**	1.09	-1.35	1.99	5.31**	2.44	2.58	2.17	5.71**	2.56
Central city	1.77	1.15	2.80	2.09	3.09	2.66	.01	2.31	5.25	2.70
R^2	.63		.56		.66		.73		.65	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 16. Estimates of United States and regional demand relationships for niacin in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	65.76**	27.59	135.20***	51.40	7.39	60.92	-50.23	56.14	125.61*	66.78
Implicit Prices										
Protein	-1914.82**	816.05	-1471.57	1706.15	-1701.82	1625.36	-2459.63	1744.48	-2639.70	1890.77
Fat	-174.83	1747.70	-86.30	3015.70	2940.49	5643.77	-1448.42	3145.51	-1083.85	4457.58
Carbohydrates	-3623.92	3420.13	4639.68	6959.56	-10823.13	7692.87	666.18	7353.55	-12038.23	7550.77
Calcium	-3494.74	10204.87	-1593.91	20676.30	-5271.05	19547.22	6742.03	20943.21	-42034.15	29416.03
Iron	-371.75**	165.65	-247.60	365.57	-320.09	361.58	-339.83	361.20	-624.43*	344.65
Magnesium	-8582.05***	2836.16	-11393.35**	5553.94	385.38	6271.81	-4584.21	6889.85	-15429.78***	6153.19
Phosphorus	-26739.07**	12385.80	-32170.18	25116.22	-17422.97	23812.02	-16959.52	27020.53	-57006.82*	30112.53
Vitamin A	-3749.82	88881.99	-2694.25	164934.08	140465.35	164538.20	-55665.80	219523.97	-92624.41	258453.22
Thiamin	-20.73	18.75	10.31	41.53	-23.02	40.22	-19.67	41.82	-37.36	35.83
Riboflavin	-20.77	19.57	.71	39.84	-5.96	40.83	-17.83	40.20	-57.15	44.07
Niacin	-490.50**	220.03	-360.95	450.83	-122.65	504.12	-521.54	-510.66	-574.93	406.85
Vitamin B_6	-48.96***	15.81	-54.94*	29.86	-22.29	32.76	-50.36	35.41	-70.00**	34.07
Vitamin B_{12}	-5.09	55.49	97.94	112.23	-77.14	108.77	11.53	116.49	-170.37	132.83
Vitamin C	-1247.58	1079.48	-3188.19	2209.59	2880.61	3810.15	-617.42	2619.43	-1394.91	2482.71
Income ($100)	.29***	.06	.39***	.13	.11	.15	.31***	.09	.31**	.13
Family Size	165.81***	4.65	148.22**	8.86	158.23***	10.17	200.20***	8.47	136.06***	10.99
Race										
White[f]										
Black	21.58	15.89	7.49	24.17	-57.11	39.47	19.49	40.25	130.52***	47.29
Other	-40.10	26.43	-48.67	57.56	-59.23	51.18	-8.74	61.03	-25.94	46.66
Education										
Elementary school[f]										
High school	13.43	14.25	7.37	23.93	36.13	32.14	3.96	29.32	50.11	36.52
Some college	-19.54	17.58	-47.40	33.28	27.51	40.74	-26.32	34.31	15.41	40.53
College graduate	-37.28**	19.05	-87.72**	37.47	9.35	40.32	10.78	39.64	-27.66	43.34
Life Cycle[g]										
Stage 1[f]										
Stage 2	-90.72***	20.75	-78.55*	40.93	-29.14	42.61	-121.86***	39.64	-77.88*	44.70
Stage 3	-20.49	22.45	-15.75	43.74	77.60*	46.07	-65.76	44.49	6.22	47.73
Stage 4	33.74	21.82	54.77	42.20	80.19*	46.48	20.48	41.95	4.26	46.23
Stage 5	16.64	22.50	-.11	42.99	88.03**	44.72	39.84	44.19	-16.40	52.58
Stage 6	-2.85	17.57	-11.58	35.73	5.07	34.16	30.97	35.29	-9.88	36.51
Stage 7	26.31	22.23	1.15	44.15	30.40	43.77	91.15**	46.97	.70	45.03

TABLE 16. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	154.70***	7.01	156.90***	12.83	144.83***	15.61	170.59***	13.56	127.00***	15.16
Homemaker Employed	3.99	10.20	1.77	19.37	-18.10	21.76	39.23**	19.36	-19.63	22.04
Urbanization										
Nonmetropolitan[f]										
Suburban	26.40**	11.29	-9.16	21.81	74.61***	24.22	25.22	21.92	41.60	26.35
Central city	22.69*	11.95	55.32**	22.86	40.91	26.50	1.85	23.36	42.79	27.74
R^2	.62		.55		.67		.71		.60	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 17. Estimates of United States and regional demand relationships for vitamin B_6 in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	.38*	.22	.55	.40	.00	.48.	-.20	.49	1.15**	.53
Implicit Prices										
Protein	-13.30**	6.64	-2.06	13.43	-13.46	12.81	-17.62	15.30	-29.13*	15.14
Fat	-3.16	14.24	2.65	23.75	6.19	44.48	-13.15	27.60	-12.44	35.71
Carbohydrates	-5.17	27.86	48.06	54.81	-44.95	60.63	28.98	64.5	-61.46	60.49
Calcium	-7.35	83.14	57.32	162.84	-13.69	154.07	98.30	183.80	-243.82	235.69
Iron	-2.79**	1.34	-1.10	2.87	1.85	2.85	-2.98	3.16	-6.24**	2.76
Magnesium	-68.65***	23.10	-75.53*	43.74	13.61	49.43	-25.02	60.46	-164.79***	49.30
Phosphorus	-203.16**	100.91	-187.79	197.86	-120.77	187.69	-74.79	237.13	-561.70**	241.27
Vitamin A	-241.20	724.20	-390.52	1298.98	1097.77	1296.95	-966.22	1926.56	-1571.59	2070.83
Thiamin	-.02	.15	.31	.32	.01	.31	-.04	.36	-.17	.28
Riboflavin	-.18	.16	.11	.31	-.02	.32	-.18	.35	-.61*	.35
Niacin	-2.65	1.79	.66	3.55	-.80	3.97	-1.51	4.48	-6.37***	3.25
Vitamin B_6	-.43***	.12	-.42*	.23	-.31	.25	-.46	.31	-.67***	.27
Vitamin B_{12}	-.70	.45	.10	.88	-.89	.85	-.91	1.02	-2.40**	1.06
Vitamin C	-14.17	8.79	-22.88	17.40	16.29	30.03	-18.76	22.98	-14.36	19.89
Income ($100)	.00***	.00	.00***	.00	-.00	.00	.00***	.00	.00***	.00
Family Size	1.30***	.03	1.18***	.06	1.26***	.08	1.59***	.07	.98***	.08
Race										
White[f]										
Black	.26**	.12	.19	.19	-.15	.31	.37	.35	1.00***	.37
Other	-.41*	.21	-.57	.45	-.15	.40	-.39	.53	-.32	.37
Education										
Elementary school[f]										
High school	.16	.11	.17	.18	.27	.25	-.01	.25	.52*	.29
Some college	.01	.14	-.17	.26	.37	.32	-.14	.30	.42	.32
College graduate	-.13	.15	-.42	.29	.31	.31	.00	.34	-.03	.34
Life Cycle[g]										
Stage 1[f]										
Stage 2	-.57***	.16	-.35	.32	-.37	.33	-1.06***	.35	-.15	.35
Stage 3	.00	.18	.16	.34	.60*	.36	-.61	.39	.41	.38
Stage 4	.34*	.17	.50	.33	.67*	.36	.07	.36	.26	.37
Stage 5	.04	.18	.04	.33	.51	.35	-.27	.38	.59	.42
Stage 6	-.02	.14	.08	.28	.14	.26	-.04	.30	-.15	.29
Stage 7	.26	.18	.13	.34	.30	.34	.72*	.41	-.03	.36

TABLE 17. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	1.20***	.05	1.21***	.10	.96***	.12	1.33***	.11	1.12***	.12
Homemaker Employed	.05	.08	.12	.15	-.02	.17	.19	.16	-.25	.17
Urbanization										
Nonmetropolitan[f]										
Suburban	.22***	.09	.01	.17	.52***	.19	.17	.19	.43***	.21
Central city	.31***	.09	.45***	.18	.44**	.20	.08	.20	.65***	.22
R^2	.61		.55		.66		.68		.61	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 18. Estimates of United States and regional demand relationships for vitamin B_{12} in micrograms, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	21.73	14.06	45.15***	21.98	49.18	40.59	.31	27.94	-.31	34.05
Implicit Prices										
Protein	-967.09**	415.83	-1619.22**	729.44	-1408.59	1082.97	-869.44	868.27	-562.53	963.99
Fat	-189.87	890.56	-637.87	1289.73	-1576.81	3760.41	751.59	1565.59	-1081.82	2272.66
Carbohydrates	-1300.75	1742.76	-2592.61	2975.48	-1105.70	5125.71	-771.82	3660.03	-2385.67	3849.69
Calcium	-7790.45	5200.00	-13878.99	8839.90	-14079.88	13024.21	-3650.67	10423.93	-6791.20	14997.47
Iron	-212.91***	84.41	-309.85**	156.30	-310.92	240.92	-219.86	179.78	-309.32*	175.72
Magnesium	-1712.55	1445.20	-5533.53**	2374.52	52.96	4178.88	-2899.99	3429.24	-523.12	3137.15
Phosphorus	-15081.32**	6311.32	-29340.50***	10738.14	-14077.01	15865.82	-12865.00	13448.75	-15238.03	15352.57
Vitamin A	-59883.50	45290.75	-23752.97	70515.57	-70272.48	109630.90	-115064.51	109262.19	-38222.11	131769.79
Thiamin	-16.95*	9.55	-20.41	17.76	31.29	26.80	-23.94	20.82	-6.55	18.26
Riboflavin	-29.57**	9.97	-37.84**	17.03	47.95*	27.20	-25.81	20.01	-28.42	22.47
Niacin	185.11	112.12	-241.95	192.75	-355.55	335.89	-201.59	254.17	-41.39	207.43
Vitamin B_6	-17.72**	8.05	-39.15***	12.77	7.69	21.83	-32.24*	17.62	-9.55	17.37
Vitamin B_{12}	-93.21***	28.28	-125.13***	47.98	-117.69	72.48	78.35	57.98	-140.60**	67.72
Vitamin C	-641.99	550.06	-882.37	944.69	1050.30	2538.68	-1765.64	1303.75	-450.51	1265.79
Income ($100)	.06*	.03	.09	.06	.09	.10	.13***	.05	.05	.07
Family Size	35.40***	2.37	26.79***	3.79	38.86***	6.78	40.23***	4.22	37.16***	5.60
Race										
White[f]										
Black	22.90***	8.10	23.52**	10.34	-7.38	26.30	53.62***	20.03	59.44***	24.11
Other	-29.34**	13.47	-37.51	24.61	-40.88	34.10	-5.91	30.38	-29.68	23.79
Education										
Elementary school[f]										
High school	3.71	7.26	12.24	10.23	-12.99	21.41	8.02	14.59	5.90	18.62
Some college	2.66	8.96	-3.08	14.23	-25.80	27.14	12.47	17.08	19.50	20.66
College graduate	-7.39	9.71	-19.53	16.02	-12.06	26.87	2.23	19.73	-7.23	22.10
Life Cycle[g]										
Stage 1[f]										
Stage 2	-21.26**	10.57	-9.11	17.50	.37	28.40	-38.85**	19.73	-28.45	22.79
Stage 3	-10.11	11.43	.68	18.70	-14.88	30.70	-18.40	22.15	8.50	24.33
Stage 4	6.79	11.12	24.52	18.05	9.18	30.97	-2.07	20.88	-5.55	23.57
Stage 5	.68	11.47	-9.52	18.38	10.69	29.80	16.30	21.99	30.67	26.81
Stage 6	-4.42	8.96	-2.50	15.28	-10.57	22.76	.15	17.56	6.70	18.61
Stage 7	-1.66	11.33	2.54	18.87	-27.36	29.17	18.50	23.38	11.33	22.96

TABLE 18. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	35.43***	3.57	30.32***	5.49	35.97***	10.40	37.62***	6.75	29.63***	7.73
Homemaker Employed	1.85	5.19	-.69	8.28	18.65	14.50	-1.08	9.64	-4.22	11.24
Urbanization										
Nonmetropolitan[f]										
Suburban	17.18***	5.75	1.68	9.32	24.46	16.14	10.95	10.91	40.19***	13.44
Central city	19.01***	6.09	20.47**	9.77	17.64	17.65	1.63	11.63	45.34***	14.14
R^2	.23		.24		.21		.33		.29	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages, see page 60.

* Significant at .10 level.

** Significant at .05 level.

*** Significant at .01 level.

TABLE 19. Estimates of United States and regional demand relationships for Vitamin C in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	285.62	201.84	520.53	342.46	549.03	497.03	-15.77	424.73	689.02	498.96
Implicit Prices										
Protein	-6075.24	5968.77	-3561.21	11365.84	-9845.48	13260.09	-18961.04	13196.29	-430.47	14126.45
Fat	562.07	12782.97	773.69	20089.71	9548.78	46043.16	1089.50	23794.45	12638.76	33303.67
Carbohydrates	1145.65	25015.32	-26926.27	46362.44	-1757.93	62760.13	-5301.27	55626.39	-24511.55	56413.58
Calcium	-1520.75	74639.85	-75289.53	137739.03	13172.66	159470.56	-130301.45	158426.27	-275473.95	219774.03
Iron	-1662.42	1211.61	-1881.99	2435.38	-1435.44	2949.91	-3463.99	2732.36	-1643.22	2574.99
Magnesium	-61426.48***	20744.09	-53833.85	36998.67	-39001.50	51166.88	-91749.57*	52118.74	-104220.48**	45971.97
Phosphorus	-138443.06	90591.45	-209854.22	167316.44	-151070.96	194263.75	-322115.91	204398.51	-171937.86	224977.74
Vitamin A	-241494.29	650094.78	-1569577.02	1098739.21	-112553.06	1342338.96	961231.25	1660602.56	-564622.75	1930964.01
Thiamin	-167.50	137.14	-349.66	276.71	29.24	328.15	-445.84	316.38	-22.22	267.70
Riboflavin	-181.28	143.14	-265.25	265.40	-7.17	333.15	-432.83	304.17	-128.76	329.28
Niacin	-1568.52	1609.36	-2507.79	3003.32	-1613.99	4112.73	-803.93	3862.94	-1982.44	3039.71
Vitamin B_6	-273.15**	115.66	-437.06*	198.97	-473.29*	267.27	-33.23	267.92	-202.54	254.59
Vitamin B_{12}	-515.66	405.90	-80.02	747.71	-581.92	887.39	-778.26	-881.26	-729.05	992.46
Vitamin C	-35216.63***	7895.51	-51416.80***	17419.63	-70163.59**	31084.07	-62983.57***	19814.87	-44634.20**	18548.94
Income ($100)	2.16***	.45	1.68*	.91	1.20	1.30	2.52***	.71	2.42***	.96
Family Size	681.16***	34.05	584.10***	59.04	685.22***	83.05	805.50***	64.09	578.18***	82.11
Race										
White[f]										
Black	147.15	116.23	208.35	161.06	-282.33	322.03	519.98*	304.50	310.90	353.38
Other	-141.85	193.34	-295.89	383.44	-5.45	417.55	-29.19	461.71	-320.85	348.65
Education										
Elementary school[f]										
High school	-1.84	104.24	-15.90	159.42	-118.92	262.25	-59.97	221.86	210.87	272.87
Some college	132.07	128.63	-38.59	221.74	-19.64	332.41	438.65*	259.60	355.39	302.85
College graduate	292.85	139.39	50.33	249.64	290.32	328.95	461.99	299.89	316.39	323.85
Life Cycle[g]										
Stage 1[f]										
Stage 2	-249.12*	151.81	-65.20	271.69	-249.65	347.70	-544.69*	299.90	226.43	333.97
Stage 3	141.50	164.10	397.90	291.43	348.43	375.92	61.97	336.62	-73.79	356.64
Stage 4	231.69	159.62	281.80	281.19	300.31	379.24	298.88	317.40	132.81	345.34
Stage 5	155.99	164.60	234.01	286.42	90.98	364.91	155.62	334.32	314.45	392.90
Stage 6	248.33**	128.55	189.23	238.09	199.68	278.75	356.97	266.90	444.51*	272.84
Stage 7	1.67	162.60	-126.27	294.17	157.45	357.13	532.83	355.36	-288.02	336.49

TABLE 19. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	610.87***	51.34	648.45***	85.50	494.29***	127.39	586.11***	102.60	597.64***	113.31
Homemaker Employed	-86.91	74.62	33.18	129.08	64.78	177.60	-161.87	146.50	-420.70***	164.73
Urbanization										
Nonmetropolitan[f]										
Suburban	342.27***	82.59	179.93	145.33	512.99***	197.67	242.45	165.83	201.86	196.93
Central city	425.21***	87.45	414.36***	152.29	525.65***	216.21	342.09**	176.71	304.38	207.27
R^2	.36		.33		.37		.46		.37	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

* Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

Implicit Prices

Household implicit prices for 14 nutritional attributes were included in each of the nutrient demand equations. It was hypothesized in Chapter V that own-implicit prices for each attribute would be negative. An analysis of the United States estimates indicates that all nutritional attributes except fat, vitamin A, and thiamin, have negative own-implicit price coefficients significant at the .05 level, Tables 6 through 19. Thus, as the implicit prices of these attributes increases, the quantity demanded of these attributes decreases. Examining the own-implicit price coefficient for protein in the United States, a $0.001 increase in the implicit price of protein will lead to a reduction in households' quantity demanded of protein by approximately six grams, Table 6. Conversely, a $0.001 decrease in the own-implicit price of protein would lead to a six gram increase in quantity demanded. Other negative own-implicit price coefficients can be interpreted in a similar manner.

The United States estimates of own-implicit prices for fat, vitamin A, and thiamin (Tables 7, 13, and 14) were not significantly different from zero at the .10 level. Thus, a change in the own-implicit prices of these attributes would not (with 90 percent confidence) affect significantly the quantity demanded, of the respective nutritional attributes.

In the South region of the United States, own-implicit price coefficients were significant for magnesium, vitamin B_6, vitamin B_{12}, and vitamin C, Tables 11, 16, 18, and 19. Each had a negative sign.

In the Northeast region, only own-price coefficients for carbohydrates and vitamin C were significant and negative (Tables 8 and 19), while in the North Central, only own-implicit price coefficients for magnesium and vitamin C (Tables 11 and 19) were significant and negative. In the West region all coefficients were negative and significant except for protein, fat, carbohydrates, vitamin A, thiamin, and niacin. All other own-implicit price coefficients were not significant at the .10 level.

Attention is now turned to cross-implicit price relationships among attributes. In Chapter V, protein, fat, and carbohydrates were hypothesized to be substitutes because they are forms of food energy. Thiamin, riboflavin, niacin, vitamin B_6, and vitamin B_{12} are all fat soluble members of the B complex and were hypothesized to be substitutes for one another. Examining the estimates for the United States, without exception all cross-implicit price coefficients for all attributes that were significant, and most that were not, had a negative sign. That is, all significant cross-implicit price relationships were complementary. Returning to protein (Table 6), for example, an increase in the implicit prices for iron, magnesium, phosphorus, and/or vitamin B_6 would cause reductions in household demand for protein. Without exception, all significant cross-implicit price relationships in the United States and all regions, for all nutritional attributes, showed complementary associations. One possible explanation for this may be that households do not view individual nutritional attributes, but an aggregation of these attributes. An example

might be that households view minerals as one nutritional attribute, rather than calcium, iron, magnesium, and phosphorus independently. This leads to the possibility that implicit price estimates may be robbing each other of explanatory power, i.e., multicollinearity, and a reason why so many implicit price coefficients are not significant. These possibilities will be examined in the next two sections.

Income

As stated in Chapter IV, the demands for all nutritional attributes, except fat and carbohydrates, were expected to relate positively to income. With increasing incomes, the demands for fat and carbohydrates were expected to fall, for the United States and all regions. However, only the demands for carbohydrates and thiamin in the Northeast region, exhibited significant negative estimates for income, Tables 8 and 14, pages 100 and 112. For fat, the income coefficients were positive and significant for the United States and all regions except the Northeast, Table 7, page 98. In the Northeast region the income coefficient for fat was not significant. For carbohydrates, there were no significant estimates for income coefficients, except for the previously mentioned Northeast region, Table 8. However with few other exceptions, the income coefficients were positive and significant for the United States and all regions, for all other nutritional attributes, Tables 6 through 19, pages 96-123.

The effect of income upon food nutrient demand was considerably different in the four regions. However, the equations representing food nutrient demand in the North Central region more closely

approximated relationships depicted by United States nutrient demand equations. The regional estimates most radically different from the overall United States estimates for practically all food nutrient demand equations were for the Northeast. It could be argued that consumption was not different, just the estimated coefficients. It may be that the spring quarter imposes differences in regional consumption patterns because of different growing seasons, but is assumed that most consumers are confronted with a uniform distribution system.

Family Size

Family size was a highly significant ($P \leq .01$) factor affecting the demand for all nutrients in the United States and in each of the four regions, Tables 6 through 19, pages 96-123. As hypothesized, the signs of the family size coefficients were significant and positive; i.e., as family size increased, household demand for each respective nutrient increased.

The impact of family size varied among the four regions of the United States. For example, an increase in family size by one member would increase household protein demand by 536, 610, 732, and 561 grams in the South, Northeast, North Central, and West regions, respectively, Table 6. The impact of increased family size on the demand for nutrients was generally lowest in the South and West regions, and highest in the North Central region, Tables 6 through 19.

Race

Race of the household members was categorized into one of three classes: white, black, and other. The white class was utilized as the base race class and was omitted. Thus, tests for significant differences in nutrient demand by race was relative to the white class.

In the United States equations, white households demanded significantly less protein, fat, iron vitamin A, thiamin, and vitamin B_{12} than black households, Tables 6, 7, 10, 13, 14, and 18, pages 96, 98, 104, 110, 112, and 120. However, in no cases did other races households demand significantly more of any attributes than did white households, Tables 6 through 19, pages 96-123.

White households demanded significantly more calcium and magnesium than did both black and other race households, Tables 9 and 11, pages 102 and 106. White households demanded significantly more protein, fat, vitamin B_6, and vitamin B_{12} than other race households, but demanded significantly less than black households, Tables 6, 7, 17, and 18, pages 96, 98, 118, and 120. Also, white households demanded significantly more phosphorus and riboflavin than did other race households, but there was no significant difference in phosphorus and riboflavin demand between white and black households, Tables 12 and 15, pages 108 and 114. Race had no significant impact on the demand for carbohydrates, niacin, and vitamin C, Tables 8, 16, and 19, pages 100, 116, and 122.

The patterns of food nutrient demand by households of different races varied among the different regions of the United States. Also,

none of the regional results were totally consistent with the United States results.

In the South, white households demanded significantly less protein, vitamin A, and vitamin B_{12} (Tables 6, 13, and 18, pages 96, 110, and 120), but significantly more calcium and magnesium than black households (Tables 9 and 11, pages 102 and 106). But, there were no significant differences in the demand for fat, carbohydrates, iron, phosphorus, thiamin, riboflavin, niacin, vitamin B_6, and vitamin C, Tables 7, 8, 10, 12, 14, 15, 16, 17, and 19, pages 98, 100, 104, 108, 112, 114, 116, 118, and 122. Other race households demanded significantly less fat, calcium, and riboflavin than white households, Tables 7, 9, and 15, pages 98, 102, and 114.

In the Northeast, white households demanded significantly more carbohydrates, calcium, magnesium, phosphorus, and riboflavin than black households, with no significant differences for the other nutrients, Tables 6 through 19, pages 96-123. Other race households demanded significantly less riboflavin than white households, with no significant demand differences for other nutrients, Tables 6 through 19.

In the North Central region, black households demanded significantly more fat, vitamin A, vitamin B_{12}, and vitamin C than white households, Tables 7, 13, 18, and 19, pages 98, 110, 120, and 122. Also, black households demanded significantly less calcium and magnesium than white households, Tables 8 and 11, pages 100 and 106. For other race households in the North Central region, there were no

significant differences in the demand for any nutrients when compared to the white households, Tables 6 through 19, pages 96-123.

In the Western region of the United States, black households demanded significantly more of all nutrients except carbohydrates, calcium, magnesium, phosphorus, and vitamin C, Tables 6 through 19. There was no significant differences in the demands of these five nutrients noted between black and white households, Tables 8, 9, 11, 12, and 19, pages 100, 102, 106, 108, and 122. The only significant differences in nutrient demand between white and other race households in the West region were that white households demanded significantly more fat, calcium, magnesium, phosphorus, and riboflavin, Tables 7, 9, 11, 12, and 15, pages 98, 102, 106, 108, and 114.

Summarizing, the effect of race of the household on food nutrient demand varied among the four regions. Fewer significant differences in nutrient demand were noted between white households and black and other race households, respectively, in the Northeast and North Central regions than were noted in the United States, South, or West locations.

Education of the Homemaker

Educational attainment of the homemaker was classified into one of four discrete classes: up through grade school, completed some high school, completed some college, and completed a college education. The grade school class was utilized as the base class; that is, measurement of food nutrient demands by households in other education

classes was relative to nutrient demand by households with the homemaker having a grade school education. It was hypothesized previously that increased education would have a positive effect on the demand for all nutrients except fat and carbohydrates.

In the United States, households with the homemaker having a grade school education demanded significantly less protein, fat, and riboflavin than households having a homemaker with a high school education, Tables 6, 7, and 15, pages 96, 98, and 114. There were no significant differences between the demand for food nutients by households with the homemaker having a grade school education and the households with a homemaker having completed some college, Tables 6 through 19, pages 96-123. Households with the homemaker having completed a college education demanded significantly less fat and niacin, and significantly more vitamin C than households with the homemaker having a grade school education, Tables 7, 16, and 19, pages 98, 116, and 122. Educational attainment did not significantly influence household demand for carbohydrates, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, vitamin B_6, and vitamin B_{12}, Tables 8, 9, 10, 11, 12, 13, 14, 17, and 18, pages 100, 102, 104, 106, 108, 110, 112, 118, and 120.

The impact of educational attainment of the homemaker on household food nutrient demands varied among the four regions. Also, there was little similarity in the impact of education on nutrient demand in the United States equations and the regional equations.

In the Southern region of the United States, signs of significant coefficients for education classes corresponded to those noted

for United States estimates for only niacin, Table 16, page 116. There were no significant differences, between households with the homemaker having a grade school education and households with homemakers having a high school education, for any food nutrient demands, Tables 6 through 19, pages 96-123. Households with homemakers having some college demanded significantly less carbohydrates and thiamin than households with homemakers having an elementary school education, Tables 8 and 14, pages 100 and 112. Households with homemakers having completed a college education demanded significantly less carbohydrates, iron, magnesium, phosphorus, thiamin, riboflavin, and niacin, Tables 8, 10, 11, 12, 14, 15, and 16, pages 100, 104, 106, 108, 112, 114, and 116. No significant differences in the demand for any of the other nutrients between households in the education classes for the Southern region were noted, Tables 6, 7, 9, 13, 17, 18, and 19, pages 96-123.

In the Northeast region of the United States, households with homemakers having a grade school education or less, demanded significantly less calcium than all households with homemakers having more extensive education, Table 9, page 102. Also, households with homemakers having grade school educations demanded significantly less phosphorus and riboflavin than households with homemakers having high school educations, Tables 12 and 15, pages 108 and 114. No significant differences in the demand for any of the other nutrients between households in the education classes for the Northeast region were observed, Tables 6, 7, 8, 10, 13, 14, 16, 17, 18, and 19, pages 96, 98, 100, 104, 110, 112, 116, 118, 120, and 122.

In the North Central region of the United States, the only significant differences in nutrient demand between households with homemakers having an elementary school education and households with homemakers having a more extensive education was for vitamin C. Households with homemakers having some college education consumed significantly more vitamin C than households with homemakers having a grade school education, Table 19, page 122. No other significant variables were noted for nutrient demand in the North Central region.

In the Western region of the United States, households with homemakers having a high school education demanded considerably more protein, fat, carbohydrates, iron, phosphorus, thiamin, riboflavin, and vitamin B_6 than households with homemakers having a grade school education, Tables 6, 7, 8, 10, 12, 14, 15, and 17, pages 96, 98, 100, 104, 108, 112, 114, and 118. Households having a homemaker with some college education demanded significantly more calcium and riboflavin than households with homemakers having an elementary school education. In the Western region, educational attainment did not significantly influence household demand for magnesium, vitamin A, niacin, vitamin B_{12}, and vitamin C, Tables 11, 13, 16, 18, and 19, pages 106, 110, 116, 120, and 122.

Educational attainment of the homemaker of the household seemed to exert few consistent and significant relationships among the different regions of the United States. Exceptions were noted in the Southern region for households with homemakers having a college degree, and in the Western region for households with homemakers having

a high school education. Generally, Southern households with homemakers having a college diploma demanded smaller quantities of most nutritional attributes than households with homemakers having a grade school education, but these differences in demand were not always significant. Also, households in the Western region having a high school education tended to demand more of all nutrients than households with a homemaker having a grade school education or less, although these differences were not always significant, either.

Final patterns noted relative to education of the homemaker and the demand for nutrients were noted for households with homemakers having a high school education and households with homemakers having a college diploma. Households with homemakers having a high school education tended to demand more of all nutrients for the United States and all regions, while households with homemakers having a college degree tended to demand less of all nutrients. Some, but not all, of these differences in demand from the households with homemakers having an elementary education were significant.

Meal Adjustment

The meal adjustment variable, a technical relationship, was developed to incorporate differences in eating habits among all households by combining all family meals consumed in the home with guest meals and subtracting meals eaten away from home or skipped by members of the household, Tables 6 through 19, pages 96-123. This variable had a highly significant ($P \leq .01$) impact on the demand for all nutrients

in the United States equations and also in all regional equations. Thus, an increase in total or guest meals increased household demand for each respective nutrient and an increase in skipped or away meals decreased household demand for each respective nutrient. The influence of meal adjustment on the demand for the respective nutrients was similar among the four regions.

Employment Status of the Homemaker

Whether the homemaker of the household was employed outside the home was entered as an explanatory variable in each of the nutrient demand equations. The impact of the homemaker being employed outside the home was reflected by the appropriate coefficient in each of the equations. It was hypothesized in Chapter IV that households with employed homemakers would demand smaller amounts of all elements except fat and carbohydrates. Fat and carbohydrate demands were expected to increase.

In the United States equations, the employment status of the homemaker of the household had a positive impact on the demand for all nutrients except iron, vitamin A and thiamin, Tables 6 through 19, pages 96-123. However, the employment status of the homemaker was found to have a significant positive impact on only household demand for calcium, Table 9. All other relationships between homemaker employment and nutrient demands were insignificant at the .10 level, for the United States equations.

In the Southern region of the United States, estimates for the homemaker employed variable had positive coefficients for all

nutrients, except iron and vitamin B_{12}, Tables 6 through 19, pages 96-123. However, only the demand for calcium was affected significantly by the household's homemaker being employed, Table 9, page 102.

In the Northeast region of the United States, the homemaker employed coefficients had negative signs for all nutrients, except fat, carbohydrates, calcium, vitamin B_{12}, and vitamin C, Tables 6 through 19. However, no demand for any nutrient was affected significantly by the employment of the household's homemaker, and nothing can be inferred.

In the North Central region of the United States, homemaker employment coefficients were positive for all nutrients except vitamin A, vitamin B_{12}, and vitamin C, Tables 6 through 19. Households with an employed homemaker demanded significantly more protein, carbohydrates, calcium, magnesium, phosphorus, and niacin, Tables 6, 7, 9, 11, 12, and 16, pages 96, 98, 102, 106, 108, and 116. All other relationships between homemaker employment and nutrient demands were not significant, Tables 6 through 19.

In the Western states, homemaker employment coefficients were negative for all nutritional attributes except carbohydrates. There were significant reductions in the demand for calcium, iron, vitamin A, riboflavin, and vitamin C, Tables 9, 10, 13, 15, and 19, pages 102, 104, 110, 114, and 122. Other coefficients were not significant at the .10 level.

In summary, the North Central and Western regions tended to be as hypothesized, a priori. Thus, for these regions households

with homemakers employed generally demanded less of all nutrients except fat and carbohydrates. However, for the United States, and the South and Northeast regions, employment of the homemaker tended to have a reverse effect.

Urbanization

Households were classified as being located in one of three urbanization classes: nonmetropolitan, suburban, and central city. The nonmetropolitan class was utilized as the base class. It had been hypothesized earlier that nonmetropolitan households would demand more of each nutritional attribute.

Households classified as being nonmetropolitan in the United States equations demanded significantly less protein, calcium, magnesium, phosphorus, vitamin A, niacin, vitamin B_6, vitamin B_{12}, and vitamin C, Tables 6, 9, 11, 12, 13, 16, 17, 18, and 19, pages 96, 102, 106, 108, 110, 117, 118, 120, and 122. Also, suburban households demanded significantly more riboflavin, while central city households demanded significantly more iron than did nonmetropolitan households, Tables 10 and 15, pages 104 and 114. Nonmetropolitan households demanded more carbohydrates than either the suburban or central city households, but not significantly more, Table 8, page 100. Other nutrients not affected significantly by urbanization were fat and thiamin, Tables 7 and 14, pages 98 and 112.

In the South, suburban households demanded less carbohydrates than did nonmetropolitan households, Table 8, page 100. Other

coefficients were not significant at the .10 level. Central city households demanded significantly more of all nutrients except carbohydrates, calcium, phosphorus, thiamin, and riboflavin than did nonmetropolitan households, Tables 6 through 19, pages 96-123.

In the Northeast region of the United States, suburban and central city households demanded significantly more protein, iron, phosphorus, vitamin B_6, and vitamin C than nonmetropolitan households, Tables 6, 10, 12, 17, and 19, pages 96, 104, 108, 118, and 122. Also suburban households demanded significantly more fat, magnesium, vitamin A, thiamin, riboflavin, and niacin than nonmetropolitan households, Tables 7, 11, 13, 14, 15, and 16, pages 98, 106, 110, 112, 114, and 116.

In the North Central region of the United States, suburban households demanded significantly more calcium, while central city households demanded more vitamin C, Tables 9, 11, 12, 13, and 19, pages 102, 106, 108, 110, and 122. The demand for fat was less for both the suburban and central city households than the nonmetropolitan households, but not to a significant degree.

In the Western region of the United States, suburban and central city households demanded significantly more protein, phosphorus, vitamin A, vitamin B_6, and vitamin B_{12} than the nonmetropolitan households, Tables 6, 12, 13, 17, and 18, pages 96, 108, 110, 118, and 120. Also, suburban households demanded more calcium and riboflavin, Tables 9 and 15, pages 102 and 114. Central city households tended to demand less carbohydrates than nonmetropolitan

households, although not significantly so, Table 8, page 100.

With the exception of the Southern region, the effect of urbanization on food nutrient demand did not vary considerably among the regions. Suburban households in the South tended to demand less of many nutritional attributes than nonmetropolitan households. Otherwise, suburban and central city households were inclined to demand more of all other nutrients, except carbohydrates, than nonmetropolitan households.

Family Life Cycle

The family life cycle variable was developed to reflect the impact of the stage of development of the family unit on food nutrient demand. Stages in the life cycle were represented by seven discrete stages or classes as follows: (1) no children were present and the female head of the household was under 40 years of age (stage 1), (2) the female head was present and the average age of the children was under six years (stage 2), (3) the female head was present and the average age of the children ranged from six to less than 12 years (stage 3), (4) the female head was present and the average age of the children ranged from 12 to less than 19 years (stage 4), (5) the female head was present and the average age of the children was over 19 years (stage 5), (6) no children were present and the female head was 40 years of age or more (stage 6), and (7) the female head was absent from the household (stage 7). Stage 1 was the base class for comparisons.

The primary criterion used to evaluate the signs of the family life cycle stages were based mainly on the children's average age. The average age reflected the expected level of activity and growth of the children which should have, in turn, affected attribute demand. Therefore, households with children (stages 2-5) were hypothesized to have positive coefficients for nutritional demands.

The impact of the stages in the family life cycle variable generally were not as expected. In all cases, stage 2 showed significantly less nutrient demand than stage 1, that is, households with the female head present and children with an average age of less than six years old, demanded significantly less of all nutritional attributes than households with the female head under 40 years of age and no children, Tables 6 through 19, pages 96-123. Also, with the exception of vitamin B_6 and vitamin C, households with the female head present and children with an average age ranging from six to less than 12 years, demanded less of all nutrients than households with the female head under 40 years of age and no children.

The reason for these incorrectly hypothesized signs might be of a statistical nature. It was expected that the family size variable was explaining the bulk of the variation that was also being explained by the family life cycle stages. The family size variable was explaining a relative large portion of the variation in the demand for nutritional attributes. Examining Table 30, Appendix, it can be seen that family size exhibits a relatively high correlation among the family life cycle variables. Correlations were .17, .37,

.44, .07, -.48, and -.27 for stage 2, stage 3, stage 4, stage 5, stage 6, and stage 7, respectively. Also, each stage of the family life cycle was regressed against all other independent variables to determine the coefficient of multiple correlation among the variables. The coefficients obtained were .76, .81, .83, .69, .82, and .62 for stage 2 through stage 7, respectively. Therefore, each of the nutritional demand equations was reestimated after deleting the family size variable to determine the impact of the family life cycle stages in the absence of family size.

With the deletion of the family size variable, the impact of the stages in the life cycle variable were as hypothesized, a priori, Tables 31 through 44, Appendix. For the United States equations, households in stage 1 demanded significantly less of all nutrients than did households in stages 2, 3, 4, and 5, Tables 31 through 44 in the Appendix. They also demanded more protein, fat, carbohydrates, calcium, iron, magnesium, and phosphorus than households in stage 6. There were no differences between households in stage 7 and households in stage 1 for any variables, at the .10 level of significance, Tables 31 through 44.

The impact of stage of the household in the family life cycle seldom varied among the four regions and between the United States estimates and the respective regional estimates, variations in signs, across regions, for stage 6 occurred only for vitamin A and vitamin B_{12}, Tables 38 and 43, Appendix. Variations for stage 7 occurred for carbohydrates, calcium, magnesium, thiamin, and vitamin C, Tables

33, 34, 36, 39, and 44, Appendix. However, in no cases were these variations of signs across regions significantly different from zero at the .10 level.

In summary, with deletion of family size from the model, stage in the family life cycle influenced nutrient demand in a consistent fashion. Households in stage 2, 3, 4, and 5 demanded more of all nutrients than households in stage 1. Households in stages 6 and 7 tended to demand smaller quantities of most nutrients than did households in stage 1. But equations estimated with family size deleted had considerably lower R^2's. More variables became significant with the deletion of family size, but there were few changes of signs. Thus, the original model with family size included was accepted as the better of the two models, with the above limitations noted.

III. IMPLICIT PRICES USING A REDUCED LINEAR MODEL: POOLED-SAMPLE

It was assumed that households assess, or act as if they assess, individual dietary components of food products. However, results from the previous section led to the hypothesis that households do their assessment of nutrients in a more aggregate way; i.e., households choose foods which contain numerous vitamins and minerals, but they do not know or precisely evaluate each individual vitamin or mineral contained within a particular food. It is, therefore, postulated that households perceive or are aware of protein, fat, and

carbohydrates and, to a lesser extent, vitamin A, vitamin C, B vitamins and minerals in food.[10]

Utilizing the a priori information previously mentioned, a households' reduced implicit price model was specified as:

$$P_i^h = \beta_1^h X_{i1} + \beta_2^h X_{i2} + \beta_3^h X_{i3} + \beta_4^h X_{i4} + \beta_5^h X_{i5} + \beta_6^h X_{i6} + \beta_7^h X_{i7} + \varepsilon \quad (53)$$

where P_i^h is the price per unit paid for the ith product by household h, and the X_{ij} is the quantity of the jth nutritional attribute (j = 1, . . . , 7) provided by one unit of the ith food product where

j = 1 = protein in grams

j = 2 = fat in grams

j = 3 = carbohydrates in grams

j = 4 = minerals in milligrams

j = 5 = vitamin A in International Units

j = 6 = B vitamins in milligrams

j = 7 = vitamin C in milligrams

ε = error term.

For the average household, implicit prices for all attributes were again hypothesized to be positive. Table 20 shows the estimated coefficients, standard errors, and level of probability for rejecting

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[10] It was assumed that one milligram of a B vitamin was equivalent to one milligram of another B vitamin in the eyes of the households, and likewise for minerals. Therefore, B vitamins consist of the sums of milligrams of thiamin, riboflavin, niacin, vitamin B_6, and vitamin B_{12}, while minerals consist of the sums of milligrams of calcium, iron, magnesium, and phosphorus.

TABLE 20. Estimated implicit prices, in dollars per unit, for nutritional attributes of food for pooled households, using reduced linear hedonic price equation, for the United States and regions, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors	Implicit Prices	Standard Errors
Protein (gm)	.0043163***	.0001077	.0032655***	.0001908	.0058377***	.0002181	.0035925***	.0002109	.0048923***	.0002534
Fat (gm)	.0024877***	.0000356	.0023986***	.0000600	.0025518***	.0000748	.0025352***	.0000706	.0024937***	.0000844
Carbohydrates (gm)	.0002040***	.0000238	-.0001178***	.0000417	.0005105***	.0000490	.0001589***	.0000459	.0004109***	.0000566
Minerals (mg)	.0001229***	.0000021	.0001190***	.0000035	.0001369***	.0000045	.0001335***	.0000044	.0001021***	.0000046
Vitamin A (I. U.)	-.0000141***	.0000004	-.0000175***	.0000008	-.0000118***	.0000009	-.0000154***	.0000008	-.0000100***	.0000010
B Vitamin (mg)	.0235473***	.0001485	.0259926***	.0002573	.0216173***	.0003019	.0238446***	.0002911	.0215690***	.0003587
Vitamin C (mg)	.0016302***	.0000284	.0020178***	.0000490	.0012237***	.0000652	.0015745***	.0000521	.0015095***	.0000657
R^2	.20		.25		.18		.20		.15	

[a] N = 104,178.

[b] N = 31,277.

[c] N = 24,837.

[d] N = 28,269.

[e] N = 19,795.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

the null hypotheses, for the reduced linear hedonic price equation for pooled households. Again, the food nutrients obtained from per unit foods consumed by each household in a one week period in the Spring of 1977 were combined for all households in the sample, in the United States and the four regions, and regressed on the respective per unit market price to obtain the implicit prices for each nutrient. Examination of Table 20 reveals that for the United States and all regions, only vitamin A had a negative coefficient. Carbohydrates had a negative marginal implicit price for the pooled households in the South, but positive implicit prices for the United States and the other regions. Protein, fat, minerals, B vitamins and vitamin C all had highly significant positive implicit prices for the average household in the United States and all regions. However, there was a substantial drop in the R^2's for the United States and all four regions.

Interpreting the implicit price coefficients for the representative household in the United States, the willingness to pay for an additional gram of protein is $0.0043. For an additional unit of B vitamins, the representative household in the United States would be willing to pay $0.0235 for an additional milligram of B vitamins.

In the reduced hedonic price equation, vitamin A maintained its negative implicit price. The absolute value of vitamin A also became considerably larger. Again the argument that vitamin A may degrade taste can be raised. The simple correlation coefficients for the reduced linear hedonic equation, Table 21, shows no evidence

TABLE 21. Simple correlation coefficients of the independent variables of the hedonic price equation, reduced model, seven food nutritional attributes, United States, Spring 1977, N = 104178.

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	1.00	.14	-.04	.38	-.00	.21	-.14
X_2		1.00	-.23	.01	.03	-.07	-.15
X_3			1.00	.11	-.01	.24	.04
X_4				1.00	.01	.27	-.05
X_5					1.00	.16	.15
X_6						1.00	.05
X_7							1.00

X_1 = Protein.

X_2 = Fat.

X_3 = Carbohydrates.

X_4 = Minerals.

X_5 = Vitamin A.

X_6 = B vitamins.

X_7 = Vitamin C.

of high collinearity. Therefore, neither few observations nor collinear sets of attributes appear to be the cause of the negative signs obtained for vitamin A.

Implicit prices for the seven nutritonal attributes were estimated for each household. The number of observations associated with each household was determined by the number of different foods consumed during a one week period in the Spring of 1977. Table 22 shows the means, standard deviations, extremes, and coefficients of variation for the estimated implicit price coefficients for 2,218 households. The food nutrients obtained from per unit foods consumed by each household in a one week period in the Spring of 1977 were regressed on the respective per unit market price to obtain the implicit prices for each nutrient, for each of the 2,218 households. The mean estimate for vitamin A was negative, while mean estimates for the other nutritional attributes were positive. Minimum implicit prices for all attributes were negative, while maximums were positive. The coefficient of variation was largest for carbohydrates, 4.98, and smallest for fat, 1.05. Results from the aggregated equation (Table 20) and the individual households (summarized in Table 22) indicate that it is reasonable to estimate the household demand for attributes equations.

IV. FOOD NUTRIENT DEMAND: REDUCED MODEL

Quantity demanded of food nutrients was hypothesized to be affected by implicit prices for protein, fat, carbohydrates, minerals,

TABLE 22. Means, standard deviations, minimum and maximum values, and coefficients of variation for estimated implicit price coefficients for nutritional attributes of food for households, using reduced linear hedonic price equation, for the United States, Spring 1977.

Variables	Number of Households	Mean	Deviation	Minimum	Maximum	Coefficient of Variation
Protein (gm)	2218	.0029483	.0106309	-.0762000	.0584410	3.6057728
Fat (gm)	2218	.0026807	.0028027	-.0139510	.1001400	1.0455105
Carbohydrates (gm)	2218	.0003187	.0015868	-.0180490	.0122160	4.9789771
Minerals (mg)	2218	.0002093	.0002891	-.0013815	.0022897	1.3812709
Vitamin A (I. U.)	2218	-.0000177	.0000535	-.0005192	.0004927	3.0225989
Vitamin B (mg)	2218	.0217199	.0236365	-.0897960	.3582100	1.0882417
Vitamin C (mg)	2218	.0013660	.0036972	-.0522490	.0398500	2.7065886

vitamin A, B vitamins, and vitamin C. Characteristics of the household hypothesized to affect the demand for food nutrients were income, race, stage in the family life cycle, urbanization, family eating habits, and family size. Characteristics of the homemaker hypothesized to influence the demand for food nutrients were educational attainment and employment status.

Family size was a highly significant explanatory variable in the original food nutrient demand model. Again, it is noted that family size has a relatively high degree of collinearity with the stages of the family life cycle. However, by deleting family size, only the coefficients for the stages of the family life cycle change both in direction and degree. Other coefficients are not changed substantially. Also, the reduction in the percentage of variability in the demands for each respective nutrient explained by variations in the independent variables is noteworthy, when family size is deleted from the food nutrient demand equations. Therefore, the family size variable is maintained in this food nutrient demand model.

These characteristics of the household and homemaker were included, along with implicit prices, as independent variables in the respective food nutrient demand equations of the United States and the four regions of the United States. The reduced food nutrient demand model was specified as follows:

$$X_j = a + \sum_{j=1}^{7} \delta_j \hat{\beta}_j + \delta_8 U + \delta_9 N + \delta_{10} R_1 +$$

$$\delta_{11} R_2 + \delta_{12} E_1 + \delta_{13} E_2 + \delta_{14} E_3 + \delta_{15} D_1 +$$

$$\delta_{16} E_2 + \delta_{17} D_3 + \delta_{18} D_4 + \delta_{19} D_5 + \delta_{20} D_6 +$$

$$\delta_{21} M + \delta_{22} W + \delta_{23} U_1 + \delta_{24} U_2 + \varepsilon \ . \qquad (54)$$

The dependent variable, X_j, is the weekly aggregate consumption of a particular nutrient ($j = 1, \ldots, 7$) obtained from all foods. Equation (54) is estimated for each of seven nutritional attributes and observations are households. The previously estimated implicit price coefficients ($\hat{\beta}_j$) are defined on page 143. The remaining independent variables (socioeconomic variables) are defined on pages 77 through 79.

Estimated coefficients and standard errors of these coefficients were presented in Tables 23 through 29. Also, the percentage of variability in the demand for each respective nutrient explained by variations in the independent variables was represented by the respective R^2's in Tables 23 through 29.

In the United States and regional food nutrient demand equations, the implicit prices and the characteristics of the household and homemaker explained a significant amount of the variation in demand and quantity demanded for each food nutrient. In fact, the reduced model yielded R^2's equivalent to that of the full model examined in Section II. The explained variation for all nutrients except vitamin A and vitamin C for the United States and regional

TABLE 23. Estimates of United States and regional demand relationships for protein in grams, using reduced linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[c]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	185.25**	95.98	458.90***	184.30	-100.29	225.68	-68.17	193.05	204.18	225.27
Implicit Prices										
Protein	-5115.02*	2890.12	-4258.72	6417.23	-1983.80	5873.12	-10024.27*	6044.28	-608.97	5817.39
Fat	-9251.84	6428.51	-12715.50	16924.35	-7443.07	23035.67	-7716.12	8304.46	-8443.49	23455.01
Carbohydrates	-9220.40	13197.08	-1635.19	25389.30	-3721.32	30736.28	190.06	27986.43	-31257.78	25268.37
Minerals	-157577.78*	92424.54	-259987.42	184083.97	218580.46	216308.30	-358956.13**	181757.87	8971.11	196317.10
Vitamin A	373175.31	335904.05	-303219.10	561098.60	1672754.29***	773923.33	657589.27	771399.69	1189956.77	918347.42
Vitamin B	-2264.24**	1083.85	-3048.01	2413.32	-825.12	2108.62	-2977.47	2286.20	-1193.08	2114.75
Vitamin C	3189.15	4694.26	-3960.74	7791.13	25387.08*	13306.65	9642.61	9716.70	-4787.74	9886.13
Income ($100)	1.36***	.22	1.59***	.47	.41	.59	1.41***	.33	1.64***	.44
Family Size	614.77***	16.33	538.99***	30.34	610.03***	37.35	730.73***	30.07	535.62***	37.01
Race										
White[f]										
Black	122.70**	55.60	114.83	81.61	-105.50	141.86	143.61	143.20	389.29**	161.44
Other	-155.59*	93.09	298.16	193.67	-14.92	186.12	-118.78	215.28	-155.75	160.70
Education										
Elementary school[f]										
High school	102.37**	50.09	102.13	80.81	154.96	117.76	61.50	105.10	247.38**	125.94
Some college	26.89	61.83	-78.76	113.27	155.72	147.72	1.04	122.20	217.83	139.73
College graduate	-47.63	66.82	-184.52	126.13	93.90	145.85	60.40	140.12	62.10	150.20
Life Cycle[g]										
Stage 1[f]										
Stage 2	-347.91***	73.01	-309.42**	138.82	-174.35	156.66	-489.66***	140.43	-245.38	154.30
Stage 3	-152.54**	78.83	-82.95	148.52	40.48	167.44	-330.64**	157.76	-54.01	162.96
Stage 4	129.38*	76.66	192.10	142.40	368.84**	169.48	67.29	149.79	-67.26	159.56
Stage 5	89.58	78.97	79.98	145.20	303.77	162.56	76.09	155.71	57.60	181.54
Stage 6	-68.39	61.39	-56.46	119.16	-6.85	122.57	14.65	125.27	-161.09	124.50
Stage 7	94.57	77.61	-34.31	146.34	43.90	156.99	371.12***	165.28	95.61	153.54

TABLE 23. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	580.20***	24.64	603.22***	43.29	488.52***	57.13	642.06***	48.20	490.42***	52.40
Homemaker Employed	22.66	35.82	67.04	65.71	-64.27	79.11	127.20*	68.35	-113.27	75.85
Urbanization										
Nonmetropolitan[f]										
Suburban	118.57***	39.73	.86	73.61	260.36***	89.01	102.51	76.82	188.66**	91.31
Central city	109.11***	42.17	149.84*	78.15	213.95**	96.76	43.40	82.56	120.05	94.96
R^2	.65		.58		.68		.73		.65	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 24. Estimates of United States and regional demand relationships for fat in grams, using reduced linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[c]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	471.56***	150.56	695.34**	304.21	89.10***	328.89	58.47	290.24	660.26*	365.43
Implicit Prices										
Protein	-10451.85**	4533.74	-1974.30	10592.43	-6739.86	8558.81	-17797.23***	9087.17	263.03	9436.68
Fat	-30576.18***	10084.43	-72926.20***	27935.72	-49546.19	33569.55	-21423.79*	12485.19	-17968.97	38047.55
Carbohydrates	-8514.80	20702.32	26676.04	41908.17	24224.17	44791.56	8073.26	42075.71	-4319.73	41573.05
Minerals	-268895,36***	144986.79	-266698.02	303853.27	278366.05	315223.06	-361874.49	273260.71	-80498.32	318455.74
Vitamin A	451797.93	526934.20	-904000.06	926162.33	2304376.54**	1127827.62	769974.49	1159747.47	1418631.99	1489697.10
Vitamin B	-2735.30	1700.24	-289.08	3983.49	-1784.57	3072.86	-5195.69	3437.15	-890.73	3430.43
Vitamin C	11979.31	7363.91	3948.36	12860.22	39007.77**	19391.59	23731.24*	14608.41	-7082.26	16036.79
Income ($100)	1.71***	.34	1.79**	.77	.24	.85	2.29***	.50	1.95***	.72
Family Size	832.55***	25.61	801.99***	50.08	822.81***	54.43	990.00***	45.20	633.56***	60.03
Race										
White[f]										
Black	185.28**	87.22	1.57	134.71	-160.80*	206.72	536.50***	215.28	654.77***	261.88
Other	-422.53***	146.03	-653.04**	319.68	91.85	271.24	-212.34	323.66	-697.79***	260.67
Education										
Elementary school[f]										
High school	114.20	78.57	150.05	133.39	130.03	171.61	71.63	158.02	351.09*	204.29
Some college	-28.62	96.99	-73.45	186.97	3.27	215.27	-61.49	183.72	285.66	226.66
College graduate	-222.66**	104.82	-189.90	208.20	-114.63	212.55	-190.21	210.66	-9.35	243.64
Life Cycle[g]										
Stage 1[f]										
Stage 2	-432.99***	114.53	-454.25**	229.13	-230.87	228.29	-715.47***	211.12	-77.68	250.30
Stage 3	-143.88	123.66	-211.45	245.15	149.77	244.01	-552.59**	237.18	285.06	264.34
Stage 4	134.41	120.25	206.55	235.05	160.09	246.98	-68.01	225.21	317.56	258.83
Stage 5	99.97	123.89	28.54	239.68	440.54*	236.90	-72.26	234.10	217.25	294.49
Stage 6	-138.77	96.31	-104.12	196.68	-114.71	178.61	-56.29	188.34	-190.53	201.96
Stage 7	154.13	121.74	-53.64	241.56	4.47	228.79	609.40**	248.49	154.52	249.06

TABLE 24. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	788.28***	38.66	795.77***	71.46	665.61***	83.25	828.05***	72.47	768.36***	85.00
Homemaker Employed	39.97	56.19	5.41	108.46	27.43	115.28	205.66**	102.75	-147.58	123.03
Urbanization										
Nonmetropolitan[f]										
Suburban	85.60	62.33	-71.41	121.50	500.50***	129.71	4.52	115.50	59.91	148.12
Central city	85.36	66.16	307.22**	129.01	287.45**	141.01	-83.97	124.12	-61.72	154.04
R^2	.58		.51		.64		.68		.57	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 25. Estimates of United States and regional demand relationships for carbohydrates in grams, using reduced linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[c]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	1251.19***	345.78	2384.18***	669.22	334.67	724.14	-384.20	700.01	1088.36	898.60
Implicit Prices										
Protein	-46285.43***	10412.16	-43554.77*	23301.83	-24155.50	18844.63	-72283.56***	21916.64	-14440.69	23205.21
Fat	-49827.94**	23159.85	-78006.82	61454.59	-53762.68	73912.80	-44195.40	30112.06	-17590.36	43560.62
Carbohydrates	-78482.43*	47544.84	-70892.56	92191.99	-24345.99	98621.19	46494.85	101479.14	-101479.14**	102229.99
Minerals	-1230854.14***	332975.99	-1385733.14**	668433.75	-335314.59	694052.09	-1761832.33**	659056.25	-230193.34	783096.92
Vitamin A	-842910.65	1210154.64	-2478219.89	2037424.75	3587267.94	2483229.27	-907985.55	2797104.75	-902745.91	3663231.89
Vitamin B	-11756.43***	3904.77	-11638.99	8763.10	-5922.45	6765.76	-17019.80**	8289.79	-10423.10	8435.59
Vitamin C	12581.33	16911.92	-11945.17	28290.66	29901.26	42696.03	44510.36	35232.89	4186.55	39435.18
Income ($100)	.60	.78	1.84	1.69	-4.37**	1.88	1.55	1.21	1.50	1.77
Family Size	2107.64***	58.82	1965.62***	110.17	1968.51***	119.83	2577.53***	109.02	1755.39***	147.62
Race										
White[f]										
Black	-279.50	200.32	-366.33	296.34	-1278.37***	455.16	-174.73	519.23	406.29	643.96
Other	-324.72	335.38	-695.98	703.26	-141.18	597.20	74.53	780.62	-429.87	641.00
Education										
Elementary school[f]										
High school	-80.75	180.44	-360.70	293.44	259.99	377.84	-86.98	381.11	826.94*	502.37
Some college	-340.77	222.76	-1067.16***	411.30	210.14	473.97	-49.60	443.11	652.74	557.36
College graduate	-354.59	240.74	-940.95**	458.01	277.60	467.98	97.40	508.08	446.06	599.12
Life Cycle[g]										
Stage 1[f]										
Stage 2	-884.89***	263.03	-634.54	504.06	-32.62	502.65	-1603.22***	509.19	-625.80	615.50
Stage 3	-225.13	283.99	-138.27	539.29	1062.96**	537.26	-1417.70***	572.03	578.38	650.03
Stage 4	314.40	276.17	603.84	517.08	948.97*	543.79	-87.57	543.16	114.49	636.47
Stage 5	-246.10	284.52	-358.66	527.25	626.10	521.60	-540.99	564.61	-115.43	724.16
Stage 6	-119.89	221.18	-404.27	432.68	451.16	393.27	356.17	454.24	-380.05	496.64
Stage 7	455.58*	279.59	-46.55	531.40	988.62**	503.75	1098.15*	599.30	149.85	612.46

TABLE 25. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	1675.11***	88.78	1885.88***	157.19	1420.86***	183.30	1645.71***	174.79	1477.58***	209.02
Homemaker Employed	29.12	129.03	62.62	238.61	245.17	253.82	184.10	247.82	-484.55	302.55
Urbanization										
Nonmetropolitan[f]										
Suburban	-51.85	143.15	-579.64**	267.28	372.14	285.60	286.47	278.56	45.29	364.24
Central city	-113.32	151.94	-45.33	283.79	153.55	310.46	175.02	299.36	-255.11	378.79
R^2	.60		.56		.65		.69		.57	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 26. Estimates of United States and regional demand relationships for minerals in milligrams, using reduced linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	9404.84***	3184.58	18793.46***	6103.09	-3687.05	6851.83	-3484.38	6515.45	17610.00**	7906.41
Implicit Prices										
Protein	-442461.14***	95895.13	-438912.40**	212506.62	-212122.90	178308.80	-698273.26***	204022.94	-303261.46	204172.42
Fat	-391777.21*	213300.22	-321042.90	560449.95	-224600.13	699366.49	-313106.04	280314.53	-880115.36	823198.77
Carbohydrates	-802221.89*	437883.98	-733802.11	840767.11	-673548.93	933158.41	-443128.85	944673.90	-1282426.87	899476.81
Minerals	-15478189.89***	3066680.61	-18909023.45	6095942.81	-5548764.31	6567153.96	-22778235.47***	6135184.19	-8156557.78	6890125.48
Vitamin A	5968868.37	11145421.49	-18997655.94	18580786.30	41010450.79*	23496433.56	-26243170.87	26038373.47	10599913.02	32231166.59
Vitamin B	-125790.09***	35962.64	-166338.93	79917.21	-35817.34	64017.93	-156841.30**	77169.99	-131475.15*	74221.08
Vitamin C	-8751.74	155757.36	-286129.00	258003.46	412197.92	403991.86	171187.65	327984.56	-125555.06	346972.85
Income ($100)	32.08***	7.17	48.84***	15.44	-2.04	17.81	31.21***	11.30	40.66***	15.59
Family Size	20903.71***	541.73	18308.57***	1004.69	20509.22***	1133.88	25609.22***	1014.86	17407.66***	1298.86
Race										
White[f]										
Black	-6920.84***	1844.92	-5632.57	2702.59	-13297.49***	4306.75	-8645.72	4833.52	-4928.90	5665.95
Other	-10752.05***	3088.84	-10491.61*	6413.55	-7936.25	5650.74	-5531.41	7266.82	-17551.66***	5639.92
Education										
Elementary school[f]										
High school	1952.15	1661.86	323.79	2676.13	7457.66**	3575.18	1261.32	3547.72	7082.45*	4420.13
Some college	1593.26	2051.57	-5089.78	3750.94	8867.06**	4484.75	2620.04	4124.93	8339.84*	4904.01
College graduate	-932.75	2217.17	-7376.17*	4176.93	7571.49*	4428.06	1915.20	4729.77	3037.21	5271.43
Life Cycle[g]										
Stage 1[f]										
Stage 2	-10108.71***	2422.51	-7469.68*	4596.88	-2070.06	4756.10	-16205.01***	4740.07	-9492.91*	5415.43
Stage 3	-6724.30***	2615.50	-3909.11	4918.21	1316.81	5083.56	-16384.91***	5325.09	5.68	5719.31
Stage 4	2712.10	2543.49	6146.44	4715.61	11038.07**	5145.33	-2488.81	5056.27	-823.35	5600.04
Stage 5	700.75	2620.40	2996.05	4808.39	8866.66*	4935.36	-3818.17	5255.98	90.14	6371.53
Stage 6	-1136.79	2037.01	912.32	3945.90	1847.12	3721.13	1830.40	4228.53	-7469.98*	4369.70
Stage 7	4703.21	2574.98	1135.29	4846.20	7561.74	4766.89	12480.53**	5578.94	2657.82	5388.74

TABLE 26. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	16247.12***	817.63	17783.88***	1433.55	15217.19***	1734.35	14919.63***	1627.09	14828.66***	1839.11
Homemaker Employed	1374.45	1188.39	2678.88	2176.03	143.90	2401.70	5649.11**	2306.99	-5713.16**	2661.98
Urbanization										
Nonmetropolitan[f]										
Suburban	3139.84**	1318.39	-2299.46	2437.50	5168.43*	2702.35	5362.57	2593.17	6826.75**	3204.81
Central city	2778.29	1399.35	2619.21	2588.12	5113.68*	2937.63	2879.85	2786.73	3034.99	3332.81
R^2	.64		.57		.70		.72		.63	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 27. Estimates of United States and regional demand relationships for vitamin A in International Units, using reduced linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	17053.52	11991.88	23960.80	22597.82	44992.58*	27960.89	-4270.38	23997.24	6579.89	31273.10
Implicit Prices										
Protein	-200416.61	361103.32	-6763.33	786844.78	411884.33	727641.06	-687297.31	751327.33	-443708.05	807586.01
Fat	-1070807.55	803204.66	-1210146.03	2075168.84	-3446188.06	2853968.74	-1079420.77	1032275.93	511983.30	3256090.23
Carbohydrates	-2340464.99	1648898.66	-1390253.33	3113094.57	-1106559.66	3808025.07	-5288938.25	3478821.20	-3503821.83	3557801.29
Minerals	10792329.36	11547911.86	8531434.07	22571347.35	39719975.83	26799187.18	2779180.71	22593202.42	-3497293.42	27253284.46
Vitamin A	152659652.64***	41969269.50	19906983.24	68798772.39	267671082.15***	95884050.39	296753190.90***	95887951.49	233204606.44*	127487540.52
Vitamin B	-194820.06	135421.15	-331029.54	295908.13	-160416.03	261243.85	-243611.63	284183.36	7402.52	293574.93
Vitamin C	-579972.27	586520.91	-1477935.78	955305.18	1023890.57	1648606.61	-36082.22	1207823.81	-521072.88	1372420.54
Income ($100)	72.01***	26.88	67.92	57.18	-74.22	72.66	142.43***	41.62	55.15	61.65
Family Size	42428.29***	2039.96	42538.11***	3720.04	34234.50***	4627.13	48607.99***	3737.28	42005.23***	5137.52
Race										
White[f]										
Black	37556.32***	6947.23	25567.13***	10006.83	23883.55	17574.93	76750.67***	17799.73	53191.61**	22411.16
Other	-17975.67	11631.35	-27962.01	23747.34	-35343.77	23059.50	31364.22	26760.51	-24726.42	22308.20
Education										
Elementary school[f]										
High school	-683.91	6257.90	-5451.62	9908.89	-1796.79	14589.56	1427.77	13064.72	9505.73	17483.42
Some college	7350.86	7725.41	-16514.02	13888.55	13954.96	18301.33	7758.24	15190.33	30293.89	19397.37
College graduate	33066.07	8349.00	-15979.11	15465.85	17856.14	18070.01	12582.11	17417.69	8857.60	20850.70
Life Cycle[g]										
Stage 1[f]										
Stage 2	-22304.88**	9122.24	-15231.60	17020.80	-7468.90	19408.66	-38144.11**	17455.60	-20397.81	21420.24
Stage 3	-10869.01	9848.94	-14141.60	18210.56	10516.46	20744.93	-22429.79	19609.97	-10009.41	22622.21
Stage 4	2681.77	9577.80	4738.58	17460.40	21432.10	20997.01	-1393.40	18620.04	-5357.86	22150.46
Stage 5	5646.80	9867.41	3639.81	17803.95	27388.45	20140.17	-823.73	19355.46	32144.78	25202.02
Stage 6	10078.02	7670.56	16136.10	14610.40	5863.72	15185.16	10143.12	15571.83	13115.25	17283.98
Stage 7	-1774.98	9696.37	-4194.95	17943.96	-23738.36	19451.04	16889.87	20544.81	8864.40	21314.70

TABLE 27. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	35807.98***	3078.89	34662.16***	5307.97	32872.04***	7077.53	36500.13	5991.86	32648.92***	7274.44
Homemaker Employed	-6822.83	4475.03	6941.63	8057.16	-8041.99	9800.83	-8876.06	8495.66	-25912.49***	10529.22
Urbanization										
Nonmetropolitan[f]										
Suburban	13114.79***	4964.52	-4597.09	9025.29	17423.36	11027.74	18332.95	9549.51	27288.09**	12676.36
Central city	20704.74***	5269.42	22963.52**	9582.99	17927.88	11987.86	13779.40	10262.32	34247.49***	13182.63
R^2	.34		.31		.33		.45		.36	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 28. Estimates of United States and regional demand relationships for vitamin B in milligrams, using reduced linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[c]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	118.88***	39.19	282.68***	74.89	67.41	93.95	-54.82	77.01	107.93	93.89
Implicit Prices										
Protein	-3217.97***	1179.96	-5192.81**	2607.57	-1520.70	2444.99	-4705.66**	2411.07	-1235.72	2424.46
Fat	-4688.02*	2624.59	-9751.42	6877.02	-9945.83	9589.82	-3478.63	3312.66	3130.62	9775.13
Carbohydrates	-10962.17**	5388.02	-15803.08	10316.67	-9729.00	12795.61	-3175.33	11163.82	-14997.67	10680.90
Minerals	-50474.23	37734.50	-130490.40	74800.52	35473.26	90049.81	-78189.60	72503.44	22577.48	81317.27
Vitamin A	-4908.73	137140.78	-284077.43	227996.31	405261.62	322186.65	212484.76	307712.31	274089.49	382731.21
Vitamin B	-1804.61***	442.51	-3091.30***	980.63	-1356.44	877.82	-1680.28*	811.97	-1031.25	881.34
Vitamin C	-1217.94	1916.54	-5335.96*	3165.84	5602.40	5539.60	2165.36	3876.01	-2021.54	4120.15
Income ($100)	.42***	.09	.54***	.19	.04	.24	.52***	.13	.35**	.19
Family Size	229.44***	6.67	202.95***	12.33	225.58***	15.55	278.78***	11.99	186.92***	15.42
Race										
White[f]										
Black	38.12*	22.70	24.48	33.16	-80.34	59.05	74.87	57.12	145.16**	67.28
Other	-78.99**	38.01	-112.55	78.70	-90.97	77.48	-30.27	85.88	-72.85	66.97
Education										
Elementary school[f]										
High school	14.18	20.45	7.48	32.84	28.36	49.02	14.79	41.93	54.49	52.49
Some college	-19.86	25.24	-61.92	46.03	9.44	61.50	-13.86	48.75	45.19	58.23
College graduate	-52.59**	27.28	-123.24**	51.25	-6.80	60.72	13.66	55.89	-26.01	62.60
Life Cycle[g]										
Stage 1[f]										
Stage 2	124.77***	29.81	-104.47*	56.41	-25.85	65.22	-183.01***	56.02	-100.31	64.31
Stage 3	-28.99	32.18	-17.63	60.35	65.26	69.71	-101.94*	62.93	48.62	67.91
Stage 4	50.01	31.30	85.29	57.86	98.70	70.55	33.18	59.75	17.10	66.50
Stage 5	17.91	32.24	-11.46	59.00	97.69	67.67	56.13	62.11	9.52	75.66
Stage 6	-5.98	25.06	-16.48	48.42	.12	51.02	47.82	49.97	-17.09	51.89
Stage 7	26.97	31.68	-4.86	59.47	-4.16	65.36	147.60**	65.93	4.89	63.99

TABLE 28. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	213.32***	10.06	215.02***	17.59	198.26***	23.78	232.42***	19.23	177.84***	21.84
Homemaker Employed	3.22	14.62	1.06	26.70	.71	32.93	40.21	27.26	-36.42	31.61
Urbanization										
Nonmetropolitan[f]										
Suburban	43.91***	16.22	-16.89	29.91	109.54***	37.06	35.80	30.65	89.11**	38.06
Central city	40.46**	17.22	69.71**	31.76	69.97*	40.28	6.29	32.93	69.19*	39.58
R^2	.60		.55		.63		.70		.58	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 29. Estimates of United States and regional demand relationships for vitamin C in milligrams, using reduced linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[c]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	214.95	199.02	300.62	360.41	211.37	494.07	9.96	410.03	813.69	483.32
Implicit Prices										
Protein	994.49	5992.87	6086.55	12549.15	3259.50	12857.56	-19994.07	12837.64	1740.68	12481.09
Fat	-4999.80	13329.98	-11283.56	33096.25	6058.31	50430.20	-14804.19	17638.10	-15388.03	50322.26
Carbohydrates	-6152.65	27365.12	1937.27	49649.81	-12847.17	67288.56	2706.11	59441.27	-95233.27*	54985.14
Minerals	-25446.24	191649.10	175168.73	359983.67	188518.83	473546.97	-585767.49	386041.30	-231943.11	421194.33
Vitamin A	1414104.29**	696521.83	-291519.79	1097251.05	2906372.99*	1694290.24	3444121.11**	1638400.29	1365980.43	1970295.71
Vitamin B	-1990.99	2247.45	-2121.34	4719.35	749.98	4616.23	-5934.36	4855.73	-6301.41	4537.14
Vitamin C	-17300.40*	9733.90	-11409.11	15235.88	-35619.64	29131.21	-16760.73	20637.62	-20134.69	21210.50
Income ($100)	2.23***	.45	1.79**	.91	.97	1.28	2.70***	.71	2.77**	.95
Family Size	681.63***	33.86	609.81***	59.33	694.13***	81.76	811.64***	63.86	562.75	79.40
Race										
White[f]										
Black	109.18	115.30	197.99	159.60	-430.46	310.55	481.47	304.14	166.68	346.36
Other	-175.46	193.03	-357.33	378.74	-78.19	407.47	33.36	457.25	-294.03	344.77
Education										
Elementary school[f]										
High school	-21.33	103.86	-52.93	158.03	-81.08	257.80	-92.64	223.23	224.55	270.20
Some college	123.30	128.21	-78.42	221.50	13.72	323.39	353.34	259.55	346.31	299.78
College graduate	270.98**	138.56	71.49	246.66	319.10	319.30	471.59	297.61	338.09	322.24
Life Cycle[g]										
Stage 1[f]										
Stage 2	-256.26*	151.39	-53.87	271.46	-188.51	342.95	-574.90**	298.26	83.15	331.05
Stage 3	177.53	163.43	399.44	290.43	458.95	366.57	59.85	335.07	-144.44	349.62
Stage 4	253.22	158.95	286.82	278.47	376.35	371.02	319.32	318.15	62.63	342.33
Stage 5	173.97	163.76	268.85	283.95	209.17	355.88	223.75	330.72	181.82	389.49
Stage 6	270.77**	127.30	258.64	233.02	243.62	268.32	466.44*	266.07	295.58	267.12
Stage 7	-1.09	160.92	-101.05	286.18	34.69	343.70	572.89	351.04	-262.01	329.41

TABLE 29. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	612.87***	51.10	676.69***	84.66	502.24	125.06	590.53***	102.38	594.62***	112.43
Homemaker Employed	-98.49	74.27	31.04	128.50	53.52	173.18	-138.37	145.16	-429.78***	162.73
Urbanization										
Nonmetropolitan[f]										
Suburban	335.04***	82.39	214.11	143.94	519.93***	194.86	217.32	163.17	198.17	195.91
Central city	410.38***	87.45	403.51***	152.84	544.92***	211.83	362.26**	175.35	222.77	203.73
R^2	.36		.32		.37		.45		.36	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

equations was greater than 50 percent, Tables 23, 24, 25, 26, and 28, pages 151, 153, 155, 157, and 161. The percentages of variation in household demands for vitamins A and C, explained by variations of the independent variables in these equations, were not as large, Tables 27 and 29, pages 159 and 163. Coefficients of determination (R^2's) were .34 and .36 for the United States equations representing vitamin A and vitamin C demands, respectively. Similar results were obtained in the regional equations.

Implicit Prices

Household implicit prices for seven nutritional attributes were included in each of the nutrient demand equations. It was expected that own-implicit prices for each attribute would be negative. An analysis of the United States estimates indicates that all nutrients except vitamin A have significantly negative own-implicit price coefficients, Tables 23 through 29, pages 151-164. Thus, as the implicit prices of these attributes increase, the quantity demanded of these attributes decrease. However, the own-implicit price of vitamin A was positive and significantly different from zero at the .01 level. Thus, as the implicit price of vitamin A increases, the quantity demanded of vitamin A increases. One possible explanation of this positively sloped demand curve is that households may have the view that the higher the price, the higher the quality [Ladd and Zober, p. 97]. A more plausible explanation may be that the price of vitamin A is related to other variables not taken into account by the

estimated model. Prices may be higher for some households (holding nutritional amounts constant), but increased quality in terms of smell, taste, and/or appearance may more than offset the affects of higher prices and lead to an increase in the quantity demanded. This may be the case with food products containing large quantities of vitamin A, dark green vegetables and deep yellow fruit and vegetables.

In the Southern region of the United States, own-implicit price coefficients were negative and significant for fat and B vitamins only, Tables 23 and 28, pages 151 and 161. In the Northeast region, only a positive vitamin A own-implicit price coefficient was significant, Table 27, page 159. In the North Central section of the country, all own-implicit prices were significant, except for carbohydrates and vitamin C. Again, the coefficient for vitamin A was positive, while all others were negative, Tables 23 through 29, pages 151-164. In the Western region, only the negative own-implicit price coefficient for minerals and the positive one for vitamin A were significant, Tables 26 and 27, pages 157-159.

Cross-implicit prices are similar to those seen in the original model results, Tables 6 through 19, pages 96-123. With the exception of vitamin A coefficients, all cross-implicit price coefficients for all attributes that were significant, and most that were not, had a negative sign, Tables 23 through 29. Vitamin A appeared to be a substitute for most other nutrients. The cross-implicit price relationships in the United States and the four regions were not always significant, Tables 23 through 29.

Income

The income coefficients for the United States and the four regions were usually positive and highly significant ($P \leq .01$), Tables 23 through 29, pages 151-164. In fact, income coefficients for protein, fat, carbohydrates, vitamin A, and vitamin C were extremely close to those estimated under the earlier model, Tables 6, 7, 8, 13, 19, 23, 24, 25, 27, and 29, pages 96, 98, 100, 110, 122, 151, 153, 155, 159, and 163.

Sociological and Demographic Variables

A direct comparison of the remaining independent variables (family size, race of the household, education of the homemaker, household stage of the family life cycle, meal adjustment, employment status of the homemaker, and residential location of the household) for protein, fat, carbohydrates, vitamin A, and vitamin C yielded no meaningful coefficient changes between the original and the reduced models, Tables 6, 7, 8, 13, 19, 23, 24, 25, 27, and 29. The two models were comparable for the United States and all four regions. Coefficient signs did not change between models, and in most cases levels of significance did not change. Estimates for minerals were generally in accordance with the previous estimates for calcium, iron, magnesium, and phosphorus, Tables 9, 10, 11, 12, and 26, pages 102, 104, 106, 108, and 157. The same was true for the B complex vitamin estimates using the reduced model and thiamin, riboflavin, niacin, vitamin B_6, and vitamin B_{12} of the full model, Tables 14, 15, 16, 17, 18, and 28, pages 112, 114, 116, 118, 120, and 161.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The emphasis of this study focused on the development of a model based on characteristic theory, specifying the impact of implicit prices, income, and other selected socioeconomic characteristics of the household, and the homemaker of the household on food nutrient demand.

I. SUMMARY

In the classical theory of consumer behavior, utility is assumed to be a function of the physical quantities of goods and services consumed. Houthakker [1952-53] introduced a utility function with qualities as separate variables, in addition to traditional quantity variables. He assumed that a commodity could be described by two variables, physical quantity and quality. In his model, Houthakker stated that commodities with different characteristics were treated as the same good, but one with variable quality. Consumers could choose the quality of the food explicitly. Thus, in Houthakker's model, utility is a function of both quantities and qualities consumed.

From the Consumer Goods Characteristic Model (CGCM) developed by Ladd and Suvennunt [1976], utility was assumed to be a function of total quantities consumed of product characteristics (X_j), equation (26). It was also assumed that the total quantity consumed

of the jth product characteristic ($j = 1, 2, \ldots, m$) is determined by n physical quantities of goods and services consumed, equation (27). After substituting the latter into the former, utility became a function of both physical quantities of goods and services consumed (Q_i; $i = 1, 2, \ldots, n$) and product characteristics (X_{ij}; $i = 1, 2, \ldots, n$; $j = 1, 2, \ldots, m$), equation (28).

Consumers were assumed to act rationally by maximizing utility subject to a linear budget constraint, equation (29). From the first order conditions of the quality model, equations (33) and (34), a hedonic price model was derived, equation (37) or (39). This physical price-quality price model states that for each product consumed, the price paid by the consumer equals the sum of the implicit prices of the characteristics possessed by the product, multiplied by the respective quantities of those characteristics obtained from the marginal unit consumed. Equation (39) was extended to span the household, equation (41). This equation was used to estimate implicit prices for each household.

Since the first order conditions (33) and (34) contain prices and income, just as in traditional demand analysis, the attribute demand equation was designed to be a function of prices and income. Also, a change in a product's attributes had an effect on quantities of attributes demanded, such that household demands for attributes depend upon prices, income, and product characteristics, equation (45). By use of the price decomposition equation (41), each product price was expressed as a function of characteristics prices, equation

(46). If producers did not vary characteristic input-output coefficients over the relevant time period, the household's total demand for an attribute would be affected by the prices of product attributes and income, equation (47). Finally, the household attribute demand equation was modified to allow for preference structures to vary in response to selected household characteristics, equation (49). Thus, a transition was made from a representative consumer used in model development, to allowing for different household compositions.

Data from approximately 2,200 households located in the contiguous states of the United States were utilized to specify household nutrient demand relationships (Nationwide Food Consumption Survey 1977-78). Also, these data were separated by geographic location of the household to facilitate the estimation of nutrient demand relationships for households in the South, Northeast, North Central, and West regions of the United States. United States and regional household demand relationships were estimated for protein, fat, carbohydrates, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and vitamin C using multiple regression analysis. These nutrient demand relationships estimated the impact of implicit prices, income, and selected socioeconomic factors on household demand for the respective food nutrients.

Impact of Implicit Prices: Full Model

Testing of the full model showed some erratic and nonuniform implicit prices for the dietary components; that is, a priori information indicated they should have been positively related to price. For pooled-sample estimates, as well as individual household implicit price estimates, negative coefficients are possibly due, in part, to statistical procedures. Pooled-sample estimates seemed to be adversely affected by multicollinearity among the explanatory variables, while individual household implicit price coefficients were affected by multicollinearity and relatively low numbers of observations.

Household implicit prices for the 14 nutritional attributes were included in each of the nutrient demand equations (Tables 6 through 19, pages 96-123). The own-implicit prices were hypothesized to be negative for each attribute. All significant own-implicit prices were negative for the United States and all regions, but many own-implicit prices were not significantly different from zero. Also, without exception, all cross-implicit price coefficients for all attributes that were significant, and most were not, possessed complementary relationships.

Impact of Socioeconomic Factors: Full Model

Characteristics of the household hypothesized to influence household demand for food nutrients were: income, family size, race, education of the homemaker, stage in the family life cycle, eating habits, employment status of the homemaker, and residential location.

Higher incomes had a significant negative impact on household demands for carbohydrates and thiamin in the Northeast region. For carbohydrate demand in the United States and all regions except the Northeast, there was no significant estimates for income coefficients. However, with few other exceptions the income coefficients were positive and significant for the United States and all regions for the other 13 nutritional attributes.

Family size was a highly significant and positive factor affecting the demand for all nutrients in the United States and in each of the four regions. Generally, the impact of family size on the demand for most nutrients was highest in the North Central regions of the United States and lowest for households located in the South and West regions of the United States.

There were significant differences in nutrient demand associated with race. White households in the United States demanded significantly less protein, fat, iron, vitamin A, thiamin, and vitamin B_{12} than black households. Black households as well as other race households, demanded significantly less calcium and phosphorus than white households. Also, white households demanded significantly more phosphorus and riboflavin than did other race households, in the United States. In the South, white households demanded significantly less protein, vitamin A, and vitamin B_{12}, but significantly more calcium and magnesium than black households. Also, in the South, other race households demanded significantly more carbohydrates, calcium, magnesium, phosphorus, and riboflavin than black households,

while other race households demanded significantly less riboflavin than white households. In the North Central region, black households demanded significantly more fat, vitamin A, vitamin B_{12}, and vitamin C, but they demanded significantly less calcium and magnesium than white households. In the Western region of the United States, black households demanded significantly more of all nutrients except carbohydrates, calcium, magnesium, phosphorus, and vitamin C. Also, white households demanded significantly more fat, calcium, magnesium, phosphorus, and riboflavin than other race households.

In the United States, households with the homemaker having a grade school education demanded significantly less protein, fat, and riboflavin than households having a homemaker with a high school education. Households with the homemaker having completed a college education demanded significantly less fat and niacin, and significantly more vitamin C than households with the homemaker having a grade school education. The impact of educational attainment of the homemaker on household food nutrient demands varied among the four regions. Generally, the level of educational attainment by the homemaker was not a significant factor influencing demand for nutrients.

Meal adjustment had a significant positive impact on household food nutrient demand in the United States and regions of the United States. Therefore, an increase in either home or guest meals would increase household nutrient demand and an increase in either skipped or away from home meals would have the opposite effect.

In the United States and the Southern region, the homemaker of the household being employed outside the home had a significant positive impact only on calcium. In the North Central region, the employment status of the homemaker had a significant positive impact on the demand for protein, fat, calcium, magnesium, phosphorus, and niacin. For the homemaker of the household in the Western region, being employed had a significant negative impact on calcium, iron, vitamin A, riboflavin, and vitamin C. The employment status of the homemaker of the household was not a significant factor affecting the demand for any food nutrient in the Northeast region.

The impact of degree of urbanization of the household on nutrient demand was relatively uniform among households in the United States and all regions except the South. Suburban households in the South tended to demand less of many nutritional attributes than nonmetropolitan households. Otherwise, suburban and central city households were inclined to demand more of all nutrients, except carbohydrates, than nonmetropolitan households.

The impact of stage of the household in the family life cycle was relatively uniform for households in the United States and regions of the United States, but the signs of the estimated coefficients were not as expected. Periods of change in the family unit were characterized by seven stages: (1) the early period (stage 1), (2) the developing period (stages 2 and 3), (3) the stable period (stages 4 and 5), and (3) the decline period (stages 6 and 7). In most cases stages 2 and 3 showed significantly less nutrient demand

than stage 1. Estimates for other stages were not significantly different from stage 1. The reason for these incorrectly hypothesized variable signs is possibly due to multicollinearity between family size and various stages of the family life cycle. Reestimation of the equations with family size deleted revealed that households in developing and stable periods of the family life cycle generally demanded more of food nutrients than did households in the early period.

Impact of Implicit Prices: Reduced Model

Based on the argument that people may respond to dietary components in somewhat more broadly defined categories than the narrow dietary components originally specified, a reduced model was formulated. The nutritional attributes were redefined into seven groups: protein, fat, carbohydrates, minerals, vitamin A, B vitamins and vitamin C. The effects of socioeconomic variables were the same as postulated in the original model. Testing this model showed negative implicit prices for the pooled-sample and individual household implicit price equations. All own-implicit prices, except for vitamin A, were negative and significant for the United States. Vitamin A was positive and significant. In the Southern region, implicit price coefficients were negative and significant for fat and B vitamins only. In the Northeast region, only a positive vitamin A own-implicit price coefficient was significant. In the North Central section, all own-implicit prices were significant, except for carbohydrates and vitamin C. Again, the coefficient for vitamin A was

positive, while all others were negative. In the Western region, only the negative own-implicit price coefficient for minerals and the positive one for vitamin A were significant. With the exception of vitamin A, all cross-implicit price coefficients for attributes that were significant, and most were not, had a negative sign.

Impact of Socioeconomic Factors: Reduced Model

A direct comparison of the remaining independent variables (income, family size, race of the household, education of the homemaker, household stage of the family life cycle, meal adjustment, employment status of the homemaker, and residential location of the household) yielded no meaningful coefficient changes between the original and the reduced models. The estimated parameters of the two models were similar for the United States and all four regions. Coefficient signs did not change between models, and in most cases the levels of significance did not change.

II. CONCLUSIONS

Overall, the estimated implicit prices of the hedonic price equations examined in this project had a relatively small impact on the explanatory power of the demand equations for nutritional attributes. With the full model, many own-implicit prices were not significantly different from zero, while all significant cross-implicit price coefficients possessed complementary relationships. One interpretation of these results is that people do not respond

to dietary components when specified narrowly as individual items, but are more responsive to dietary components as the broadly defined categories used in the reduced model. It may also be that homemakers realize they will obtain many of the necessary nutrients for good health by buying a variety of foods. Thus, their purchasing decisions are impacted substantially by the implicit prices of characteristics such as taste, texture, smell, form of the product (i.e., fresh, frozen, dried, etc.), and convenience and time saving characteristics, which were not included in the empirical model. Also, the results may suggest that the nutrients are unique (distinct) and/or consumption technologies make it hard to switch, especially among specific food products as opposed to broad categories of food.

The model was reestimated using a broader definition of nutrient categories. Results from the reduced hedonic model generated implicit prices for food nutrients that were statistically better indicators of the basis of choice utilized by households (i.e., with one exception, signs were as hypothesized). However, as with the original model, implicit price estimates from the reduced hedonic model still had relatively minor impact on the estimates of the demand for nutritional attributes.

III. IMPLICATIONS

Households may not be utilizing product nutrient information as effectively as they might, and/or households may have a limited awareness of nutritional information. The empirical evidence from

this study implies that buyers do not fully assess the dietary components of foods. Additional education regarding food nutrients and/or the incorporation of existing nutritional knowledge into food purchasing decisions may help to improve consumer diets, from a nutritional standpoint.

From the producer's and marketer's standpoint, advertising campaigns to increase sales would probably be more effective if the emphasis is placed on food attributes, such as taste or convenience, rather than on nutritional attributes. On the other hand, it appears from the findings of this study that advertising and labeling of dietary components might have greater impact on households if they emphasized clusters of nutrients; i.e., B vitamins rather than thiamin, riboflavin, niacin, vitamin B_6, and vitamin B_{12}.

Examination of the effects of household characteristics on household demands for nutritional attributes revealed some interesting observations. Increases in household disposable income in the United States should result in increases in household demand for all nutritional attributes, except carbohydrates. Carbohydrate demand by households remained constant or declined slightly with increases in income. Therefore, the household demand for products such as wheat, rice, corn, and potatoes may decline with future increases in real income, while other commodities may experience increased demands. Also, income is a characteristics which is susceptible to manipulation by the government for the purpose of improving household diets. More specifically, household disposable

income affords a mechanism tied directly to the household food and nutrient demand decision-making process. Thus, income redistribution policy decisions coupled with educational programs and overt action on the part of the government, perhaps in the area of food stamps, could contribute to remedies concerning nutritional problems of low income households.

Black households had lower demands for calcium and magnesium, while other race households had diets lower in fat, calcium, magnesium, and phosphorus. Both black and other race households had a higher demand for vitamin A. These results imply a possible need for larger levels of consumption of milk and milk products for black and other race households, while white households may need a larger level of consumption of green leafy and yellow vegetables.

Generally, the level of educational attainment by the homemaker was not a significant factor influencing nutrition demand. Perhaps higher education tends to place little emphasis on better nutritional consumption and knowledge, or consumers' perception of nutritional requirements do not vary by education. Also, a trend away from the traditional three meals per day pattern to fewer meals per day could result in declines in household nutrient demand, due to limited stomach capacity. Implications relative to the impact of an increase in away from home meals could not be made.

IV. RECOMMENDATIONS FOR FUTURE RESEARCH

Progress has been made towards developing a theory which examines product attributes and attribute demands. There are many criticisms that can be raised against characteristic theory. But, the question is not whether the models are perfect, but whether they provide a usable format for increasing our knowledge. This study seems to support an affirmative answer. Based on the results of this study, additional research is needed in the area of food attribute demand to extend the model to include additional attributes such as taste, texture, form, and time-saving features. By extending the model to include additional attributes of foods, more extensive information could be obtained about household behavior in specific settings. Another important variable that should be included is one to represent advertising expenditures.

In addition, other types of nondurable consumer goods, e.g., clothing, might also be assessed through use of characteristic theory. Such investigations could provide information not only for marketers, but also for consumer policy makers, by indicating informational needs of consumers.

Characteristic theory's continued use and appraisal should contribute to an increased understanding of consumer behavior, and thus aid professionals in helping to improve consumer performance in the market place. It is hoped that this study will stimulate further investigation in this field.

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APPENDIX

TABLE 30. Simple correlation coefficients of the independent variables of the full attribute demand equation, United States, Spring 1977, N = 2218.

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}	X_{27}	X_{28}	X_{29}	X_{30}	X_{31}
X_1	1.00	-.08	.30	.06	-.37	.25	-.55	.12	-.09	.03	-.24	-.13	-.25	.13	.05	-.00	.02	.00	-.02	.01	.03	.02	-.00	-.01	.01	-.04	.03	-.00	.01	.05	.01
X_2		1.00	-.00	.13	-.01	-.03	-.16	-.21	.01	.01	.03	.16	-.05	.09	.03	-.05	.02	.00	-.02	.01	.03	.02	-.01	-.01	.01	-.04	.02	-.02	.05	-.02	-.00
X_3			1.00	.13	-.23	-.25	-.14	.07	-.45	-.13	.22	-.05	.02	.31	.01	-.02	-.05	.01	-.04	.04	.05	.02	.00	-.00	-.04	-.02	.01	-.01	.03	.02	.01
X_4				1.00	.22	-.43	-.52	-.10	-.36	-.46	.50	.21	.09	.53	.05	.01	-.05	-.01	-.02	.03	.03	-.01	.00	.01	-.04	.01	.01	-.03	.01	.02	-.01
X_5					1.00	-.08	-.08	-.08	-.30	-.03	-.06	-.01	-.02	-.05	.02	-.03	-.05	-.02	.00	.02	.03	-.03	-.01	.01	-.01	.01	.01	-.01	.02	-.02	.01
X_6						1.00	-.21	.11	.39	.30	-.69	-.18	.08	-.59	.03	-.01	-.03	.01	.02	-.01	-.01	-.01	-.01	-.01	.05	.01	.01	.02	-.00	.00	-.01
X_7							1.00	.03	.20	-.08	.06	-.14	-.07	-.14	-.07	-.01	.05	.02	.04	-.04	-.04	.02	-.01	.01	-.00	.01	-.01	.01	-.00	-.04	.03
X_8								1.00	.08	-.16	-.02	-.10	.02	-.20	-.01	.01	-.04	.06	.01	-.05	.02	.02	-.04	.01	.02	.01	.00	.03	-.01	-.00	.03
X_9									1.00	-.12	-.46	.04	.26	-.46	-.02	.02	.04	-.00	.04	-.04	-.04	.01	.00	.00	.06	-.03	-.01	.02	-.03	.01	-.01
X_{10}										1.00	-.39	.02	-.39	-.30	.01	-.03	-.04	-.00	-.04	.04	-.04	-.01	.01	-.03	.01	-.01	.02	-.02	.03	-.01	-.03
X_{11}											1.00	-.06	.13	.54	.01	-.00	-.02	-.00	-.02	.01	-.01	-.02	.00	.01	-.04	.07	-.03	-.01	-.01	.01	-.01
X_{12}												1.00	-.14	.14	-.03	-.08	.04	-.00	.00	.01	.03	-.00	-.04	-.05	-.01	-.04	.08	-.02	.06	-.00	.04
X_{13}													1.00	-.03	.01	.06	-.01	.02	.04	-.02	-.04	.02	.03	.02	.02	.02	-.05	.03	-.04	.00	-.02
X_{14}														1.00	-.02	.01	.02	-.00	-.03	.02	.00	.02	.02	.00	-.06	.01	-.02	-.02	.01	-.02	.00
X_{15}															1.00	.31	-.16	-.03	-.03	.12	.18	-.01	.08	.19	.08	-.18	-.10	-.16	.16	.14	-.09
X_{16}																1.00	.03	.08	.12	.03	-.06	.17	.37	.44	.07	-.48	-.27	-.32	-.04	.08	-.10
X_{17}																	1.00	-.07	-.03	-.02	-.05	.00	.08	.02	-.01	-.04	.02	-.03	-.01	-.13	.27
X_{18}																		1.00	-.04	-.02	.01	.01	.05	-.00	-.02	-.04	.01	-.00	.01	-.04	.10
X_{19}																			1.00	.48	-.43	.03	.09	.04	.01	.00	-.14	.00	-.05	.00	-.06
X_{20}																				1.00	-.19	.05	.02	.03	-.04	-.11	.00	-.06	.12	.05	.01
X_{21}																					1.00	.03	-.05	-.02	-.05	-.13	.10	-.05	.16	.05	.05
X_{22}																						1.00	-.16	-.18	-.12	-.25	-.11	-.04	-.07	.04	-.04
X_{23}																							1.00	.18	-.12	-.25	-.11	-.13	-.01	-.00	.01
X_{24}																								1.00	-.14	-.28	.13	-.18	.07	.06	-.06
X_{25}																									1.00	-.20	-.09	-.01	-.02	.02	-.02
X_{26}																										1.00	.18	.30	-.20	-.06	-.00
X_{27}																											1.00	.01	.09	-.05	.10
X_{28}																												1.00	-.20	-.04	-.02
X_{29}																													1.00	.01	.06
X_{30}																														1.00	-.47
X_{31}																															1.00

Variables:
X_1 = implicit price of protein.
X_2 = implicit price of fat.

TABLE 30. (Continued)

X_3 = implicit price of carbohydrates.
X_4 = implicit price of calcium.
X_5 = implicit price of iron.
X_6 = implicit price of magnesium.
X_7 = implicit price of phosphorus.
X_8 = implicit price of vitamin A.
X_9 = implicit price of thiamin.
X_{10} = implicit price of riboflavin.
X_{11} = implicit price of niacin.
X_{12} = implicit price of vitamin B_6.
X_{13} = implicit price of vitamin B_{12}.
X_{14} = implicit price of vitamin C.
X_{15} = income.
X_{16} = family size.
X_{17} = black race.
X_{18} = other race.
X_{19} = high school.
X_{20} = some college.
X_{21} = college graduate.
X_{22} = life cycle stage 2.
X_{23} = life cycle stage 3.
X_{24} = life cycle stage 4.
X_{25} = life cycle stage 5.
X_{26} = life cycle stage 6.
X_{27} = life cycle stage 7.
X_{28} = meal adjustment.
X_{29} = homemaker worked outside home.
X_{30} = suburban.
X_{31} = central city.

TABLE 31. Estimates of United States and regional demand relationships (excluding the family size variable) for protein in grams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	1553.08***	115.72	1545.17***	195.30	1450.49***	258.50	1629.19***	268.41	1502.98	270.02
Implicit Prices										
Protein	-19578.65***	3665.44	-17853.92***	6949.94	-20092.51***	7452.18	-29454.32***	8802.43	-18886.85***	8118.17
Fat	-12640.31	7896.36	-10270.26	12370.72	-7782.66	26139.07	-15958.44	15998.32	-18321.41	19244.36
Carbohydrates	-48571.47***	15412.84	2872.17	28571.99	-72586.80**	35532.46	-86273.15**	37175.50	95788.75***	32155.36
Calcium	-105411.98**	46121.74	-131716.33	84791.19	-99565.28	90516.20	-205452.53**	106085.33	-177037.20	127018.14
Iron	-3993.38***	743.10	-3393.54**	1490.31	-3628.73**	1656.31	-5718.35***	1821.81	-4255.79***	1475.46
Magnesium	-68167.41***	12763.55	-84970.23***	22595.27	-6053.82	29026.32	-94764.05***	34909.36	-89309.86***	26338.47
Phosphorus	-292198.75***	55679.08	-347784.98***	102117.88	-213457.92**	109595.39	-400822.03***	136448.77	-361549.00***	129314.55
Vitamin A	137270.57	402369.33	91948.41	678139.82	950515.58	762488.54	-216614.97	1118710.46	-326247.87	1116429.36
Thiamin	250.32***	84.42	-163.48	169.94	-146.63	186.09	-532.47**	210.85	-221.32	153.72
Riboflavin	-359.85***	88.05	-273.72*	162.84	-266.08	187.78	-630.84***	202.50	-374.91**	189.77
Niacin	-4805.46***	988.78	-3738.62**	1841.40	-3590.29	2323.77	-8834.53***	2573.07	-4314.94***	1741.56
Vitamin B_6	-396.50***	71.09	-454.02***	121.03	-298.34**	151.35	-482.51***	179.72	-388.05***	146.26
Vitamin B_{12}	-768.46***	250.61	-255.68	460.49	-1094.57***	502.27	-1044.81*	592.02	-1021.70**	573.24
Vitamin C	-8636.20*	4880.50	-19840.70**	9055.90	8741.01	17673.56	-5303.14	13345.76	-13123.78	10675.43
Income ($100)	3.05***	.27	3.44***	.55	3.26***	.70	2.68***	.48	2.85***	.55
Race										
White[f]										
Black	159.96**	71.94	203.50**	99.32	-293.00	182.29	278.67	205.04	520.51***	204.36
Other	202.81*	119.07	111.20	235.34	-127.90	237.47	628.49**	308.09	314.63	197.96
Education										
Elementary school[f]										
High school	124.53**	64.52	150.47	98.38	64.03	149.05	170.12	149.33	324.87**	157.76
Some college	-27.71	79.58	-166.09	136.72	109.67	189.09	-52.04	174.85	255.81	175.10
College graduate	-146.92*	86.18	-389.86**	153.40	-90.40	186.54	92.09	202.02	-5.49	187.23
Life Cycle[g]										
Stage 1[f]										
Stage 2	650.36***	87.49	531.27***	158.83	726.14***	183.72	658.93***	189.85	744.89***	172.04
Stage 3	1277.58***	88.57	1137.34***	159.66	1412.44***	184.57	1469.98***	199.15	1181.19***	172.61
Stage 4	1572.34***	85.37	1291.17***	156.84	1957.09***	176.25	1802.16***	185.66	1189.63***	166.75
Stage 5	823.57***	98.61	749.18***	171.01	1070.58***	198.84	835.53***	220.37	646.56***	220.92
Stage 6	-200.40***	79.47	-147.96	146.82	-159.17	158.17	-236.50	179.53	-206.29	157.74
Stage 7	-144.28	100.31	-114.78	181.40	-139.35	202.54	-146.51	237.91	-141.84	193.59

TABLE 31. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	393.97***	31.11	400.16***	51.06	316.11***	71.13	460.53***	68.22	371.40***	64.56
Homemaker Employed	-118.30***	45.90	-60.97	79.09	-277.25***	99.70	30.00	98.53	-200.20**	94.91
Urbanization										
Nonmetropolitan[f]										
Suburban	92.83*	51.12	-19.54	89.68	75.91	111.68	180.84*	111.60	118.54	113.78
Central city	19.22	54.02	108.38	93.93	103.20	122.84	-128.88	118.66	103.81	119.68
R^2	.42		.39		.50		.45		.48	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 32. Estimates of United States and regional demand relationships (excluding the family size variable) for fat in grams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	2228.16***	172.89	2223.49***	316.13	2110.28***	370.10	2338.10***	384.62	2039.12	399.20
Implicit Prices										
Protein	-21258.27***	5476.40	-15380.49	11249.64	-23002.67**	10669.31	-37289.98***	12613.48	-12869.75	12001.91
Fat	-25469.27***	11797.64	-30661.90	20024.08	-32232.76	37423.89	-21216.57	22924.86	-11741.47	28450.88
Carbohydrates	-76111.83***	23027.73	7341.20	46248.54	-117275.00**	50871.93	-122641.46	53270.76	-132658.84***	47539.51
Calcium	-125295.64*	68908.71	-143267.03	137248.69	-93168.56	129592.33	-265702.57*	152015.36	-217699.44	187783.76
Iron	-4617.43***	1110.24	-3129.62	2412.32	-4539.36*	2371.34	-6851.25***	2610.57	-3407.09	2181.33
Magnesium	-85960.01***	19069.53	-84059.31**	36574.21	-18410.55	41557.07	-137686.22***	50023.50	-102371.59***	38938.82
Phosphorus	-341496.23***	83187.97	-371566.66**	165294.84	-245446.83	156908.07	-512894.21***	195524.75	-337466.45*	191178.78
Vitamin A	1115074.51	601164.52	-511991.03	1097682.50	1135813.73	1091657.25	-452172.32	1603060.15	144581.04	1650530.44
Thiamin	306.89**	126.13	-136.73	275.07	-285.88	266.42	-620.82**	302.14	-130.67	227.26
Riboflavin	-368.20***	131.56	-196.30	263.59	-240.18	268.84	-740.67***	290.17	-188.32	280.55
Niacin	-6030.76***	1477.30	-3676.54	2980.62	-6275.31*	3326.95	-12287.87***	3687.09	-3941.73	2574.73
Vitamin B_6	-458.91***	106.22	-471.79**	195.91	-420.59**	216.69	-605.50**	257.53	-334.61	216.23
Vitamin B_{12}	-539.98	374.43	345.31	745.39	-1066.91	719.09	-1174.24	848.34	-399.23	847.49
Vitamin C	-4574.19	7291.77	-24951.52	14658.48	11388.61	25303.30	1780.85	19123.85	-15393.82	15782.56
Income ($100)	3.96***	.40	4.44***	.89	4.09***	.10	3.99***	.68	3.37	.81
Race										
White[f]										
Black	216.61**	107.49	109.41	160.76	-427.57*	260.98	663.60**	293.82	805.52***	302.13
Other	53.47	177.90	-106.00	380.93	-82.04	339.99	826.46**	441.48	-114.01	292.67
Education										
Elementary school[f]										
High school	139.42	96.40	189.65	159.24	-23.03	213.40	209.56	213.98	460.67	233.23
Some college	-108.78	118.90	-220.94	221.31	-112.43	270.72	-146.02	250.55	342.29	258.86
College graduate	-362.99**	128.77	-513.97**	248.31	-428.82	267.07	-148.79	289.49	-74.24	276.81
Life Cycle[g]										
Stage 1[f]										
Stage 2	917.50***	130.71	787.99***	257.09	1017.82***	263.03	844.57***	272.05	1111.49***	254.34
Stage 3	1797.83***	132.33	1623.37***	258.44	2014.69***	264.26	1894.22***	285.38	1764.86***	255.20
Stage 4	2100.08***	127.54	1868.45***	253.87	2340.65***	252.34	2294.72***	266.04	1829.76***	246.53
Stage 5	1100.71***	147.32	1039.32***	276.81	1493.38***	284.68	984.63***	315.77	904.23***	326.62
Stage 6	-316.46***	118.73	-233.24	237.65	-293.62	226.45	-389.86	257.25	-230.26	233.21
Stage 7	-183.40	149.86	-215.37	293.63	-244.16	289.98	-90.77	340.77	-92.89	286.21

TABLE 32. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	536.89***	46.48	497.07***	82.65	443.22***	101.84	581.48***	97.76	628.17***	95.45
Homemaker Employed	-152.41***	68.58	-190.82	128.02	-265.81**	142.75	73.61	141.18	-261.25	140.31
Urbanization										
Nonmetropolitan[f]										
Suburban	39.22	76.37	-141.25	145.17	233.03	159.89	116.47	159.92	-20.58	168.21
Central city	-47.57	80.72	213.40	152.03	109.73	175.87	-330.16**	170.04	-71.69	176.93
R^2	.37		.33		.46		.41		.46	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 33. Estimates of United States and regional demand relationships (excluding the family size variable) for carbohydrates in grams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	5818.51***	409.06	6243.90***	711.62	5333.74***	830.20	5757.25	964.05	5052.19	1015.56
Implicit Prices										
Protein	-75567.51***	12957.65	-74477.03***	25322.95	-75622.39***	23933.20	-119647.37***	31615.77	-59475.93**	30532.81
Fat	-67137.84**	27914.27	-60121.20	45074.24	-101613.59	83947.43	-95511.85*	57461.31	-34534.78	72378.89
Carbohydrates	-242602.19***	54485.68	-65801.095	104105.55	-324209.91***	114114.95	-379660.59***	133523.53	-395764.82***	120937.73
Calcium	-389754.50**	163044.19	-404360.05	308497.09	-33140.81	290699.04	-929692.31**	381027.54	-623224.33	477720.90
Iron	-17081.93***	2626.92	-15627.17***	5430.13	-19665.02***	5319.34	-24134.03***	6543.41	-15061.16***	5549.28
Magnesium	-249144.13***	45120.22	-237153.03***	82328.63	-150505.03	93220.02	-381370.31***	125384.25	-304255.95***	99060.14
Phosphorus	-1062316.94***	196830.18	-1188521.05***	372079.02	-806892.70**	351973.18	-1681022.24***	490084.14	-1083781.90**	486357.79
Vitamin A	-66988.49	1422409.09	-124386.62	2470885.56	3187049.28	2448784.64	-1818343.78	4018081.37	-2609183.34	4198940.62
Thiamin	-1554.52***	298.43	-1305.00**	619.18	-1464.63***	597.64	-2550.10***	757.37	-1304.86**	578.14
Riboflavin	-1331.35***	311.27	-981.07**	593.34	-988.71	603.06	-2631.79***	727.32	-1229.18*	713.72
Niacin	-18882.59***	3495.43	-11998.47**	6709.38	-21184.76***	7462.94	-32362.73***	9241.70	-16140.58***	6550.09
Vitamin B_6	-1584.05***	251.33	-1669.66***	440.99	-1288.22***	486.07	-1990.86***	645.51	-1288.87**	550.10
Vitamin B_{12}	-1955.21**	885.93	-866.17	1677.85	-1901.76	1613.06	-4198.51**	2126.37	-2373.37	2156.01
Vitamin C	-45364.28***	17252.99	-66114.23**	32996.27	-23985.09	56759.87	-56598.65	47934.07	-52021.28	40150.76
Income ($100)	6.21***	.96	8.10***	2.00	5.12**	2.24	6.02***	1.71	5.32***	2.05
Race										
White[f]										
Black	-143.85	254.32	-42.13	361.88	-1828.84***	585.43	132.61	736.45	937.08	768.61
Other	827.86**	420.94	696.01	857.48	-502.69	762.66	2624.32**	1106.58	1096.87	744.55
Education										
Elementary school[f]										
High school	-40.28	228.09	-218.30	358.45	-54.08	478.69	222.37	536.34	1043.38*	593.34
Some college	-571.19**	281.33	-1426.62***	498.16	-31.95	607.27	-254.36	628.02	744.80	658.55
College graduate	-766.48***	304.67	-1800.43***	558.95	-442.30	599.09	200.39	725.61	120.98	704.19
Life Cycle[g]										
Stage 1[f]										
Stage 2	2514.88***	309.27	2370.24***	578.21	2947.20***	590.03	2414.80***	681.90	2695.62***	647.04
Stage 3	4669.21***	313.20	4264.15***	581.75	5407.99***	592.77	4931.33***	715.30	4531.98***	649.22
Stage 4	5264.09***	301.78	4587.65***	571.47	6060.51***	566.04	5979.03***	666.83	4357.31***	627.16
Stage 5	2269.20***	348.58	2038.56***	623.10	3034.51***	638.58	2019.64***	791.50	1926.45**	830.91
Stage 6	-608.70**	280.93	-838.12	534.96	-61.69	507.97	-598.08	644.81	-453.35	593.29
Stage 7	-421.37	354.59	-488.48	660.95	396.34	650.47	-795.05	854.15	-487.58	728.11

TABLE 33. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	1033.53***	109.98	1133.66***	186.04	861.39***	228.45	1008.89***	245.04	1062.46***	242.81
Homemaker Employed	-462.98***	162.28	-457.05	288.16	-441.96	320.21	-138.56	353.87	-768.66***	356.95
Urbanization										
Nonmetropolitan[f]										
Suburban	-151.32	180.70	-665.39***	326.77	-167.43	358.66	607.98	400.84	-128.06	427.92
Central city	-452.82**	190.99	-250.53**	342.23	-124.77	394.50	-448.47	426.21	-328.90	450.11
R^2	.37		.37		.45		.38		.42	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 34. Estimates of United States and regional demand relationships (excluding the family size variable) for calcium in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	18193.46***	1473.29	17246.61***	2348.01	15797.57***	3094.31	18889.74***	3591.59	20476.01***	3657.41
Implicit Prices										
Protein	-2955.83***	46668.33	-238260.01***	83554.35	-281432.59***	89204.07	-449427.38***	117785.84	-353491.73***	109960.34
Fat	-262868.17***	100536.21	-180627.21	148724.73	-157252.45	312889.78	-357283.00*	214074.46	-371829.28	260664.14
Carbohydrates	-697611.95***	196235.95	-113034.00	343501.48	-949941.16**	425330.47	-1247595.49***	497447.36	-1011915.12**	435543.12
Calcium	-2157487.52***	587220.89	-2095424.96**	1019386.42	-1511290.84	1083496.64	-3842844.49***	1419533.67	-35]0119.58	1720456.08
Iron	-58689.87***	9461.14	-45354.65***	17916.98	-56321.17***	19826.31	-92134.75***	24377.75	-60213.86***	19985.09
Magnesium	-978683.70***	162505.25	-978941.35***	271647.43	-399647.14	347450.66	-1456240.77***	467124.13	-1289723.27***	356753.55
Phosphorus	-4471278.67***	708904.71	-4130049.18***	1227693.39	-3899269.49***	1311878.25	-6250194.57***	1825828.48	-6018242.70***	1751560.83
Vitamin A	-710217.18	5122956.83	398410.71	8152810.86	5485122.34	9127136.77	-4206651.82	14969526.22	-15586262.06	15121994.75
Thiamin	-4628.07***	1074.85	-4220.63**	2043.02	-2990.36	2227.51	-9005.38***	2821.43	-3602.80*	2082.11
Riboflavin	-5927.02***	1121.08	-4635.70**	1957.75	-5028.54**	2247.72	-9525.94***	2709.65	-7255.13***	2570.38
Niacin	-67851.36***	12589.18	-50301.02**	22137.92	-53119.96	27815.96	-118620.72***	34430.35	-74517.95***	23589.40
Vitamin B_6	-5772.17***	905.21	-5461.19***	1455.10	-5750.48***	1811.67	-6260.72***	2404.88	-5782.48***	1981.05
Vitamin B_{12}	-12827.06***	319.08	-4703.56	5536.14	-16430.86**	6012.22	-18217.66**	7921.91	-19953.77***	7764.62
Vitamin C	-176782.20***	62138.47	-275809.60***	108872.85	-231192.25	211555.99	-216354.45	178580.34	-115023.22	144598.27
Income ($100)	29.09***	3.45	35.36***	6.62	30.16***	8.39	25.44***	6.38	27.17***	7.40
Race										
White[f]										
Black	-3753.99***	915.97	2143.79*	1194.03	-8451.80***	2182.03	-3125.14	2743.68	-3398.12	2768.04
Other	-644.42	1516.04	-166.14	2829.31	-4329.16	2842.61	6383.13	4122.61	-3284.60	2681.40
Education										
Elementary school[f]										
High school	786.10	821.52	-46.01	1182.74	2209.91	1784.19	1749.04	1998.17	3105.07	2136.86
Some college	339.27	1013.27	-3327.99**	1643.72	3178.52	2263.44	1263.48	2339.70	3923.52*	2371.69
College graduate	-1125.33	1097.30	-4868.50***	1844.28	1586.03	2232.92	995.20	2703.30	432.45	2536.07
Life Cycle[g]										
Stage 1[f]										
Stage 2	8982.91***	1113.88	8206.50***	1909.49	11255.97***	2199.15	8435.14***	2540.43	8546.49***	2330.24
Stage 3	14153.81***	1127.67	12918.52***	1919.50	15301.40***	2209.39	14988.71***	2664.87	14516.19***	2338.09
Stage 4	18500.76***	1086.90	14945.29***	1885.61	23479.51***	2109.74	20341.70***	2484.29	15405.04***	2258.64
Stage 5	8523.12***	1255.00	9174.85***	2055.94	11556.72***	2380.11	5894.45**	2948.73	6851.54**	2992.44
Stage 6	-1918.52*	1011.82	-262.02	1765.11	-1087.68	1893.33	-2937.70	2402.26	-3438.41*	2136.66
Stage 7	-903.39	1277.11	-601.74	2180.85	1690.10	2424.45	-1844.36	3182.17	-1270.97	2622.19

TABLE 34. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	2449.15***	396.11	2885.59***	613.85	2354.16***	851.49	1430.36	912.90	3346.77***	874.46
Homemaker Employed	-1044.06*	584.45	-60.67	950.81	2172.52*	1193.47	812.30	1318.37	-3400.29***	1285.53
Urbanization										
Nonmetropolitan[f]										
Suburban	839.33	650.81	-1210.88	1078.20	-1300.85	1336.82	3076.27	1493.34	2468.37	1541.10
Central city	-278.50	687.86	-237.68	1129.20	437.52	1470.39	-1381.94	1587.85	989.90	1621.01
R^2	.36		.33		.47		.37		.44	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 35. Estimates of United States and regional demand relationships (excluding the family size variable) for iron in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	340.54***	24.13	347.49	42.14	201.84***	52.67	337.67***	54.88	317.87***	57.75
Implicit Prices										
Protein	-4264.68***	764.50	-4020.20***	1499.68	-4757.10***	1518.52	-6385.11***	1799.94	-3200.05*	1736.38
Fat	-2969.87*	1646.94	-2314.38	2669.39	-1931.87	5326.33	-4799.66	3271.36	-3942.24	4116.15
Carbohydrates	-11983.27***	3214.65	-1690.94	6165.35	-16015.19**	7240.40	-15176.42**	7601.71	-25475.41***	6877.66
Calcium	-22933.83**	9619.59	-25923.63	18296.48	-12496.64	18444.37	-38566.92*	21692.50	-45984.34*	27167.73
Iron	-972.50***	154.99	-885.34***	321.58	-1149.10***	337.50	-1216.88***	372.53	-932.01***	315.58
Magnesium	-14515.25***	2662.09	-17637.11***	4875.67	-6504.09	5914.66	-15635.19**	7138.32	19201.07***	5633.50
Phosphorus	-63120.61***	11612.97	-76806.92***	22035.29	-49314.95**	22332.12	-78727.01***	27901.27	-74972.25***	27658.91
Vitamin A	11519.12	83922.04	56173.64	146330.94	172609.65	155371.33	-35727.50	228755.77	-118223.54	238791.53
Thiamin	-65.56***	17.61	-44.70	36.67	-64.15*	37.92	-98.99**	43.12	-62.66*	32.88
Riboflavin	-76.24***	18.37	-53.03	35.14	-70.12*	38.26	-123.66***	41.41	-88.72**	40.59
Niacin	-980.02***	206.23	-648.78*	397.34	-997.06**	473.51	-1592.05***	526.14	-675.01*	372.50
Vitamin B_6	-85.70***	14.83	-97.44***	26.12	-61.84**	30.84	-97.63***	36.75	-76.70**	31.28
Vitamin B_{12}	-135.24***	52.27	-65.45	99.36	-164.57	102.34	-212.98	121.05	189.87	122.61
Vitamin C	-2340.74**	1017.92	-3734.48*	1954.11	1075.48	3601.32	-780.57	2728.96	-3650.15	2283.35
Income ($100)	.50***	.06	.61***	.12	.45***	.14	.50***	.10	.40***	.12
Race										
White[f]										
Black	23.47	15.01	20.66	21.43	-82.11**	37.14	45.93	41.93	125.30***	43.71
Other	65.71***	24.84	79.88	50.78	-5.05	48.39	135.45**	63.00	79.85**	42.34
Education										
Elementary school[f]										
High school	7.96	13.46	4.67	21.23	22.57	30.37	10.06	30.53	67.60**	33.74
Some college	-22.93	16.59	-36.56	29.50	23.28	38.53	-47.28	35.75	47.84	37.45
College graduate	-45.08**	17.98	-104.20***	33.10	-12.49	38.01	11.82	41.31	-2.56	40.05
Life Cycle[g]										
Stage 1[f]										
Stage 2	166.57***	18.25	144.43***	34.27	194.88***	37.44	175.67***	38.82	167.04***	36.80
Stage 3	274.80***	18.47	242.02***	34.45	299.95***	37.61	306.11***	40.72	288.21***	36.92
Stage 4	307.90***	17.81	277.00***	33.84	343.36***	35.91	358.58***	37.96	242.60***	35.67
Stage 5	147.08***	20.57	140.06***	36.90	177.04***	40.52	151.35***	45.06	123.40***	47.25
Stage 6	-32.07**	16.58	-29.08	31.68	-26.35	32.23	-27.39	36.71	-25.04	33.74
Stage 7	-25.92	20.92	-24.97	39.14	-21.24	41.27	-21.91	48.63	-24.18	41.41

TABLE 35. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	74.48***	6.48	66.16***	11.02	62.13***	14.49	85.27***	13.95	85.85***	13.81
Homemaker Employed	-38.19***	9.57	-39.06**	17.07	-50.52***	20.32	-11.97	20.15	-49.68**	20.30
Urbanization										
Nonmetropolitan[f]										
Suburban	1.92	10.66	-28.01	19.35	13.81	22.76	31.63	22.82	5.66	24.34
Central city	-4.07	11.27	23.61	20.27	18.82	25.03	-26.00	24.26	4.52	25.60
R^2	.39		.37		.45		.42		.47	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 36. Estimates of United States and regional demand relationships (excluding the family size variable) for magnesium in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	6991.05***	468.61	6693.59***	792.84	6488.12***	1022.07	7107.76***	1074.35	8203.68***	1153.94
Implicit Prices										
Protein	-99417.31***	14843.91	-83984.73***	28213.26	-101157.98***	29464.58	-152202.16***	35233.21	-126395.49***	34693.35
Fat	-80075.86***	31977.79	-72150.06	50218.91	-94174.89	103349.15	-106885.87*	64035.97	-59457.77	82241.59
Carbohydrates	-240637.36***	62417.24	5429.57	119587.92	-367280.70***	140488.91	-434307.35***	148801.14	-376866.85***	137417.29
Calcium	-407691.09**	186778.75	344209.60	334209.60	-216108.43	357884.69	-989929.19**	424624.28	-940957.28**	542817.45
Iron	-20344.65***	3009.33	-16574.47***	6049.91	-21118.12***	6548.73	-30345.53***	7292.10	-23057.56***	6305.45
Magnesium	-366522.35***	51688.43	-349727.01***	91725.43	-198289.83*	114764.80	-506246.92***	139730.57	-532171.02***	112558.56
Phosphorus	-1408475.34***	225483.01	-1366926.29***	414547.27	-1216137.12***	433320.35	-2068934.36***	546159.01	-2082443.11***	552631.25
Vitamin A	498359.35	1629471.06	534819.75	2752906.77	4380857.04	3014741.74	-1924007.30	4477825.64	-2839823.69	4771108.52
Thiamin	-1474.77***	341.88	-890.55	689.85	-1177.32	735.76	-2987.95***	843.97	-1505.96***	656.92
Riboflavin	-1545.87***	356.58	-921.17	661.06	-1279.08*	742.44	-3002.11***	810.53	-1967.83**	810.97
Niacin	-24004.76***	4004.27	-14841.33**	7475.17	-21477.33**	9187.76	-41589.37***	10299.13	-27427.80***	7442.64
Vitamin B_6	-2152.99***	287.92	-2108.06***	491.33	-1901.21***	598.41	-2477.87***	719.37	-2393.81***	625.04
Vitamin B_{12}	-302.34***	101.49	-1038.03	1869.35	-4297.14**	1985.69	-4475.86**	2369.67	-6289.92***	2449.80
Vitamin C	-69357.80***	19764.53	-92833.28***	36762.39	-3997.85	69878.07	-80745.42	53418.42	-62979.58	45621.89
Income ($100)	10.79***	1.09	13.90***	2.24	12.99***	2.77	8.65***	1.91	8.83***	2.33
Race										
White[f]										
Black	-674.27**	291.35	425.42	403.18	-2184.65***	720.74	-730.36	820.72	886.68	873.34
Other	574.68	482.21	1368.01	955.36	-1173.04	938.93	2806.67**	1233.19	-67.37	846.00
Education										
Elementary school[f]										
High school	253.03	261.30	277.82	399.37	306.68	589.33	351.07	597.71	673.79	674.20
Some college	-157.64	322.29	-858.33	555.02	695.23	747.63	-353.41	699.87	505.23	748.29
College graduate	-644.35*	349.02	-1768.85***	622.74	-304.40	737.55	25.92	808.64	-270.25	800.15
Life Cycle[g]										
Stage 1[f]										
Stage 2	2430.30***	354.30	2042.73***	644.76	3009.29***	726.39	2719.06***	759.92	2181.07***	735.21
Stage 3	5010.29***	358.68	4231.34***	648.15	5947.92***	729.77	6041.56***	767.14	4372.51***	737.69
Stage 4	5692.24***	345.71	4661.08***	636.70	6844.96***	696.86	6810.78***	743.12	4225.11***	712.62
Stage 5	3081.49***	399.32	2878.75***	694.21	4005.08***	786.16	3079.91***	882.05	2394.51***	944.14
Stage 6	-563.76*	321.83	-360.41	596.01	-353.65	625.38	-574.12	718.59	-605.05	674.13
Stage 7	561.05	406.22	-236.08	736.39	209.21	800.81	-1008.49	951.88	-1330.63	827.32

TABLE 36. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	1362.56***	125.99	1405.28***	207.27	1466.79***	281.25	1289.80***	273.07	1395.60***	275.90
Homemaker Employed	-500.70***	185.90	-539.45*	321.05	-853.45**	394.21	296.36	394.36	-916.61**	405.59
Urbanization										
Nonmetropolitan[f]										
Suburban	327.23	207.00	-268.36	364.07	52.84	441.56	-1008.18**	446.70	236.89	486.23
Central city	51.69	218.79	479.87	381.29	76.34	485.68	-146.65	474.97	96.43	511.44
R^2	.38		.36		.47		.41		.42	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid signularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 37. Estimates of United States and regional demand relationships (excluding the family size variable) for phosphorus in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	29224.84***	2029.77	28781.38***	3569.63	25916.64***	4227.36	28955.41***	4753.92	30190.21***	4667.25
Implicit Prices										
Protein	-398128.86***	64295.68	-330029.68***	127025.73	-406589.81***	121868.16	-609572.09***	155904.27	-426495.94***	140321.55
Fat	-319507.03**	136510.27	-252573.28	226102.72	-297307.83	427461.44	-423493.26	283354.27	-347698.51	332636.27
Carbohydrates	-1004384.10***	270357.26	-53800.54	522217.27	-1397557.14**	581074.83	-1661124.53***	658433.68	-1631088.58***	555801.21
Calcium	-2215105.80***	809023.17	-2065396.89	1549749.32	-1355002.66	1480243.42	-4168027.96**	1878930.03	-3587199.78*	2195492.29
Iron	81519.66***	13034.75	-65515.99**	27238.76	-79309.61***	27086.16	-121131.83***	32266.99	-85743.18***	25503.19
Magnesium	-1391040.80***	223885.85	-1507273.33***	412979.23	-462294.48	474677.58	-1908084.29***	618297.10	-1801115.24***	455256.99
Phosphorus	-5965201.46***	976668.82	-6163518.01***	1866533.53	-5019740.91***	1792252.13	-8219580.88***	2416711.93	-7558413.87***	2235185.40
Vitamin A	1895284.10	7057975.68	4647676.45	12394527.53	13045690.30	12469244.23	-5586629.63	19814036.76	-12484066.10	19297338.26
Thiamin	-5657.09***	1480.84	-3822.97	3105.95	-3859.84	3043.17	-11160.91***	3734.52	-4743.97*	2657.01
Riboflavin	-7086.52***	1544.52	-4435.73	2976.32	-6352.57**	3070.78	-12566.60***	3586.55	-7079.21*	3280.08
Niacin	-94555.10***	17344.29	-62393.04*	33655.76	-75739.97**	38001.40	-166290.79***	45572.86	-96631.38***	30102.68
Vitamin B_6	-8325.67***	1247.12	-8482.83***	2212.16	-7058.44***	2475.06	-9786.76***	3183.16	-8051.66***	2528.04
Vitamin B_{12}	-15073.46***	4395.97	-4309.14	8416.46	-22470.08***	8213.74	-22785.63**	10485.63	-22939.42**	9908.52
Vitamin C	-213701.81***	85609.12	-345750.29**	165516.85	-43052.93	289022.01	-240330.42	236373.38	-209480.02	184523.38
Income ($100)	47.69***	4.75	57.84***	10.07	49.92***	11.46	41.97**	8.45	44.08***	9.44
Race										
White[f]										
Black	-935.52	1261.95	239.21	1815.25	-8472.61***	2981.03	-304.57	3631.61	3293.40	3523.33
Other	1113.85	2088.67	1453.17	4301.34	-4824.39	3883.49	10376.93*	5456.79	143.16	3421.76
Education										
Elementary school[f]										
High school	1449.89	1131.82	1415.32	1789.09	1692.91	2437.51	2671.53	2644.83	4874.41	2726.87
Some college	-603.39	1395.99	-4368.63*	2498.91	3395.52	3092.25	-1.42	3096.89	4194.82	3026.54
College graduate	-2833.72*	1511.77	-8102.49***	2803.81	-64.02	3050.56	1589.03	3578.16	-365.63	3236.30
Life Cycle[g]										
Stage 1[f]										
Stage 2	12480.42***	1534.61	11231.72***	2902.95	14589.68***	3004.42	12737.43***	3362.58	12355.00***	2973.64
Stage 3	22475.23***	1553.60	20275.17***	2918.17	25092.53***	3018.41	25497.76***	3527.29	21040.72***	2983.66
Stage 4	27352.73***	1497.44	23785.88***	2866.64	33223.73***	2882.27	31062.54***	3288.27	20513.39***	2882.27
Stage 5	13802.05***	1729.62	13538.78***	3125.59	17900.39	3251.65	13008.61***	3903.01	10227.80***	3818.68
Stage 6	-3308.52**	1393.99	-1956.27	2683.48	-1993.77	2586.62	-3610.73	3179.70	-4456.62*	2726.62
Stage 7	-2132.57	1759.50	-1399.81	3315.49	-95.29	3312.21	-2447.78	4212.00	-3248.02	3346.20

TABLE 37. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	5996.12***	545.73	6471.95***	933.22	5321.45***	1163.28	5655.33***	1208.33	6267.16***	1115.90
Homemaker Employed	-1809.43**	805.21	-1351.85	1445.49	-3666.00**	1630.49	1130.19	1745.03	-3721.24**	1640.48
Urbanization										
Nonmetropolitan[f]										
Suburban	995.25	896.63	-1487.10	1639.16	207.02	1826.32	4097.41**	1976.63	1805.19	1966.61
Central city	-344.81	947.68	621.79	1716.69	1232.60	2008.81	=1749.29	2101.72	1421.70	2068.58
R^2	.41		.37		.51		.43		.48	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 38. Estimates of United States and regional demand relationships (excluding the family size variable) for vitamin A in International Units, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	119607.70***	12330.08	119394.42***	21554.97	149849.14***	27301.08	98679.26***	26599.40	132183.99***	32614.94
Implicit Prices										
Protein	-1914953.65***	390571.06	-1823478.94***	767036.32	-2456624.83***	787046.40	-2399000.21***	872323.57	-2244276.21**	980572.08
Fat	-1938352.86**	841395.70	-1456826.73	1365306.07	-4692343.50*	2760622.46	-1051688.37	1585438.34	-4068520.51*	2324474.27
Carbohydrates	-4989741.73***	1642314.53	-2969763.74	3153373.83	-5763397.94	3752685.24	-7287318.98**	3684101.90	-9759125.10***	3883958.86
Calcium	-9890410.72***	4914490.11	-10850878.50	9358057.03	-7953839.05	9559676.87	-14713822.67	10513085.74	-26786195.56*	15342179.26
Iron	-458516.09**	79181.03	-443107.69***	164479.41	-526619.48***	174927.24	-564548.07***	180541.97	-632064.43***	178217.20
Magnesium	-5094675.33***	1360019.54	-6623930.52***	2493747.30	-2238677.68	3065552.72	-5676459.45*	3459527.66	-8922456.73***	3181352.31
Phosphorus	-28674119.36***	5932880.81	-36110838.64***	11270333.39	-25991797.54**	11574684.93	-31033937.55**	13522110.64	-45812405.62***	15619556.12
Vitamin A	-51386482.41	42874439.79	-92073351.65	74843520.86	29523743.51	80528610.12	-7619383.56	110864515.47	-190880586.51	134850495.26
Thiamin	-39803.35***	8995.50	-30260.35	18755.10	-38248.26**	19653.33	-71680.52***	20895.57	-41908.70**	18567.27
Riboflavin	-44073.66***	9383.38	-35722.75**	17972.31	-49196.96***	19831.67	-55122.62***	20067.67	-70622.75***	22921.34
Niacin	-412940.64***	105359.82	-276229.35	203228.07	-594178.64**	245419.83	-531466.04**	254991.62	-424553.74**	210538.60
Vitamin B_6	-42497.86***	7575.79	-60499.29***	13357.95	-24295.77	15984.36	-36540.20**	17810.59	-51554.28***	17666.05
Vitamin B_{12}	-103284.28***	26703.77	-103668.71**	50822.21	118342.77**	53045.78	-86506.81	59669.75	-180765.29***	69241.09
Vitamin C	-1715948.65***	520041.89	-2687914.70***	999462.34	-255702.11	1866555.83	-2454416.17	1322568.44	-2070648.54	1289456.05
Income ($100)	187.73***	28.90	206.27***	60.78	111.92	73.97	220.17***	472.74	141.77**	65.98
Race										
White[f]										
Black	39229.53***	7665.88	31480.91***	10921.28	14841.57	19252.04	85080.14***	20319.75	63485.65***	24684.05
Other	9006.88	12687.89	10678.63	25973.32	-39302.20	25080.29	74483.30**	30532.09	13999.34	23911.40
Education										
Elementary school[f]										
High school	2852.54	6875.36	3344.56	10857.62	-6283.36	15741.89	13183.68	14798.47	16521.03	19055.46
Some college	4156.65	8480.14	-17266.83	15089.48	11130.98	19970.28	8298.36	17327.85	34793.97*	21149.55
College graduate	-1181.00	9183.40	-31358.46*	16930.61	11881.72	19701.07	17028.96	20020.70	4162.72	22615.38
Life Cycle[g]										
Stage 1[f]										
Stage 2	45176.82***	9322.18	46124.70***	17529.24	40100.08**	19403.08	40722.49**	18814.48	54493.25***	20779.90
Stage 3	84695.77***	9437.52	77083.61***	17621.18	86153.79***	19493.44	97771.05***	19736.09	84814.22***	20849.95
Stage 4	100046.93***	9096.37	88251.71***	17310.03	109669.16***	18614.21	115231.82***	18398.68	91277.96***	20141.43
Stage 5	56230.51***	10506.81	45573.82***	18873.66	70784.88***	20999.72	53851.64***	21838.35	78558.71***	26685.07
Stage 6	255.23	8467.99	6010.15	16203.88	-1233.72	16704.83	-1237.34	17791.20	9668.17	19053.71
Stage 7	-17308.86	10688.28	-10746.86	20020.37	-27533.67	21390.85	-14558.98	23567.22	-13398.13	23383.40

TABLE 38. (Continued)

Variables	United States[a] Regression Coefficients	United States[a] Standard Errors	South[b] Regression Coefficients	South[b] Standard Errors	Northeast[c] Regression Coefficients	Northeast[c] Standard Errors	North Central[d] Regression Coefficients	North Central[d] Standard Errors	West[e] Regression Coefficients	West[e] Standard Errors
Meal Adjustment	22500.17***	3315.12	17761.69***	5635.18	21823.02***	7512.70	23957.61***	6760.92	22064.14***	7797.98
Homemaker Employed	-16437.57***	4891.32	-4577.51	8728.50	-18348.07*	10530.01	-14271.90	9763.86	-32193.24***	11463.71
Urbanization										
Nonmetropolitan[f]										
Suburban	12450.81***	5446.66	-6741.69	9897.97	7507.53	11794.71	26434.01**	11059.73	19488.57	13742.74
Central city	16315.71***	5726.79	21524.27**	10366.13	14308.21	12973.24	3847.97	11759.67	33231.53***	14455.34
R^2	.22		.20		.24		.29			

[a]N = 2218.

[b]N = 727,

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 39. Estimates of United States and regional demand relationships (excluding the family size variable) for thiamin in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	33.41***	2.40	33.73***	4.15	29.47***	4.95	34.33***	5.70	27.70***	5.82
Implicit Prices										
Protein	-409.94***	76.13	-332.25**	147.89	-463.10***	142.58	-655.19***	187.02	-263.75	175.20
Fat	-365.54**	164.01	-279.03	263.24	-343.15	500.09	-527.57	339.90	-177.21	415.31
Carbohydrates	-1295.61***	320.13	-192.11	607.99	-1797.59***	679.81	-2093.14***	789.83	-2005.71***	693.95
Calcium	-2646.45***	957.96	-2994.52*	1804.28	-1767.00	1731.76	-4809.77**	2253.89	-3015.20	2741.21
Iron	-95.85***	15.43	-71.89**	31.71	-107.92***	31.69	-144.93***	38.71	-81.14***	31.84
Magnesium	-1574.02***	265.10	-1806.14***	480.81	-572.53	555.33	-1995.69***	741.68	1932.61***	568.42
Phosphorus	-6410.62***	1156.47	-7204.79***	2172.98	-5292.90***	2096.78	-8459.34***	2898.99	-6049.04**	2790.77
Vitamin A	-3936.70	8357.35	-4139.49	14430.20	16436.54	14585.94	-11793.71	23768.11	-7457.51	24093.93
Thiamin	-6.57***	1.75	-3.21	3.61	-6.23*	3.56	-13.62***	4.48	-3.93	3.32
Riboflavin	-8.15***	1.82	-5.69*	3.47	-7.76**	3.57	-14.65***	4.30	-5.90	4.09
Niacin	-100.74***	20.54	-50.97	39.18	-93.21**	44.46	-174.82***	54.67	-76.76**	37.59
Vitamin B_6	-8.81***	1.47	-9.49***	2.58	-6.74**	2.90	-9.95***	3.82	-7.75***	3.16
Vitamin B_{12}	-15.64***	5.21	-6.14	9.79	22.53**	9.61	22.94*	12.58	16.59	12.37
Vitamin C	-258.81***	101.37	-367.15*	192.70	-99.57	338.13	-291.95	283.54	-374.06	230.39
Income ($100)	.04***	.00	.05***	.01	.04**	.01	.04***	.01	.03***	.01
Race										
White[f]										
Black	2.22	1.49	3.30	2.11	-7.93**	3.49	3.54	4.36	6.65	4.41
Other	4.55*	2.47	3.77	5.01	-3.91	4.54	13.83*	6.55	7.22*	4.27
Education										
Elementary school[f]										
High school	.18	1.34	-.53	2.09	2.23	2.85	.48	3.17	5.99*	3.40
Some college	-2.42	1.65	-6.54**	2.91	3.64	3.62	-3.03	3.71	5.69	3.78
College graduate	-4.54***	1.79	-10.34***	3.26	-.24	3.57	-.17	4.29	.95	4.04
Life Cycle[g]										
Stage 1[f]										
Stage 2	14.93***	1.81	14.50***	3.38	16.47***	3.51	14.28***	4.03	15.86***	3.71
Stage 3	27.95***	1.84	25.20***	3.40	32.47***	3.53	29.75***	4.23	28.37***	3.72
Stage 4	32.06***	1.77	28.52***	3.34	35.49***	3.37	27.10***	3.94	27.01***	3.60
Stage 5	14.87***	2.04	14.02***	3.64	17.98***	3.80	15.25***	4.68	12.44***	4.77
Stage 6	-2.65	1.65	-1.94	3.12	-1.08	3.02	-3.08	3.81	-2.20	3.40
Stage 7	-1.80	2.08	-1.18	3.86	.06	3.88	-1.71	5.02	-1.82	4.18

TABLE 39. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	6.35***	.65	6.15***	1.09	5.22***	1.36	6.78***	1.45	7.47***	1.39
Homemaker Employed	-3.40***	.95	-2.61	1.68	-5.22***	1.91	1.31	2.09	-4.69	2.05
Urbanization										
Nonmetropolitan[f]										
Suburban	-.09	1.06	-2.28	1.91	-.15	2.14	2.95	2.37	1.22	2.46
Central city	-1.67	1.12	-.35	1.99	.60	2.35	-3.57	2.52	1.21	2.58
R^2	.38		.36		.47		.40		.44	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 40. Estimates of United States and regional demand relationships (excluding the family size variable) for riboflavin in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	41.49***	3.20	41.10***	5.23	38.15***	7.03	42.89***	7.72	38.68***	7.54
Implicit Prices										
Protein	-620.14***	101.51	-566.73***	186.43	-626.65***	202.63	-966.83***	253.09	-544.39***	226.80
Fat	-489.75**	218.68	-337.55	331.84	-360.06	710.76	-750.64*	459.98	-538.87	537.63
Carbohydrates	-1682.76***	426.84	-394.48	766.43	-2278.88**	966.18	-2644.08***	1068.86	-2606.66***	898.31
Calcium	-4214.10***	1277.27	-4550.60**	2274.48	-3444.28	2461.28	-6905.99**	3050.14	-5534.38	3548.48
Iron	-135.49***	20.58	-114.26***	39.98	-142.56***	45.04	-209.18***	52.38	-136.27***	41.29
Magnesium	-2034.27***	353.47	-2497.51***	606.10	-752.11	789.27	-2773.46***	1003.71	-2667.03***	735.81
Phosphorus	-9458.92***	1541.95	-10508.94	2739.26	-7949.76***	2980.07	-12602.01***	3923.14	-10682.64***	3612.63
Vitamin A	-4302.00	11143.01	3323.53	18190.75	19457.65	20733.25	-19763.93	32164.90	-33918.26	31189.43
Thiamin	-10.68***	2.33	-7.61*	4.55	-9.98**	5.06	-20.41***	6.06	-8.16*	4.29
Riboflavin	-13.42***	2.43	-11.23***	4.37	-13.53***	5.10	-21.31***	5.82	-12.93**	5.30
Niacin	-145.40***	27.38	-109.42**	49.39	-114.99*	63.19	-259.13***	73.98	-122.05***	48.65
Vitamin B_6	-12.48***	1.97	-13.72***	3.25	-8.89**	4.11	-16.04***	5.16	-12.09***	4.08
Vitamin B_{12}	-28.31***	6.94	18.10	12.35	-38.28***	13.65	38.15**	17.02	-35.64**	16.01
Vitamin C	-380.67***	135.16	-490.05***	242.92	-350.04	480.57	-445.17	383.71	-371.02	298.24
Income ($100)	.07***	.00	.08***	.01	.06***	.01	.06***	.01	.05***	.01
Race										
White[f]										
Black	-.94	1.99	.18	2.66	-14.50***	4.96	3.08	5.89	7.75	5.71
Other	1.63	3.29	.49	6.31	-10.41	6.46	16.98*	8.86	2.91	5.53
Education										
Elementary school[f]										
High school	2.56	1.79	1.15	2.64	4.21	4.05	5.08	4.29	8.75**	4.40
Some college	-.07	2.20	-5.69	3.67	4.32	5.14	.85	5.02	9.29*	4.89
College graduate	-3.98*	2.38	-12.92***	4.11	-.04	5.07	3.86	5.81	1.47	5.23
Life Cycle[g]										
Stage 1[f]										
Stage 2	21.58***	2.42	19.22***	4.26	27.22***	4.99	19.56***	5.45	22.89***	4.81
Stage 3	36.42***	2.45	33.38***	4.28	40.25***	5.01	39.44***	5.72	36.23***	4.82
Stage 4	44.69***	2.36	36.74***	4.21	53.16***	4.79	50.59***	5.34	38.49***	4.66
Stage 5	19.94***	2.73	18.10***	4.59	25.97***	5.40	18.82***	6.34	18.35***	6.17
Stage 6	-3.09	2.20	-.27	3.93	-2.63	4.30	-4.70	5.17	-3.67	4.41
Stage 7	-1.60	2.77	-.67	4.87	1.47	5.51	-2.07	6.83	-2.14	5.41

TABLE 40. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	7.53***	.86	7.28***	1.37	6.65***	1.93	7.69***	1.96	8.87***	1.80
Homemaker Employed	-3.88***	1.27	-1.91	2.12	-6.66***	2.71	.43	2.83	-7.30***	2.65
Urbanization										
Nonmetropolitan[f]										
Suburban	1.68	1.42	2.19	2.41	.69	3.03	5.15	3.21	4.10	3.17
Central city	-.93	1.49	1.33	2.52	.90	3.34	-4.79	3.41	3.11	3.34
R^2	.39		.37		.48		.37		.47	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 41. Estimates of United States and regional demand relationships (excluding the family size variable) for niacin in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	436.27***	32.12	464.10***	56.21	391.10***	68.77.	409.43***	74.09	417.13***	74.25
Implicit Prices										
Protein	-5554.14***	1017.55	-5367.54***	2000.09	-5617.19***	1982.44	-8232.62***	2430.19	-5257.54**	2232.26
Fat	-4130.34***	2192.08	-3580.63	3560.13	-2672.05	6953.58	-6014.34	4416.84	-3289.31	5291.63
Carbohydrates	15278.08***	4278.71	-1926.31	8222.64	-22484.28**	9452.43	-21232.13**	10263.46	-27830.91***	8841.77
Calcium	-24772.47**	12803.67	-26969.77	24401.77	-25553.28	24079.34	-47497.44	29288.18	-54849.23	34926.24
Iron	-1167.70***	206.29	-1048.22***	428.89	-1223.52***	440.61	-1560.51***	502.98	-1201.36***	405.71
Magnesium	-19593.99***	3543.25	-24890.81***	6502.62	-6889.76	7721.65	-22017.86**	9637.83	-25798.31***	7242.30
Phosphorus	-78993.68***	15456.87	-94930.44***	29388.16	-64983.33**	29154.84	-102794.77***	37670.96	-98066.69***	35557.69
Vitamin A	30384.46	111700.34	35570.08	195159.58	279689.35	202839.08	-46933.33	308855.13	-161760.58	306985.11
Thiamin	-90.70***	23.44	-59.57	48.91	-72.61	49.50	-164.05***	58.21	-90.02**	42.27
Riboflavin	-98.32***	24.44	-72.05	46.86	-91.91*	49.95	-163.25***	55.90	-102.41**	52.18
Niacin	-1442.11***	274.49	-1232.34**	529.93	-1033.42*	618.17	-2327.54***	710.37	-1259.77***	478.88
Vitamin B_6	-115.03***	19.74	-139.85***	34.83	-70.97*	40.26	-127.67***	49.61	-118.41***	40.22
Vitamin B_{12}	-144.86**	69.57	27.94	132.52	246.91*	133.61	194.43	163.44	251.60	157.63
Vitamin C	-3248.51**	1354.86	-6183.74**	2606.17	956.76	4701.56	1949.18	3684.52	-4404.60	2935.43
Income ($100)	.76***	.08	.91***	.16	.88***	.19	.67***	.13	.63***	.15
Race										
White[f]										
Black	25.46	19.97	25.63	28.58	-118.03**	48.49	48.63	56.60	129.09**	56.19
Other	54.13*	33.06	53.95	67.73	-77.29	63.17	189.35**	85.06	83.64	54.43
Education										
Elementary school[f]										
High school	15.26	17.91	15.97	28.31	14.93	39.65	33.40	41.22	60.32	43.38
Some college	-37.24*	22.09	-73.38*	39.35	21.05	50.30	-42.92	48.27	26.48	48.15
College graduate	-69.64***	27.93	-146.95***	44.15	-40.43	49.62	16.61	55.77	-40.58	51.48
Life Cycle[g]										
Stage 1[f]										
Stage 2	179.01***	24.28	148.06***	45.71	216.34***	48.87	198.53***	52.41	173.62***	47.31
Stage 3	370.65***	24.58	321.27***	45.95	439.36***	49.10	437.12***	54.98	329.64***	47.47
Stage 4	425.06***	23.70	357.07***	45.14	496.93***	46.89	512.34***	51.26	319.16***	45.85
Stage 5	217.95***	27.37	182.33***	49.21	287.79***	52.89	255.63***	60.84	135.72***	60.74
Stage 6	-34.20	22.06	-37.83	42.25	-32.78	42.08	-18.61	49.56	-19.58	43.38
Stage 7	-38.26	27.85	-31.55	52.20	-22.82	53.88	-36.31	65.66	-55.89	53.23

TABLE 41. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	103.88***	8.63	102.51***	14.69	98.43***	18.92	119.13***	18.84	94.86***	17.75
Homemaker Employed	-36.12***	12.74	-37.71*	22.76	-72.82***	26.52	12.38	27.20	-43.37*	26.09
Urbanization										
Nonmetropolitan[f]										
Suburban	19.26	14.19	-17.87	25.81	30.65	29.71	48.98	30.81	27.14	31.28
Central city	-3.19	14.99	40.08	27.03	20.04	32.68	-42.33	32.76	23.50	32.91
R^2	.40		.37		.50		.43		.44	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 42. Estimates of United States and regional demand relationships (excluding the family size variable) for vitamin B_6 in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	3.30***	.25	3.19***	.45	3.06***	.54	3.46***	.62	3.25***	.58
Implicit Prices										
Protein	-41.89***	8.18	-33.30**	15.84	-44.67***	15.69	-63.73***	20.39	-47.91***	17.37
Fat	-34.25**	17.63	-25.37	28.18	-38.54	55.03	-50.33	37.07	-28.33	41.19
Carbohydrates	-96.75***	34.41	-4.59	65.10	-137.90*	74.80	-145.88**	86.15	-175.26***	68.82
Calcium	-173.75*	102.97	-146.16	193.19	-175.38	190.55	-334.82	245.83	-336.17	271.88
Iron	-9.05***	1.66	-7.53**	3.39	-9.05***	3.49	-12.73***	4.22	-10.40***	3.16
Magnesium	-155.18***	28.49	-183.77***	51.48	-44.38	61.10	-164.23**	80.90	-239.51***	56.38
Phosphorus	-613.75***	124.31	-691.05***	232.67	-499.91**	230.71	-760.22***	316.19	-857.58***	276.79
Vitamin A	27.01	898.35	-83.69	1545.09	2207.64	1605.14	-896.49	2592.38	-2069.77	2389.70
Thiamin	-.57***	.19	-.24	.39	-.38	.39	-1.20***	.49	.56*	.33
Riboflavin	-.79***	.19	-.47	.37	-.70*	.39	-1.34***	.47	-.94**	.40
Niacin	-10.13***	2.20	-6.32	4.19	-8.06*	4.89	-15.93***	5.96	-11.31***	3.72
Vitamin B_6	-.95***	.16	-1.10***	.27	-.70**	.32	-1.08***	.42	-1.03***	.31
Vitamin B_{12}	-1.80***	.56	.90	1.05	2.25**	1.06	-2.56*	1.37	2.99**	1.22
Vitamin C	-29.89***	10.90	-46.90**	20.63	.96	37.21	-29.40	30.93	-36.05	22.85
Income ($100)	.01***	.00	.01***	.00	.01***	.00	.01***	.00	.01***	.00
Race										
White[f]										
Black	.29*	.16	.34	.22	-.64*	.38	.60	.48	.99***	.43
Other	.32	.26	.24	.54	-.29	.50	1.19*	.71	.46	.42
Education										
Elementary school[f]										
High school	.17	.14	.24	.22	.10	.31	.21	.35	.60*	.34
Some college	-.12	.17	-.38	.31	.32	.40	-.27	.41	.50	.37
College graduate	-.38**	.19	-.89***	.34	-.09	.40	.05	.47	-.12	.40
Life Cycle[g]										
Stage 1[f]										
Stage 2	1.54***	.19	1.46***	.36	1.58***	.39	1.50***	.44	1.65***	.37
Stage 3	3.07***	.20	2.87***	.36	3.49***	.39	3.40***	.46	2.74***	.37
Stage 4	3.41***	.19	2.92***	.36	4.00***	.37	4.00***	.43	2.53***	.36
Stage 5	1.63***	.22	1.50***	.39	2.10***	.42	1.44***	.51	1.69***	.47
Stage 6	-.27	.18	-.12	.33	-.15	.33	-.44	.42	-.22	.33
Stage 7	-.24	.22	-.13	.41	-.11	.42	-.29	.55	-.43	.41

TABLE 42. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	.80***	.07	.78***	.11	.59***	.15	-.02	.23	.89***	.14
Homemaker Employed	-.26***	.10	-.19	.18	-.46**	.21	.92***	.16	-.42**	.20
Urbanization										
Nonmetropolitan[f]										
Suburban	.16	.11	-.06	.20	.17	.23	.37	.25	.32	.24
Central city	.11	.12	.33	.21	.28	.25	-.26	.27	.51**	.26
R^2	.40		.37		.48		.42		.48	

[a]N = 2218.

[b]N = 727.

[c]N = 490.

[d]N = 600.

[e]N = 401.

[f]Omitted to avoid singularity.

[g]For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 43. Estimates of United States and regional demand relationships (excluding the family size variable) for vitamin B_{12} in micrograms, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_o-intercept	100.85***	13.67	104.59***	21.01	143.40***	38.38	93.18***	28.21	79.29**	33.66
Implicit Prices										
Protein	-1744.23***	432.97	-2322.38***	747.60	-2370.07**	1106.35	-2029.52**	925.21	-1277.45	1012.04
Fat	-1034.54	932.74	-1305.44	1330.72	-2955.03	3880.61	-184.02	1681.57	-1684.11	2399.09
Carbohydrates	-3789.41**	1820.60	-4139.36	3073.49	-3968.74	5275.16	-5172.31	3907.49	-6698.58*	4008.62
Calcium	-12312.82**	5448.01	-18465.46*	9120.99	-19060.42	13438.06	-14550.16	11150.53	-10290.93	15834.60
Iron	-382.88***	87.78	-454.55***	160.31	-532.77**	245.89	-465.16**	191.49	-466.88***	183.93
Magnesium	-4064.07***	1507.66	-7973.08***	2430.57	-1733.54	4309.26	-6403.30*	3669.30	-3354.72	3283.46
Phosphorus	-26239.94***	6576.95	-40683.87***	10984.83	-25756.03	16270.57	-30113.71**	14342.03	-26451.29*	16120.88
Vitamin A	-52594.35	47528.89	-16837.03	72947.56	-36084.37	113199.30	-113309.69	117586.86	-57102.89	139178.62
Thiamin	-31.88***	9.97	-33.04*	18.27	-43.47	27.63	-52.96**	22.16	-20.93	19.16
Riboflavin	-46.13***	10.40	-50.99***	17.51	-69.06***	27.87	-55.03***	21.28	-40.79*	23.66
Niacin	-388.32***	116.80	-399.45	198.08	-579.20	344.99	-564.50**	270.45	-228.42	217.11
Vitamin B_6	-31.83***	8.39	-54.99	13.01	-4.26	22.47	-47.77***	18.89	-22.77	18.23
Vitamin B_{12}	-123.06***	29.60	-147.88**	49.53	-159.38**	74.56	-119.74**	62.22	162.78**	71.46
Vitamin C	-1069.28*	576.50	-1423.79	974.14	577.87	2623.83	-2033.26	1402.76	-1272.44	1330.84
Income ($100)	.16***	.03	.18***	.06	.10	.10	.20***	.05	.04	.07
Race										
White[f]										
Black	23.73***	8.50	26.79***	10.68	-22.35	27.06	59.47***	21.55	59.05**	25.48
Other	-9.22	14.07	-17.97	25.32	-45.32	35.26	33.89	32.38	.25	24.68
Education										
Elementary school[f]										
High school	4.10	7.62	13.80	10.59	-18.19	22.13	13.94	15.69	8.68	19.67
Some college	-1.10	9.40	-7.77	14.71	-27.38	28.07	9.14	18.38	22.53	21.83
College graduate	-14.29	10.18	-30.24*	16.50	-24.28	27.69	3.04	21.23	-10.75	23.34
Life Cycle[g]										
Stage 1[f]										
Stage 2	36.33***	10.33	31.85*	17.08	60.66**	27.27	25.52	19.96	40.23*	21.45
Stage 3	73.42***	10.46	61.60***	17.17	73.95***	27.40	82.65***	20.93	96.83***	21.52
Stage 4	90.35***	10.08	79.15***	16.87	111.51***	26.17	96.79***	19.51	80.44***	20.78
Stage 5	43.67***	11.65	23.45	18.39	59.70**	29.51	59.66***	23.16	62.21**	27.54
Stage 6	-11.11	9.39	-7.24	15.79	-19.86	23.49	-9.81	18.87	4.05	19.66
Stage 7	-15.45	11.84	-3.37	19.51	-40.43	30.07	-7.11	24.99	-4.12	24.13

TABLE 43. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	24.58***	3.67	20.51***	5.49	24.60**	10.56	27.28***	7.17	20.85***	8.04
Homemaker Employed	-6.72	5.42	-7.83	8.51	5.21	14.80	-6.48	10.36	-10.71	11.83
Urbanization										
Nonmetropolitan[f]										
Suburban	15.65***	6.03	.11	9.65	13.67	16.58	15.68	11.73	36.25***	14.18
Central city	13.48**	6.38	17.72*	10.10	12.52	18.23	-7.24	12.47	40.07***	14.92
R^2	.16		.18		.15		.22			

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 44. Estimates of United States and regional demand relationships (excluding the family size variable) for vitamin C in milligrams, using full linear hedonic price equation, Spring 1977, including regression coefficients, standard errors, and R^2's.

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
a_0-intercept	1807.69***	203.29	1816.61***	337.71	2210.60***	486.48	1837.64***	450.03	1927.80***	496.62
Implicit Prices										
Protein	-21025.69***	6439.54	-18914.24	12017.35	-26800.42*	14024.49	-42187.70***	14758.54	-11554.74	14930.88
Fat	-14687.33	13872.53	-12996.55	21390.59	-14755.49	49191.93	-17642.83	26823.48	3266.87	35394.08
Carbohydrates	-46730.01*	27077.69	-52801.20	49404.69	-52246.11	66869.63	-93405.53	62330.04	-91621.05	59139.90
Calcium	-88519.63	81027.90	-175289.25	146615.00	-74656.44	170345.34	-348525.06**	177867.24	-329930.43	233610.84
Iron	-4832.23***	1305.50	-5037.01*	2576.94	-5347.60*	3117.05	-8375.20***	3054.53	-4094.80	2713.66
Magnesium	-106663.93***	22423.35	-107023.82***	39070.16	-70505.41	54625.52	-161890.99***	58530.55	-148280.56***	48441.51
Phosphorus	-353106.91***	97818.49	-457176.20***	176575.11	-357023.91*	206250.96	-667459.95***	228775.88	-346417.91	237834.38
Vitamin A	-101269.38	706893.14	-1418787.15	1172592.06	490325.47	1434950.79	996365.31	187678.19	-858410.46	2053328.76
Thiamin	-454.90***	148.31	-625.04**	293.84	-185.46	350.21	-1026.71***	353.52	-245.96	282.72
Riboflavin	-499.83***	154.69	-552.01**	281.58	-379.35	353.38	-1017.92***	339.52	-321.07	349.02
Niacin	-5477.75***	1737.12	5941.73*	2184.02	-5557.90	4373.17	-8070.04**	4314.11	-4892.58	3203.06
Vitamin B_6	-544.54***	124.91	-771.67***	209.28	-684.08***	284.83	-344.26	301.33	-408.20	268.99
Vitamin B_{12}	-1089.81***	440.28	-576.16	796.24	-1317.06	945.23	-1606.94	992.61	-1074.18	1054.31
Vitamin C	-43436.51***	8574.20	-63221.47***	15658.82	-78494.58**	33260.43	-68341.67***	22376.08	-57423.57***	19634.17
Income ($100)	4.09***	.48	3.72***	.95	4.52***	1.31	3.96***	.80	3.76***	1.01
Race										
White[f]										
Black	163.07	126.39	279.84*	171.93	-546.14	343.05	637.18*	343.78	304.80	375.86
Other	245.29	209.19	108.53	406.93	-83.66	446.91	767.83	516.56	144.85	364.09
Education										
Elementary school[f]										
High school	5.66	113.38	17.96	170.11	-210.74	280.51	58.42	250.37	254.19	290.15
Some college	59.38	139.82	-140.92	236.41	-47.66	355.85	371.85	293.16	402.39	322.04
College graduate	159.92	151.41	-183.05	265.26	74.73	351.06	485.45	338.72	261.54	344.36
Life Cycle[g]										
Stage 1[f]										
Stage 2	858.98***	153.70	827.82***	274.64	813.37**	345.75	744.33**	318.32	1295.15***	316.41
Stage 3	1748.36***	155.60	1726.04***	276.08	1914.97***	347.36	2085.26***	333.90	1300.56***	317.48
Stage 4	1839.19***	149.98	1473.06***	271.20	2104.93***	331.69	2277.79***	311.28	1470.89	306.69
Stage 5	982.92***	173.23	952.98***	295.70	955.96***	374.20	1023.77***	369.48	960.89**	406.32
Stage 6	119.56	139.62	85.81	253.87	37.78	297.67	157.50	301.00	403.31	290.12
Stage 7	-263.59	179.22	-255.18	313.66	-73.05	381.17	20.01	398.73	-528.50	356.05

TABLE 44. (Continued)

Variables	United States[a]		South[b]		Northeast[c]		North Central[d]		West[e]	
	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors	Regression Coefficients	Standard Errors
Meal Adjustment	402.08***	54.65	434.36***	88.28	293.34***	133.87	379.06***	114.39	461.06***	118.74
Homemaker Employed	-251.74***	80.65	-122.44	136.75	-172.16	187.64	-269.90*	165.19	-521.51***	174.55
Urbanization										
Nonmetropolitan[f]										
Suburban	312.92***	89.80	145.64	155.07	322.60	210.17	337.12*	187.11	140.43	209.25
Central city	318.89***	94.91	354.27**	162.41	435.27*	231.17	164.34	198.96	222.36	220.11
R^2	.24		.18		.28		.31		.30	

[a] N = 2218.

[b] N = 727.

[c] N = 490.

[d] N = 600.

[e] N = 401.

[f] Omitted to avoid singularity.

[g] For explanation of stages see page 60.

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

TABLE 45. Simple correlation coefficients of the independent variables of the reduced attribute demand equation, United States, Spring 1977, N = 2218.

Variables	X_1	X_2	X_3	X_m	X_8	X_B	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}	X_{27}	X_{28}	X_{29}	X_{30}	X_{31}
X_1	1.00	-.24	.30	-.69	.24	-.55	.22	.03	.02	.08	.01	-.01	.03	.05	.10	-.01	-.01	-.02	-.11	.04	-.00	.04	.02	.08
X_2		1.00	-.04	.07	-.28	.04	.03	-.01	-.07	.05	-.00	-.04	-.00	.01	-.02	-.01	-.03	-.03	.04	.04	-.01	.01	-.01	.03
X_3			1.00	-.36	.19	-.50	.04	.04	.04	-.06	.00	-.04	.07	.07	.06	.02	.02	-.01	-.11	-.01	-.02	.07	.04	-.01
X_m				1.00	-.24	.21	-.12	.02	-.04	-.09	.00	.03	-.02	-.02	-.09	.00	-.00	.02	.08	.01	-.00	-.01	.02	-.08
X_8					1.00	-.20	-.11	-.02	-.01	.03	.04	-.01	-.01	.03	.03	-.06	-.00	.00	-.01	.01	-.01	.02	-.01	.04
X_B						1.00	-.25	.00	-.13	-.05	-.00	.01	-.04	-.02	-.13	-.05	-.04	.02	.12	.02	.03	.01	-.04	-.02
X_{14}							1.00	-.02	-.03	.03	.01	-.03	.01	-.02	-.12	-.05	-.04	.02	.12	.02	.03	.01	-.04	.02
X_{15}								1.00	.31	-.16	-.03	-.03	.12	.18	-.01	.08	.19	.08	-.18	-.10	-.16	.16	.14	-.09
X_{16}									1.00	.03	.08	.12	.03	-.06	.17	.37	.44	.07	-.48	-.27	-.32	-.04	.08	-.10
X_{17}										1.00	-.07	-.03	-.02	-.05	.00	.08	.02	-.01	-.04	.02	-.03	-.01	-.13	.27
X_{18}											1.00	-.04	-.02	.01	.01	.05	-.00	-.02	-.04	.01	-.00	.01	-.04	.10
X_{19}												1.00	-.48	-.43	.03	.09	.04	.01	.00	-.14	.00	-.05	.00	-.06
X_{20}													1.00	-.19	.05	.02	.03	-.04	-.11	.00	-.06	.12	.05	.01
X_{21}														1.00	.03	-.05	-.02	-.05	-.13	.10	-.05	.16	.05	.05
X_{22}															1.00	-.16	-.18	-.12	-.25	-.11	-.04	-.07	.04	-.04
X_{23}																1.00	.18	-.12	-.25	-.11	-.13	-.01	-.00	.01
X_{24}																	1.00	-.14	-.28	.13	-.18	.07	.06	-.06
X_{25}																		1.00	-.20	-.09	-.01	-.02	.02	-.02
X_{26}																			1.00	.18	.30	-.20	-.06	-.00
X_{27}																				1.00	.01	.09	-.05	.10
X_{28}																					1.00	-.20	-.04	-.02
X_{29}																						1.00	.01	.06
X_{30}																							1.00	-.47
X_{31}																								1.00

X_1 = Implicit price of protein.

X_2 = Implicit price of fat.

TABLE 45. (Continued)

X_3 = Implicit price of carbohydrates.

X_m = Implicit price of minerals.

X_8 = Implicit price of Vitamin A.

X_B = Implicit price of Vitamin B.

X_{14} = Implicit price of Vitamin C.

X_{15} = Income.

X_{16} = Family size.

X_{17} = Black race.

X_{18} = Other race.

X_{19} = High school.

X_{20} = Some college.

X_{21} = College graduate.

X_{22} = Life cycle stage 2.

X_{23} = Life cycle stage 3.

X_{24} = Life cycle stage 4.

X_{25} = Life cycle stage 5.

X_{26} = Life cycle stage 6.

X_{27} = Life cycle stage 7.

X_{28} = Meal adjustment.

X_{29} = Homemaker worked outside home.

X_{30} = Suburban.

X_{31} = Central city.

VITA

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