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DEMAND ANALYSIS OF MEATS IN THE UNITED STATES: AT THE LOCAL AND NATIONAL LEVEL

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ABSTRACT
Most changes in quantity of meat demanded by U.S. consumers can be explained by changes in meat prices and in consumers' disposable income. Changes in consumer tastes and preferences are other factors that influence demand. These tend to change more solwly, but appear to be changing more rapidly in recent years due to changes in lifestyles, diet and health concerns and the rapid growth of fast foods and quick food preparation alternatives.

This study analyzes demand for the four major meat groups: beef, pork, chicken and fish. This behavior was analyzed using national demand data relating to various meat prices and annual disposable consumer income. In addition, demand was analyzed for these same meat groups using cross-sectional data from the Nationwide Food Consumption Survey (NFCS). The former method allows estimation of the national average per capita demand, while the latter allows estimation of demand for meat consumed at-home due to differences in socioeconomic variables and area of residence.

1. Introduction

Among food items, red meats, poultry, and fish are the most important foods in most consumers' diet, and are of major importance to the U.S. agricultural economy. Producers of meat animals, packers, processors, and distributors of meat and meat products as well as allied professional interests need a better understanding of the nature of the demand for meats. Important changes in the demand structure of meat is suspected of having occurred in the past decade. For a given level of meat output, prices and revenue are derived from final consumer demand, and most of the impact of changes in the consumer market for meat and meat products is absorbed by the primary producer of meat animals. Meat producer income depends mostly on consumer demand in the short run and long range planning depends heavily on predicting consumer demand. This study is, therefore, concerned with estimates of the demand structure and attempts to provide relevant information about changes in demand structure, consumer behavior concerning meat consumption, and meat demand forecasting.

To analyze meat demand, this study contains two parts: (1) disag-

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gregated demand responses within the meat group to changes in prices and income and (2) cross-sectional analysis which is concerned with consumer expenditure for meat responses to socioeconomic factors.

The purpose of the research was to analyze consumers' demand behavior for the consumption of meat and meat products in the United States and among different socioeconomic groups. Specific objectives are to

(1) Estimate the responses of demand to a change in prices and expenditures;
(2) Develop econometric models relating household expenditure on meat products to the household's socioeconomic and demographic characteristics;
(3) Determine behavioristic parameters(elasticities), quantifying consumer responses to changes in given variables both in the household and in the market place for broad aggregates of meat products; and
(4) Develop estimates that will aid in estimating local and regional meat sales from socioeconomic characteristics of the population.

II. Theoretical Framework

1. Two-Stage Budgeting in Demand Analysis

Separability is a relative concept[1] whose frame of reference is some partition of the complete set of commodities into exhaustive, mutually exclusive subsets (Gorman and Uzawa, 1964). Under the separability the commodities can be partioned into separable groups and goods in each separable group tend to interact closely while goods between separable groups do not. That is, preferences within groups can be described independently of the quantities in other groups. Thus, if food is a group, the consumer can rank different bundles in a well-defined ordering which is independent of his consumption of housing, clothing, entertainment, and everything else outside the group. This implies that we can have a subutility function for each group and that the values of each of these subutilities combine to give total utility (Deaton and Muellbauer, 1980). If separable groups, food, shelter, clothing, are made; q_1 and q_2 are vegetables and meats and q_3 and q_4 are house and paint, and q_5 and q_6 are shirts and shoes. Then, the utility function can be written,

$$(1)\quad U=V(q_1, q_2, q_3, q_4, q_5, q_6)=f[V_f(q_1\ q_2),\ V_s(q_3\ q_4),\ V_c(q_5\ q_6)]$$

where f is some increasing function and V_f, V_s, V_c are the subutility functions associated with food, shelter, and clothing, respectively. The idea

[1] Separability concepts in demand analysis have been introduced by Sono, Strotz, Gorman, Frisch, Houthakker, and Pearce. The implications of these concepts have been shown to be of primary importance to empirical study in demand analysis.

mentioned above implies the utility tree.

The basic idea is appealing and seems highly plausible. Consumers are supposed to allocate total expenditure in two steps; at the first or higher stages, expenditure is optimally allocated among broad commodity groups corresponding to 'branches' of the utility function, while at the second or lower stage, group expenditures are allocated to the individual commodities within each group with no further reference to purchases in the other group or branch. Both of these allocations have to be perfect in the same way that the results of two-stage budgeting must be identical to what would occur if the allocation were made in one step with complete information. Weak separability to be equivalent to Stroz's concept of a utility tree is both a necessary and sufficient condition for the second stage of the two-stage budgeting procedure. If any subset of commodities appears in a separable subutility function, then quantities purchased within the group can always be expressed as a function of group expenditure and prices within the group.

2. Expenditure Function

Households differ in size, age composition, education level and other characteristics and, in general, we would expect households with different expenditure patterns. In order to examine the socioeconomic and demographic effects on demand (expenditure), the use of such variables in the traditional money income specification of household expenditure functions from cross-section data has been increasingly introduced in the literature. Price, Buse and Salathe and others have focused upon expenditure function analysis for broad food aggregates incorporating socioeconomic and demographic factors.

The role that household size and age-sex composition of household membership plays in demand analysis has been discussed by Barten(1974), Blockland(1976), Buse and Salathe(1978), Muellbauer(1974, 1980), and Price(1970). This information aids in the specification and estimations of Engel functions, demand functions, and/or demand systems. The measurement of the family size as a weighted sum of the number of household members was first proposed by Sydenstriker and King (1921). The weights are known as the consumer unit scales which recognize that different household members have different needs. Defining unit scales based on nutritional requirements has appeared attractive for most commodities (Cramer, 1971). However, such nutritional scales are based on normative judgements rather than consumer behavior. As an alternative, Prais and Houthakker (1950) have proposed a behavorial model and estimated consumer unit scales for food. This approach provides a basis for analyzing the impact of selected socio-economic characteristics on food purchases (Barten 1964, Price 1970, Muellbauer 1974, Buse and Salathe 1978). Equivalence scales are index numbers designed to indicate the relative contribution that household members of different ages and sex add to the household's cost of living or to their expenditures on a food group.

The approach employed in this study is to explicitly introduce the factors identified as responsible for expenditure variation in the estimated model (Philips 1974, Prais and Houthakker 1971, and Brown and Deaton 1972).

In many respects the theory provides insufficient guidance in the development and examination of applied relationships. Extensive research (Allen and Bowley 1935, Brown 1954, Prais and Houthakker 1971, Brown and Deaton 1972, and Philips 1974) has noted the fact that other factors, not included in the general theoretical model, impinge significantly on household expenditure decisions. The theory is defined and works in terms of consumer units which are assumed to be identical in all factors except income. Variations in observed expenditures between households in the empirical study can be attributed to different income levels as well as other factors such as family size, education level, ethnic influences, location, and region. Prais and Houthakker (1971) have stated that observed expenditure variation is the result of these factors working in concert on preferences which would prompt the consumer units to react, if in the same circumstances, in substantially the same manner. The *ceteris paribus* condition present in the theoretical development of the Engel relation allows it to focus exclusively on income as the primary agent causing expenditure variations. Some explicit modifications must be made in the empirical analysis to account for the *ceteris paribus* assumption allowing application of the theory in applied demand analysis.

Using cross-section data, which are collected from cross-sectional surveys during a short-time (enough to preclude the possibility of price level variations influencing expenditures), we can accept the fact that prices are (almost) constant to isolate the influence of income. It should be clear that Engel curves are demand functions in which all prices are supposed to be constant since the Engel curve can be derived from a diagram representing an indifference field for two goods.

The household expenditure function, considering the socio-demographic variables, can be specified in this study,

$$(2) \quad E_{ij}=E_{ij}(Y_i, AS_i, SOCIOECON_i) \qquad i=1, \ldots, N$$

where E_{ij} represents the expenditure of the jth commodity spent by the ith household; AS_i represents the age/sex composition of the ith household; and $SOCIOECON_i$ represents other relevant socioeconomic characteristics of the household.

When quantifying the income-expenditure relationship at the disaggregated commodity level, economic researchers have generally used cross-section data with little theoretical guidance for choosing the appropriate functional form. A variety of functional relationships have been suggested to represent Engel curves; but no single form has found general acceptance (Leser 1963, Prais and Houthakker 1955, Salathe 1979). This is an important issue as previous research indicates that the choice of functional form can influence the estimated income (expenditure) elasticities substantially at both the sample means and other points (Prais and Houthakker 1955). Although selecting the appropriate functional relationship is necessary to characterize elasticities properly and to improve statistical fit, the choice should be made on a systematic, theoretically and statistially sound basis.

III. Empirical Considerations

1. Almost Ideal Demand System

Deaton and Muellbauer (1980) derived and estimated the almost ideal demand system (AIDS) for annual British data achieving plausible structural results. Based on their suggestions, developments of their basic model have arisen. For example, Ray (1980, 1982) extended the AIDS to account for family size in cross-sectional analysis of Indian budget data and Blanciforti and Green extended it to account for habits in annual United States data. This model relates the value shares to the logarithms of total expenditure, that is,

(3) $W_i = \alpha_i + \beta_i \log X$

where W_i is the budget share of the ith item and X is the total expenditure. To use this model for time-series analysis, the model should be extended to include the effects of price.

Given the traditional starting point for deriving demand systems in the specification of a functional form which is general enough to act as a second-order approximation to any arbitary direct or indirect utility function or, more rarely, a cost function, Deaton and Muellbauer show a similar methodological approach. This approach starts not from some arbitary preference ordering, but from their utilization of the expenditure functional form of the PIGLOG class of preferences, which allows exact aggregation over consumers: the representation of market demand as if it were the outcome of decisions by a rational representative consumer (Deaton and Muellbauer, 1980). They define the PIGLOG class by

(4) $\log C(u, p) = (1-u)\log\{a(p)\} + u \log\{b(p)\}$

where u lies between 0(subsistence) and 1(bliss) so that the positive linearly homogeneous functions a(p) and b(p) can be regarded as the costs of subsistence and bliss, respectively, and a(p) and b(p) are functions of prices, always gives rise to demands of the form in equation (3). By choosing specific functional forms for log a(p) and log b(p) by the need for flexible functional form.

(5) $a(P)=a_0+\sum\alpha_k \log P_k+1/2\sum\sum\gamma^*_{kj}\log P_k \log P_j$

(6) $b(P)=\log a(P)+\beta_0\Pi P^{\beta}_k\kappa.$

So that the AIDS cost function is written as

(7) $\log C(u, p)=\alpha_0+\sum\alpha_k \log P_k+1/2\sum\sum\gamma^*_{kj}\log P_k \log P_j+u\beta_0\Pi P^{\beta}_k\kappa.$

where α_i and β_i and γ^*_{kj} are parameters. It can easily be checked that, for C(u, p), to be homogeneous in p, provided that

(8) $\sum\alpha_i=1,\ \sum\gamma_{ij}=\sum\gamma_{ji}=\sum\beta_i=0$

If (5) and (6) are substituted into (3), the budget share W_i can be derived from $\partial\log C/\partial p_i=W_i$, which gives, after substitution for u,

(9) $W_i=\alpha_i+\sum\gamma_{ij}\log P_j+\beta_i \log (X/P)$

where P is the price index defined in terms of individual prices by

(10) $\log P=\alpha_0+\sum\alpha_k \log P_k+1/2\sum\sum\gamma_{kj}\log P_k \log P_j$

and the parameters γ are defined by

(11) $\gamma_{ij}=1/2(\gamma^*_{ij}+\gamma^*_{ji})=\gamma_{ji}$

The model defined (9) to (10) is the AIDS (almost ideal demand system) of Deaton and Muellbauer. The model preserves the generality of both Rotterdam and Translog models. Equation (9) can be thought of as a first-order approximation to the general unknown relation between W_i, log X, and the log p's. The theoretical restrictions on (9) apply directly to the parameters.

Adding up requires, for all j,

(12) $\sum\alpha_i=1,\ \sum\gamma_{ij}=0,\ \sum\beta_i=0$

Homogeneity is satisfied if and only if, for all j,

(13) $\sum\gamma_{ij}=0.$

Symmetry is satisfied provided

(14) $\gamma_{ij}=\gamma_{ji}$

These restrictions (12) to (14) are all implied by utility maximization, (12) and (13) follow from (8), which is required for homogeneity of C(u, p), while (14) follows from (11). However, unrestricted estimation of the model (9) will only automatically satisfy the adding-up restriction since $\sum W_i=1$, where the sum of the demand equation adds up to total expenditure.

For the AIDS, the own-price, cross-price, and income elasticities are given by,

(15) $\xi_{ii}=-1+[\gamma_{ii}-\beta_i(\alpha_i+\sum\gamma_{ik}\log P_k)]/w_i,$

(16) $\xi_{ij}=[\gamma_{ij}-\beta_i(\alpha_j+\sum\gamma_{jk}\log P_k)]/w_i,$
(17) $\eta_i=1+\beta_i/w_i$

Dynamic AIDS

Much literature has been developed on demand systems applications, however, few studies permit comparisons of results for the alternative specifications obtained from the same data base. Such comparisons can be useful for a more complete understanding of consumer behavior (Green, Hassen and Johnson). The previous studies indicate that dynamic effects can be incorporated to reflect persistence in consumption patterns by specifying that certain parameters in systems of demand equations derived from static utility maximization depend upon past consumption.

The incorporation of habits into AIDS is desirable, since the AIDS is a theoretically plausible demand system, is non-additive, and with the addition of habits provides a more satisfactory explanation of consumer's behavior. Demand research based on additive utility specifications has consistently indicated that dynamic effects play a major role in U.S. consumption (Pollak and Wales, Taylor and Weiserbs, Manser). In the simple habit formation approach, certain parameters were specified to be a linear function of consumption of a particular commodity in the immediately preceding period, Thus, the static AIDS in (9) was extended by specifying the intercept term α_i, to be a linearly dependent on previous consumption levels:

(18) $\alpha_{it}=C_i+H_iq_{it-1} \qquad i=1,\ldots\ldots,n$

where q_{it-1} is the quantity of the ith commodity consumed in the previous period, C_i is the intercept term and H_i is the habit parameter. The choice, which is arbitary, has the advantage of simplicity (Manser).

The choice or habit versions of the AIDS were obtained by substituting (18) into (9);

(19) $W_{it}=C_i+H_iq_{it-1}+\sum\gamma_{ij}\log P_j+\beta_i\log(X/P)$

The linear "habit" scheme follows the approach of Pollak and Wales (1969) and Manser (1976). While this is admittedly ad hoc, it has frequently been used in empirical demand analysis.

Estimation of AIDS Model

To estimate the static and dynamic AIDS model, (9), (19) respectively an error term, ε_{it}, must be added to each model in (9), (19). The stochastic specification for the disturbance term was assumed to have zero means, contemperaneous variance-covariance matrix Ω, and to be intertemporally uncorrelated. In equation (9), (19), P was replaced by an index developed by Stone (1953). The index is,

(20) $\log P^{*}=\sum W_{k} \log P_{k}$

The Seemingly Unrelated Regression(SUR) method was employed for the estimation.

2. Tobit Analysis

Analysis of cross-sectional data encounters the problem that the error term associated with the dependent variable in the econometric model is censored or truncated, that is, the dependent variable has a number of its values clustered at a limting value, usually zero. In cross sectional data, for some reasons, many households report zero expenditures for some consumption goods. The incidence of zero expenditures in the data will normally increase, for a given commodity, the shorter the period of time covered by the survey. Depending on how narrowly the commodity of interest is defined, a substantial proportion of the households included are likely to have zero expenditures due to the survey. Or possibly, some household expenditure on specific goods for a given time may be zero until the household income exceeds a certain level. A number of articles have been written on the subject of the limited dependent variables (Tobin 1958, Amemiya 1973 1979, McDonald and Moffitt 1978, Olsen 1980, Greene 1981).

To circumvent this problem, two special cases are usually employed in the literature. One is the censored case, referring to the dependent variable having finite probability mass concentrated at some limit point; the other is the truncated case, where the dependent variable has a limited range and follows a continuous density. If zero observations in the sample are eliminated and the analysis carried out on the households reporting positive expenditures (truncated case), the least square estimator will be inconsistent because the residuals do not satisfy the assumption (Maddala 1977, Olsen 1980). The analysis in the above reflects only the change for consuming or purchasing households. Since average food consumption for the total market population represents both the average consumption of all households and the rate of their participation in the markets, the analysis of household food consumption behavior should take both into account.

The OLS model in which the dependent variable is limited yields biased and inconsistent estimates of the population parameters (Greene, 1981). To correct this problem, the Tobit analysis devised by Tobin (1958), in which it is assumed that the dependent variable has a number of its values clustered at a limiting value, usually zero, is employed in this study. The Tobit analysis, corresponding to the censored case, uses all observations, both those at the limit and above it to estimate a model, and it is to be prefered, in general, over alternative techniques that estimate a model only with the observations above the limit. The stochastic model underlying the Tobit model may be expressed by;

$$(21)\quad \begin{aligned} y_t &= X_t\beta+\mu_t \quad && \text{if } X_t\beta+\mu_t>0 \\ &=0 && \text{if } X_t\beta+\mu_t\leq 0 \\ & && t=1, 2, \ldots, N \end{aligned}$$

where y_t is a vector of the household's weekly expenditure on meat products; X_t represents a matrix of the socioeconomic characteristics of the sample households; β is a vector of unknown coefficients; and μ_t is an independently distributed error term.

The procedure Tobin proposes is an elaboration of Probit analysis (Cornfield and Mantel, 1950) in that it addresses the magnitude as well as the probability of responses above some limiting value. The dependent variables behavior can be characterized as that of a limited variable. The limiting variable in the present study behaves as a lower bound on expenditures represented by zero since negative expenditures are not considered. The data, therefore, can be characterized as consisting of two types of observations; those households which, because of the nature and value of the variable making up their underlying preference ordering, are concentrated at the limit (zero response) and those distributed above the limit (positive response). The coefficients in the Tobit model are estimated by the maximum likelihood method. The maximum likelihood estimation procedure assumes the large sample properties of consistency and asymtotic normality of the estimated coefficients so that conventional tests of significance are applicable.

Decomposition

The coefficients obtained from using Tobit can be decomposed to determine both changes in the probability of making meat purchases and changes in the value meat purchases. In the stochasitc model (21) the expected value of y is

$$(22)\quad E(y)=X\beta F(z)+\sigma f(z)$$

and the expected value of y for observations above the limit, here called y*, is simply $X\beta$ plus the expected value of the truncated normal error term

$$(23)\quad \begin{aligned} E(y^*) &= E(y\mid y>0) \\ &= E(y\mid \mu>-X\beta) \\ &= X\beta+\sigma f(z)/F(z) \end{aligned}$$

where $Z = X\beta/\sigma$ is the unit normal index, and f(z), F(z) are the standard normal density function and the cumulative normal distribution function. The equation(23) implies the conditional expected value of expenditure, E(y*) for the meat purchasing households only. The conditional expected value is always greater than or equal to the unconditional expected value because of the relationship of

(24) $E(y)=F(z)E(y^*)$

The decomposition of E(y) can be derived by considering the effect of a change in the *i*th variable of X on y;

(25) $\partial Ey/\partial X_i=F(z)(\partial E(y^*)/\partial X_i)+E(y^*)(\partial F(z)/\partial X_i)$

which represents the total change in y can be disaggregated into the change in y above the limit, weighted by the probability of purchasing meats, plus the change in the probability of being above the limit, weighted by E(y*). After obtaining the Tobit coefficients of β and σ, each term in the equation(25) can be evaluated at some value of $X\beta$. The value of E(y*) can be calculated from equation(23), and the value of F(z) can be obtained directly from statistical tables. The two partial derivatives are also calculable:

(26) $\partial F(z)/\partial X_i=f(z)\beta_i/\sigma$

(27) $\partial E(y^*)/\partial X_i=\beta_i[1-zf(z)/F(z)-f(z)^2/F(z)^2]$

where $F'(z)=f(z)$ and $f'(z)=-zf(z)$ for a unit normal density. It should be noted from equation(27) that the effect of a change in X_i on y* is not equal to β_i. This is true only when X equals infinity, in which case $F(z)=1$ and $f(z)=0$. This will of course not hold at the mean of the sample or for any individual observations. It should be noted that when equations(26) and (27) are substituted into equation(25), the total effect $\partial E(y)/\partial X_i$ is equal to simply $F(z)\beta_i$. Furthermore, by dividing both sides of equation (25) by $F(z)\beta_i$, the fraction of the total effect above the limit, $\partial Ey^*/\partial X_i$ is just $[1-zf(z)/F(z)-f(z)^2/F(z)^2]$. This is the fraction by which the β_i coefficients must be adjusted to obtain correct regression effects for observations above the limit. Briefly summarizing, the decomposition of the change in E(y) with respect to any regressor is obtained in equation(25). The right hand side of equation(25) represents the change in E(y) for those above the limit, weighted by the probability of purchasing meat items, plus the change in the probability of being above the limit, weighted by E(y*).

After obtaining the Tobit coeffieients, adjustments should be made in computing the marginal effect of a change in the *i*th variable of X on y and, hence, the elasticity of y with respect to X_i. The computations differ from the procedure used with OLS regression coefficients because the unconditional expected value E(y) in equation(21) is no longer equal to $X\beta$. Thus, the elasticity of the *i*th variable of X with respect to y is evaluated as

(28) $\eta_i=[\partial E(y^*)/\partial I]\times[I/E(y^*)]+[\partial F(z)/\partial I]\times[I/F(z)]$

where η_i is the elasticity of the *i*th variable of X with respect to y. E(y*) is the conditional expected value for y (the expected value of y for observations greater than zero); and F(z) is the cumulative normal distribution function (the probability of y being greater than zero), with $z=X\beta/\sigma$. Note that the elasticity, η_i, has two components. The first component is referred as the conditional elasticity associated with actual consumption. The second component of equation(28) represents the elasticity of change in the probability of being a consuming household associated with a change in the *i*th independent variable (McDonald and Moffit). If the cross-sectional data set is a representative sample of the entire population, e.g., all households, then the second component can be interpreted as the market participation rate. The elasticity of the probability of making meat purchases, $\eta_{F(Z)}$, and the elasticity of the conditional expected value of expenditure, $\eta_{E(y^*)}$, sum to equal the elasticity of unconditional expected value of expenditure, $\eta_{E(y)}$. These elasticities, calculated at the sample means, give insight as to how changes in household income affect the number of households likely to purchase meat items as well as the magnitude of meat item purchases during a one-week period.

Average expenditures for the total population are a combination of both average expenditures of those households purchasing and participation rates. Elasticities derived from Tobit analysis, therefore, are a combination of the two responses to income; (1) the response of expenditures by households actually purchasing the food and (2) the response due to entry-exit of consumers (or changes in the frequency of use stated in terms of the proportion of households using the food). Use of the Tobit method presents the formal relationship between these two types of responses.

Model Development for Tobit Analysis

Empirical investigations of household expenditure behavior, such as Prais and Houthakker, Burk, Brown and Deaton, and Ferber have dealt with numerous determinants of food consumption. This research hypothesizes the following socioeconomic characteristics to influence household expenditure on meats: (1) household income, (2) age-sex composition represented by variables of Buse and Salathe's(1978) adult equivalent scale, (3) education level of the household head, (4) household employment status, (5) race of the household head, (6) population density(urbanization and (7) season.

The general model of equation was fully specified to include the actual variables discussed in the previous section. The general statistical model for the *i*th household was given by,

$$(29)\quad E_{ij}=F(Y_i, P_i, Q_i, R_i, S_i, T_i, U_i, V_i, ED_i, SUB_i, NONM_i, SUMM_i, FALL_i, WIN_i, BLK_i, BME_i, BFE_i, BBU_i, OFE_i, OFU_i, OME_i, OMU_i)$$

where the included variables are as follows:

Y_i; total annual income after tax of household i
P_i, Q_i, R_i, S_i, T_i, U_i, and V_i; variables of Buse and Salathe's adult equivalent scale
ED_i; education level of household head
SUB_i and $NONM_i$; 0—1 dummy variables for urbanization
$SUMM_i$, $FALL_i$ and WIN_i; 0—1 dummy variables for season
BLK_i; 0—1 dummy variable for race
BME_i, BFE_i, BBU_i, OFE_i, OFU_i, OME_i, and OMU_i; 0—1 dummy variables for the existence and employment status of household head.

IV. Empirical Results: AIDS Analysis

Comparisons of the empirical results for the static and dynamic almost ideal demand systems for meats are reported in the following section. Such comparisons are useful for a more complete understanding of consumer behavior as well as for evaluating the demand system models.

The empirical estimates for the static and dynamic almost ideal demand system for the four meat groups(i.e., beef, pork, chicken and fish) are presented in Tables 1 and 2. Both models indicated a system R-square of 0.90.

Tables 3 and 4 present the uncompensated and compensated price elasticities. All the own-price elasticities were negative for the respective coomodities except fish, and income elasticities were all positive, in conjunction with theoretical considerations. Here, the elasticities were computed at the same mean values. Some of the uncompensated cross-price elasticity estimates were negative, but the compensated price elasticities were positive, indicating net subsititutes. In detail, all the uncompensated cross-price elasticity estimates in the beef demand model were negative, however, the compensated cross-price elasticities in the red meats were all positive, indicating a net substitute relationship. In the pork demand model the uncompensated cross-price elasticity of pork with respect to the prices of fish were negative; however, its compensated cross-price elasticities showed a net substitute. The fish demand model showed that the uncompensated and compensated cross-price elasticity of fish with respect to the price of beef and chicken was negative, indicating gross and net complements. Since there are no theoretical bases for this complementary relationship for fish, it must be assumed to be only a statistical association and not actually complements. Based on these results, the own-price elasticities of each meat item in the static model were found to be higher relative to the dynamic model.

Beef was estimated as a relative luxury, for the static and dynamic model while pork, chicken and fish indicated necessities by the U.S. population model. In the AIDS, negative β_i's imply necessities while positive β_i's indicate luxury—since the income elasticity for the AIDS

TABLE 1 STRUCTURAL PARAMETER ESTIMATES OF ALMOST IDEAL DEMAND SYSTEM OF DEMAND FOR MEATS

Meat Item	Estimated Coefficients[a]					
	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}
Beef	−0.6289	0.2023	0.0235	−0.0039	0.0118	−0.0314
	(−5.31)[b]	(8.91)	(1.91)	(−0.41)	(1.09)	(−5.04)
Pork	0.819	−0.0894	−0.0039	−0.0284	0.0454	−0.0130
	(6.49)	(−3.88)	(−0.41)	(−2.27)	(3.95)	(−2.25)
Chicken	0.4654	−0.0514	0.0119	0.0454	−0.0217	−0.0355
	(3.37)	(−1.94)	(1.10)	(3.95)	(−1.44)	(−5.55)
Fish	0.3816	−0.0614	−0.0314	−0.0130	−0.0355	0.0799
	(6.67)	(−5.59)	(−5.04)	(−2.25)	(−5.55)	(14.60)

[a] Coefficients are based on United States data for the years 1960 to 1980.
[b] Values in parenthesis are asymptotic t-statistics.
γ_{ij} represents the change in the *i*th budget share for a percent change in the *j*th price with real expenditure constant.
β_i represents the change in the *i*th budget share with respect to a change in real income with prices held constant.

TABLE 2 STRUCTURAL PARAMETER ESTIMATES OF DYNAMIC ALMOST IDEAL DEMAND SYSTEM OF DEMAND FOR MEATS

Meat Item	Estimated Coefficients[a]						
	C_i	H_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}
Beef	−0.1353	0.5460	0.0994	0.0463	0.0017	−0.0182	−0.0298
	(−0.60)[b]	(1.39)	(2.09)	(3.28)	(0.14)	(−1.48)	(−4.49)
Pork	0.9287	−0.0225	−0.1174	0.0017	−0.0187	0.0284	−0.0114
	(7.51)	(−0.07)	(−4.97)	(0.14)	(−1.44)	(2.55)	(−1.84)
Chicken	0.8199	1.8832	−0.1323	−0.0182	0.0284	0.0214	−0.0317
	(5.61)	(3.92)	(−4.43)	(−1.49)	(2.54)	(1.25)	(−4.36)
Fish	0.3897	2.0680	−0.0674	−0.0298	−0.0114	−0.0317	0.0729
	(6.19)	(1.93)	(−5.55)	(−4.49)	(−1.83)	(−4.36)	(10.1)

[a] Coefficients are based on United States data for the years 1960 to 1980.
[b] Values in parenthesis are asymptotic t-statistics.
γ_{ij} represents the change in the *i*th budget share for a percent change in the *j*th price with real expenditure held constant.
β_i represents the change in the *i*th budget share with respect to a change in real income with prices held constant.
H_i is a habit parameter.

is $\eta_i=1+\beta_i/W_i$. Thus, since W_i (budget share of commodity i) is always positive, a negative β_i implies that $\eta_i\leq 1$ while a positive β_i implies that $\eta_i>1$.

Note that these elasticities are with respect to total meat expenditures and not total food or total consumer expenditures. As Bieri and de Janvry (1972) and Barten (1977) suggested, a rough estimate of the total elasticity of demand can be obtained. To obtain unconditional or total elasticities

TABLE 3 PRICE AND INCOME PARTIAL ELASTICITIES OF STATIC AIDS MODELS OF DEMAND FOR MEATS IN 1960–80.

	Uncompensated Price				Expenditure	Compensated Price[a]			
Meats	Beef	Pork	Chicken	Fish	Meats	Beef	Pork	Chicken	Fish
Beef	−1.147	−0.156	−0.064	−0.105	1.473	−0.517	0.302	0.222	−0.006
Pork	0.110	−1.001	0.202	−0.022	0.713	0.415	−0.779	0.340	0.025
Chicken	0.175	0.317	−1.060	−0.165	0.735	0.489	0.545	−0.918	−0.116
Fish	−0.077	0.091	−0.351	−0.251	0.086	−0.040	0.118	−0.335	−0.256

[a] Compensated price elasticity: $S_{ij}=W_j\xi_{iY}+\xi_{ij}$

Note: Elasticity formulas are calculated at mean (1960–80) values of expenditure share; Mean value of expenditure share— 0.42766 for beef, 0.31121 for pork, 0.19393 for chicken, and 0.06718 for fish.

TABLE 4 PRICE AND INCOME PARTIAL ELASTICITIES OF DYNAMIC AIDS MODELS OF DEMAND FOR MEATS IN 1960–80.

	Uncompensated Price				Expenditure	Compensated Price[a]			
Meats	Beef	Pork	Chicken	Fish	Meats	Beef	Pork	Chicken	Fish
Beef	−0.991	−0.068	−0.088	−0.085	1.232	−0.464	0.315	0.151	−0.002
Pork	0.167	−0.943	0.164	−0.011	0.622	0.433	−0.749	0.285	0.031
Chicken	0.198	0.359	−0.757	−0.118	0.318	0.334	0.458	−0.695	−0.096
Fish	−0.015	0.143	−0.277	−0.153	0.003	−0.014	0.144	−0.276	−0.153

[a] Compensated price elasticity: $S_{ij}=W_j\xi_{iY}+\xi_{ij}$

Note: Elasticity formulas are calculated at mean (1960–80) values of expenditure share; Mean value of expenditure share— 0.42766 for beef, 0.31121 for pork, chicken 0.19393, 0.19393 for fish.

of the demand for meats, a practical approximation suggested by Wohlgenant was used to take into account the effects of changes in meat prices on meat expenditures and the effect of total expenditures on meat expenditures. These elasticities can be systehsized with the following formulas:

$$\xi_{ij}=\xi_i^G(1+\xi_{GG})W'_j+\xi_{ij}^G$$
$$\xi_i=\xi_i^G\xi_G \qquad \text{for } i,j\in G$$

where ξ_{ij}^G and ξ_i^G are partial price and expenditure elasticities for the Gth group (i.e., meats), ξ_{GG} is the own price elasticity of demand for meats, W_j is the expenditure share of jth meat commodity relative to meat expenditures, and ξ_G is the expenditure elasticity of meats with respect to total consumer expenditures. Using the information from Table 3 with the above formulas, the uncompensated total elasticities can be obtained as shown in Table 5. The uncompensated total elasticities can be taken as approximately equal to the compensated total elasticities because no individual meat commodity accounts for a significant share of total expenditures so that the income effects will be negligible.

TABLE 5 PRICE AND INCOME TOTAL ELASTICITIES OF DEMAND FOR MEATS IN 1960–80

	Uncompensated Price[a]				Expenditure[b]
Meats	Beef	Pork	Chicken	Fish	Total
Beef	−0.789	0.104	0.098	0.049	0.485
Pork	0.283	−0.875	0.281	0.005	0.235
Chicken	0.354	0.447	−0.979	−0.137	0.242
Fish	−0.056	0.106	−0.345	−0.248	0.028

[a] The total own-price elasticity of demand for meats was −0.432.

[b] The total expenditure elasticity of meats was 0.329.

Note: Elasticity formulas are calculated at mean (1960–80) values of expenditure share; Mean values of expenditure— 0.42766 for beef, 0.31121 for pork, 0.19393 for chicken, and 0.06718 for fish.

Source: Calculated from Table 8 using the own-price and expenditure elasticities obtained from an unpublished study by Wohlgenant using annual time series data over the period 1960–79.

Finally, the habit parameter in the dynamic model should be interpreted. If each meat's dynamic AIDS is taken as the maintained hypothesis, then the test is,

$$H_0: H_i = 0$$
$$H_a: \text{Not } H_0$$

By observing the asymptotic t-values of the H_i parameters of each meat model, chicken and fish were found to have significant t-values; that is, the null hypothesis is rejected. This indicates a statistically significant habit effect for chicken and fish. Thus, habits in consumption patterns for chicken and fish were shown to be strongly present in the AIDS. Wohlgenant and Han (1982) presented estimates of the monthly demand for meats and examined the role of inventories and habits on the estimated short-run demand elasticities. Their analysis showed the role of time on measured demand elasticities of meats. For pork, the results indicated inventory adjustment dominates consumption habits, implying demand is more elastic when monthly data are used. The results for chicken were consistent with the flow adjustment model, suggesting the predominance of consumption habits and less demand responsiveness in the short run.

The results of this analysis of aggregate demand and the review of previous work on the subject illustrates the variability in results from different functional forms, different data bases and different data transformations. Although there are conflicting results there is evidence to support the hypothesis that more expensive products have higher price and income elasticities. Own price elasticities of meat are typically less than an absolute value and cross price elasticities are small. This implies observed data showing that for a given change in quantity marketed there is a larger percentage change in price.

Another hypothesis as income rises is the income elasticities for meat will decline. There is some evidence presented in this section to indicate that the more recent years have lower income elasticities, but the results are not conclusive. In the next section, expenditure and consumption at-home data provide some additional evidence of this change.

V. Empirical Results: Household Purchase Behavior

This chapter presents the measured effects of socioeconomic and demographic characteristics on the retail demand for meat by households. The meat products investigated in this study were beef, pork, chicken, and and fish. Each meat product was estimated in four regions. A total of 16 equations were estimated suing 1977–78 NHFS data. For the estimation, the Tobit procedure was used. This procedure allows one to decompose an average household's demand responses resulting from changes in income and other demand determinants into component parts that provide useful information: (1) changes in the number of actual users of meat products in the market and (2) changes in expenditures by those already using the product. This decomposition of household demand responses is important for developing a marketing strategy and analyzing the potential for market growth.

The empirical results of the Tobit analysis on each meat are presented in Tables 6, 7, 8, and 9. Each table allows comparison of the variable effects included in equation(29) across the regions. The estimated equations generally provided a reasonably good fit to the data with most of the individual coefficients being statistically significant. The significance of the set of coefficients for each model was checked by use of the -2log likelihood ratio (Tobin). The models were statistically significant at the 1 percent probability level. Table 10 presents two components used in the McDoanld and Moffitt decompositions. The probability of non-zero consumption as evaluated by the cumulative distribution F(z), generally, reflects the ordering of ML Tobit E(Y) and E(Y*). Thus, higher expected consumption reflects a higher probability of non-zero consumption. The fraction of mean total response due to conditional response (i.e., due to the response of those actually consuming households) follows a similar pattern.

Thus, results of this study suggest that as household income increases, household consumption of beef and fish may be expected to increase, however, consumption of pork and chicken may be expected to decrease in the diet. Income elasticities evaluated at the means are presented in Table 11. A positive income elasticity indicates that an increase in household income is associated with an increase in household purchases for the item in question. A negative income elasticity indicates that household purchases decline as household income increases. The larger the magnitude of the income elasticity, the more responsive—either negatively or positively—household purchases are to changes in household income.

TABLE 6 COMPARISON OF MLE TOBIT COEFFICIENTS FOR HOUSEHOLD EXPENDITURES ON BEEF AMONG THE REGIONS OF THE 1977–78 N.F.C.S.

Variable[a]	North East	North Central	South	West
		dollars per week		
CONSTANT	2.5810	0.93209	0.86046	3.9250
	(0.93)[b]	(1.42)	(1.57)	(5.41)
ATIN	0.000024	0.0001058	0.000096583	0.000031699
	(1.26)	(7.15)	(6.52)	(1.98)
P_t	2.2286	2.0358	1.5969	1.4327
	(10.86)	(10.37)	(9.15)	(6.11)
Q_t	2.021	1.345	1.535	1.139
	(9.74)	(6.61)	(8.41)	(4.95)
R_t	1.422	0.469	0.731	−0.560
	(4.25)	(1.50)	(0.26)	(−1.69)
S_t	−0.0625	0.0071848	0.16219	0.37223
	(−0.52)	(0.06)	(1.57)	(2.87)
T_t	−0.19330	0.13225	−0.078905	0.29611
	(−1.59)	(1.13)	(−0.77)	(2.35)
U_t	1.324	0.77121	1.0330	1.2137
	(2.12)	(1.28)	(2.16)	(1.87)
V_t	0.96625	1.2324	0.63683	0.428
	(2.05)	(2.54)	(1.66)	(0.73)
ED_t	−0.33371	−0.21665	0.26108	−0.31143
	(−3.92)	(−2.49)	(3.81)	(−3.37)
SUB_t	−0.56229	0.68731	−0.45369	0.09978
	(−1.96)	(2.35)	(−1.69)	(0.37)
$NONM_t$	−1.6354	0.25989	−0.50399	−0.69741
	(5.07)	(0.91)	(−2.06)	(−2.01)
$SUMM_t$	0.46695	0.24595	−0.26863	−0.51656
	(1.38)	(0.79)	(−0.99)	(1.50)
$FALL_t$	0.31606	−0.14179	−0.23604	−0.13221
	(0.97)	(−0.48)	(−0.90)	(0.40)
WIN_t	0.26144	0.12407	−0.41947	0.0049769
	(0.79)	(0.41)	(−1.60)	(0.02)
BLK_t	0.76151	1.1673	−0.23896	2.8625
	(1.75)	(3.59)	(−0.93)	(5.22)
BME	0.90509	−0.18248	0.035834	1.3060
	(2.78)	(−0.62)	(0.27)	(3.81)
BFE	0.39851	0.31226	−0.45394	1.0011
	(0.63)	(0.55)	(0.55)	(1.52)
BBU	0.54004	0.75994	−0.31840	0.10172
	(1.06)	(1.67)	(−0.81)	(0.19)
OFE	−0.27939	−0.88038	−0.69124	−1.1395
	(−0.57)	(−1.86)	(−1.70)	(−2.26)
OFU	0.28168	−0.73862	−0.72174	−1.2694
	(0.56)	(−1.39)	(−1.73)	(−2.17)
OME	−0.50400	−2.1680	−1.8817	−1.0069
	(−0.78)	(−3.48)	(−3.61)	(−1.71)
OMU	−1.06170	−0.9164	−1.9201	−1.5360
	(−1.34)	(−1.15)	(−3.08)	(−1.88)
Summary Statistics				
Chi-Squared[c]	736.11	791.64	906.53	423.17
Sigma	5.3637	5.0360	5.0912	4.7363

[a] Variables are defined on page 29 to 30.

[b] Asymptotic t-ratio in parenthesis.

[c] 2[likelihood function—restricted(intercept) likelihood function] is distributed as X^2(r), r denoting the number of restrictions. Degrees of freedom are 22 in each model.

TABLE 7 COMPARISON OF MLE TOBIT COEFFICIENTS FOR HOUSEHOLD EXPENDITURES ON PORK AMONG THE REGIONS OF THE 1977–78 N.F.C.S.

Variable[a]	North East	North Central	South	West
		dollars per week		
CONSTANT	1.5340 (2.99)[b]	0.45095 (0.88)	2.6626 (6.55)	2.0385 (4.08)
ATIN	−0.000097014 (−6.27)	−0.0000030817 (−0.26)	−0.000052545 (−4.62)	−0.00006705 (−4.95)
P_t	1.9428 (12.22)	1.7666 (11.56)	1.4285 (11.06)	1.18955 (6.56)
Q_t	1.5906 (9.92)	1.3735 (8.67)	0.98788 (7.32)	1.3685 (7.69)
R_t	1.0932 (4.22)	0.83476 (3.42)	0.55914 (2.70)	−0.020741 (−0.08)
S_t	0.0035457 (0.04)	−0.13323 (−1.45)	−0.012476 (−0.16)	0.224543 (2.23)
T_t	−0.064003 (−0.66)	−0.11580 (−1.27)	−0.023311 (−0.31)	0.10038 (1.03)
U_t	1.6887 (3.46)	2.1145 (4.51)	1.1742 (3.33)	0.93389 (1.85)
V_t	−0.21709 (−0.59)	0.77410 (2.05)	0.40815 (1.44)	1.17131 (2.56)
ED_t	−0.44358 (−6.66)	−0.31794 (−4.67)	−0.22632 (−4.44)	−0.3297 (−4.55)
SUB_t	−0.21479 (−0.96)	0.19737 (0.86)	−0.026254 (−0.13)	−0.10756 (−0.51)
$NONM_t$	−0.66437 (−2.64)	−0.027222 (−0.12)	−0.46244 (−2.56)	−0.011605 (0.04)
$SUMM_t$	0.1730 (0.65)	−0.072555 (−0.30)	−0.24965 (−1.25)	−0.44946 (−1.68)
$FALL_t$	−0.53239 (−2.09)	−0.28921 (−1.25)	0.24907 (0.13)	−0.49268 (−1.91)
WIN_t	1.18380 (4.59)	−0.0084233 (−0.04)	−0.22263 (−1.15)	−0.20697 (−0.08)
BLK_t	1.2141 (3.63)	2.0470 (5.88)	0.86951 (4.61)	3.0541 (7.26)
BME	0.50170 (1.98)	0.37259 (1.61)	−0.16458 (−0.81)	−0.357 (−1.33)
BFE	−0.40652 (−0.82)	0.28308 (0.63)	−0.98411 (−2.38)	0.23811 (0.46)
BBU	0.25492 (0.64)	0.77887 (2.19)	−0.42824 (−1.46)	−0.4868 (−1.21)
OFE	0.16373 (0.42)	0.65931 (1.78)	−0.97236 (−3.21)	−1.0434 (−2.64)
OFU	1.51490 (3.90)	1.0330 (2.51)	−0.33311 (−1.08)	−0.54709 (−1.21)
OME	0.033182 (0.06)	0.18922 (0.39)	−0.34920 (−3.48)	−0.13809 (−0.29)
OMU	−0.57932 (−0.93)	−0.12465 (−0.20)	−1.56450 (−3.44)	0.52987 (0.84)
Summary Statistics				
Chi-Squared[c]	363.30	365.77	380.24	108.52
Sigma	4.1043	3.9050	3.7647	3.6172

[a] Variables are defined on page 29 to 30.
[b] Asymptotic t-ratio in parenthesis.
[c] 2[likelihood function—restricted(intercept) likelihood function] is distributed as X^2(r), r denoting the number of restrictions. Degrees of freedom are 22 in each model.

TABLE 8 COMPARISON OF MLE TOBIT COEFFICIENT FOR HOUSEHOLD EXPENDITURES ON CHICKEN AMONG THE REGIONS OF THE 1977–78 N.F.C.S.

Variable[a]	North East	North Central	South	West
		dollars per week		
CONSTANT	1.2704 (5.30)[b]	−0.95480 (−2.63)	0.37959 (2.20)	1.5449 (5.86)
ATIN	−0.00003718 (−5.19)	−0.000012743 (1.57)	−0.000056327 (−10.62)	−0.00005858 (−8.18)
P_t	0.69421 (9.28)	0.62903 (5.91)	0.71994 (13.14)	0.50988 (6.04)
Q_t	0.63802 (8.46)	0.54655 (4.96)	0.61178 (10.72)	0.47961 (5.75)
R_t	0.23882 (1.96)	0.67822 (3.98)	0.094907 (1.08)	0.31301 (2.64)
S_t	0.021245 (0.48)	−0.12471 (−1.94)	0.037858 (1.17)	−0.521413 (−1.12)
T_t	0.095869 (2.10)	−0.13798 (−2.16)	0.090364 (2.81)	0.0040361 (0.09)
U_t	0.50647 (2.23)	0.44951 (1.34)	0.71812 (4.82)	0.61256 (2.64)
V_t	0.14215 (0.83)	0.67628 (2.54)	0.78819 (6.63)	−0.26644 (−1.27)
ED_t	−0.10338 (−3.33)	−0.043359 (−0.89)	−0.019930 (−0.92)	−0.19368 (−5.76)
SUB_t	−1.0261 (−9.85)	0.32932 (−2.04)	−0.32708 (−3.90)	−0.086996 (−0.89)
$NONM_t$	−1.38250 (−11.74)	−0.46495 (−2.94)	−0.32130 (−4.21)	−0.70102 (−5.57)
$SUMM_t$	0.33111 (2.69)	−0.22296 (−1.30)	0.11827 (1.39)	0.42097 (0.34)
$FALL_t$	−0.029706 (−0.25)	−0.14029 (−0.85)	−0.011282 (−0.14)	0.15341 (1.28)
WIN_t	0.18564 (1.54)	−0.1389 (−0.83)	−0.0079222 (−0.09)	0.017154 (1.41)
BLK_t	1.4830 (9.53)	1.3859 (5.75)	0.93731 (11.84)	1.4081 (7.24)
BME	0.43171 (3.62)	0.076389 (0.47)	0.10141 (1.17)	0.028480 (2.286)
BFE	0.42580 (1.84)	0.13523 (0.43)	−0.049841 (−0.29)	0.93127 (3.92)
BBU	0.92149 (4.95)	0.55432 (2.20)	−0.038809 (0.31)	0.059711 (3.22)
OFE	0.16453 (0.91)	−0.11881 (−0.45)	0.32114 (2.51)	0.05432 (0.29)
OFU	0.83509 (4.59)	0.34264 (1.18)	0.28478 (2.17)	0.70710 (3.37)
OME	−0.41801 (−1.72)	−0.72306 (−1.99)	−0.087354 (−0.53)	−0.17650 (−0.81)
OMU	−0.43115 (−1.49)	−0.35261 (−0.77)	0.52074 (0.27)	0.22682 (0.78)
Summary Statistics				
Chi-Squared[c]	358.80	268.61	373.49	131.33
Sigma	1.9328	2.6139	1.5887	1.6759

[a] Variables are defined on page 29 to 30.
[b] Asymptotic t-ratio in parenthesis.
[c] 2[likelihood function—restricted(intercept) likelihood function] is distributed as $X^2(r)$; r denoting the number of restrictions. Degrees of freedom is 22 in each model.

TABLE 9 COMPARISON OF MLE TOBIT COEFFICIENTS FOR HOUSEHOLD EXPENDITURES ON FISH AMONG THE REGIONS OF THE 1977–78 N.F.C.S.

Variable[a]	North East	North Central	South	West
		dollars per week		
CONSTANT	0.81312	0.03668	0.37914	−0.052375
	(2.06)[b]	(0.09)	(0.77)	(−0.11)
ATIN	0.000085	0.0001241	0.000212	0.0000877
	(6.87)	(9.99)	(11.82)	(6.74)
P_i	1.17580	0.56303	0.92369	0.35099
	(9.60)	(4.57)	(6.02)	(2.31)
Q_i	0.60160	0.50564	0.68430	0.63694
	(4.86)	(3.95)	(4.26)	(4.28)
R_i	0.090208	0.39089	−0.24835	0.59282
	(0.44)	(2.00)	(−0.99)	(2.79)
S_i	−0.19603	−0.3048	0.19319	−0.120243
	(−2.67)	(−0.41)	(2.11)	(−1.43)
T_i	0.05110	−0.09999	0.10859	−0.18550
	(0.67)	(−1.37)	(1.18)	(−2.29)
U_i	1.54690	1.21440	1.64410	0.14271
	(4.17)	(3.29)	(3.98)	(0.34)
V_i	0.75380	0.19635	0.57252	1.54304
	(2.69)	(0.66)	(1.58)	(4.14)
ED_i	−0.052427	0.15316	0.07072	0.0099457
	(−1.02)	(2.81)	(1.15)	(1.65)
SUB_i	−1.5311	−0.31812	−0.077365	0.0060367
	(−8.89)	(−1.74)	(−0.23)	(0.34)
$NONM_i$	−1.4442	−0.26377	−0.73841	−0.49999
	(−7.48)	(−1.49)	(−3.43)	(−2.22)
$SUMM_i$	0.20788	−0.70321	−0.11379	0.37098
	(1.02)	(−3.68)	(−0.48)	(1.66)
$FALL_i$	−0.055784	−1.1540	−0.58809	0.34845
	(−0.28)	(−6.18)	(−2.55)	(1.62)
WIN_i	0.030445	−0.77125	−0.96565	0.53134
	(0.15)	(−4.09)	(−4.15)	(2.44)
BLK_i	0.92557	2.4378	1.3996	1.1525
	(3.65)	(9.18)	(6.36)	(3.33)
BME	0.37721	0.42678	−0.32949	−0.13721
	(1.89)	(2.25)	(−1.30)	(−0.61)
BFE	0.21076	−0.010765	0.31009	0.12090
	(0.55)	(−0.03)	(0.63)	(0.28)
BBU	0.26970	0.83174	0.33387	−0.35167
	(0.88)	(2.92)	(0.94)	(−1.05)
OFE	0.60316	0.32655	0.11114	−0.54201
	(2.03)	(1.09)	(0.30)	(−1.64)
OFU	0.61741	0.97234	0.26640	−0.76682
	(2.06)	(2.96)	(0.71)	(−2.03)
OME	−0.59486	−0.40279	0.04409	−0.13176
	(−1.49)	(−1.00)	(0.09)	(−0.34)
OMU	−1.02190	−0.30801	0.076115	0.61154
	(−2.13)	(−0.63)	(0.14)	(1.18)
Summary Statistics				
Chi-Squared[c]	112.81	75.37	69.91	45.428
Sigma	3.068	2.9138	4.1529	2.8964

[a] Variables are defined on pages 29 to 30.
[b] Asymptotic t-ratio in parenthesis.
[c] 2[likelihood function-restricted(intercept) likelihood function] is distributed as $\chi^2(r)$, r denoting the number of restrictions. Degrees of freedom are 22 in each model.

TABLE 10 ML TOBIT EXPECTED EXPENDITURE AND COMPONENTS OF THE MCDONALD AND MOFFITT DECOMPOSITIONS

Meats by Region	ML Tobit Expected Conditional Expenditure E(Y*)	ML Tobit Expected Expenditure E(Y)	Fraction of Sample above Limit F(Z)	Fraction of Mean Total Response Due to Conditional Response $(1\text{-}zf(z)/F(z)\text{-}f(z)^2/F(z)^2)$
Beef:				
North East	7.7847	6.9673	0.8949	0.7024
North Central	6.9993	6.1334	0.8762	0.6758
South	6.6196	5.6010	0.8461	0.6355
West	6.7909	6.0365	0.8889	0.6945
Pork:				
North East	4.9702	4.0214	0.8091	0.5926
North Central	4.7942	3.9151	0.8166	0.6009
South	4.7320	3.9285	0.8302	0.6158
West	4.0661	3.1103	0.7649	0.5483
Chicken:				
North East	2.4970	2.1049	0.8429	0.6327
North Central	2.2187	1.2281	0.5535	0.3937
South	2.0368	1.7093	0.8392	0.6270
West	1.9600	1.5467	0.7891	0.5718
Fish:				
North East	2.8530	1.7940	0.6289	0.4412
North Central	2.4284	1.3060	0.5378	0.3845
South	3.3687	1.7329	0.5144	0.3713
West	2.5936	1.5519	0.5983	0.4212

Note: Predicted expenditures are measured in dollars per household per week.

As Table 11 shows, total expenditure elasticities were decomposed into two components: the elasticity of the probability of making meat purchases (market entry response), and the elasticity of the conditional expected values (expenditure level response). These elasticities provide further insights into how changes in household income affect the number of households likely to purchase meat as well as the magnitude of meat purchases during the survey week. For example, a 10-percent increase in household income will increase consumption of beef about 0.19 percent in the North Central region. Of this total adjustment, approximately 0.13 percent came from an increase in the amount consumed (expenditure level response) and the other 0.06 percent resulted from the increase in the probability of consuming beef (market entry response). Of special interest was the estimated negative effect of household income on pork and chicken and the positive effect on beef and fish. This result indicates higher income households are more selective and, hence, substitute the more higher quality meat in their diet.

Isnpection of the component elasticities indicates that the conditional elasticity or quantity response is greater than the probability elasti-

TABLE 11 TOTAL' CONDITIONAL AND PROBABILITC INCOME ELASTICITY OF HOUSEHOLD AT-HOME MEAT EXPENDITURE IN 1977–78

Meat item	Total Elasticity	Conditional Elasticity	Probability Elasticity
Beef:			
North East	0.037	0.026	0.011
North Central	0.185***	0.125	0.060
South	0.144***	0.091	0.053
West	0.057***	0.040	0.017
Pork:			
North East	−0.234***	−0.139	−0.095
North Central	−0.008	−0.005	−0.003
South	−0.109***	−0.067	−0.042
West	−0.203***	−0.111	−0.092
Chicken:			
North East	−0.178***	−0.113	−0.065
North Central	0.070	0.028	0.042
South	−0.072	−0.171	−0.101
West	−0.368***	−0.210	−0.157
Fish:			
North East	0.355***	0.157	0.198
North Central	0.624***	0.240	0.384
South	0.621***	0.231	0.390
West	0.416***	0.175	0.241

[a] Elasticities are evaluated at the means.
Asteriks * indicate *significant at $a = 0.1$,
** significant at $a = 0.05$, and *** significant at $a = 0.01$.
Source: Estimated from 1977–78 NFCS data.

city or market participation response in beef, pork and chicken (except for chicken in North Central). Results show that for three of the four meat products analyzed, the conditional elasticity (or quantity response) is the most important component of the income elasticities. However, in the fish model the probability elasticities or market participation response is greater than the conditional elasticity. Thus, it indicates that the participation response is the most important component of the income elasticities.

VI. Summary and Conclusion

Improved estimates of market demand for meat product is of interest to meat related industries, including producers of meat animals, packers, processors and distributors of meat and meat products.

Change in market demand can be attributed to the rapidly changing economic status, size, composition, tastes and preferences of the population. Hence, a knowledge of how the variates inherent in the population composition relate to meat consumption is needed to understand the demand for meat. Also, this information could be very useful in meat marketing strategy and market development. Although much analysis has been done on the demand for meat, the recent changes are not well understood.

In order to provide information to aid in understanding and predicting the demand for meats, the study analyzed two types of data. The first part of this research concentrated on the nature of demand for meats in the U.S. and the relationships among beef, pork, chicken and fish. Thus, the analyses relate to consumption of representative consumers and, when coupled with population data, the elasticity information presented is useful for questions about U.S. market demand for meat and meat related commodities.

The conditional elasticity estimated from the AIDS was used to get total price and expenditure elasticities. Individual meat products were showed as price inelastic.

A substitution relationship appeared among beef, pork, and chicken. The same relationship, however, did not appear between fish and other meats (except pork). These results should be interpreted to mean that the empirical methods used failed to find a positive substitution effect in some cases where theory suggests it exists.

The results of the dynamic AIDS indicated statistically significant habit effects in the chicken and fish model and the almost ideal demand system incorporating habits appears to be a viable demand system to use to model consumption behavior.

The second part of this research concentrated on measuring the effects of socioeconomic and demographic factors and changing income on the retail demand for meat products by households.

With this information and knowledge about the effects of socioeconomic and demographic factors on meat expenditures in the different regions one can make longer term projections of regional consumption of meats and can develop meat marketing strategies.

A series of socioeconomic and demographic factors have been indicated to explain observed variations in household expenditures on each meat in the regions of the United States. Income was indicated to have a significant positive impact on beef (except beef in the Northeast region) and fish expenditures. However, negative impacts were found in the pork and chicken expenditure model. This a very surprisingly result, which implies that as household income increases, household purchases of these meats decline.

The decomposition of total expenditure elasticities provided further insights into how changes in household income affect the number of households likely to purchase meat as well as the magnitude of meat purchases during the survey week. The decomposition of elasticities indicated that the conditional elasticity (quantity response) was larger than the probability elasticity (market participation response) in beef, pork and chicken (except chicken in the North Central). It indicated that for three of the four meats analyzed, the conditional elasticity (quantity response) is the most important component of the income elasticities. The fish model, however, showed that the probability elasticity (market participation response) was greater than the conditional elasticity.

In conclusion, income, race, education level of household head, and the adult equivalent scale for household size and age-sex composition were found to be consistently the most important factors in explaining household expenditure behavior on each meat in the regions. Other characteristics, such as season, urbanization, presence of a certain household head and employment status were important in a particular meat expenditure or region. Generally, the demand of households located in major producing regions tends to be positive and larger than that of households located in other regions. Thus, households located in the North East and South regions tend to consume more chicken than households in other regions, and households located in the North Central (Midwest) and South regions tend to consume more pork. Results of the analyses of time-series and cross-section data in this study could be addressed to predict the future demand situation for meats. According to the results of this study, the impact of the elderly male and female scale values on household expenditures for red meat and chicken was generally less, while it was greater in household expenditures for fish. Thus, if the number of people in the over-65 age group increased faster than the total population, a declinding per-capita consumption of beef, pork, and chicken, but an increasing consumption of fish could be predicted, relative to projections from time series estimates.

The information and results presented in this study have important economic and marketing implications for the meat industry in the United States. On the basis of the observed consumption patterns, market segments can be defined for each type of meat by providing the meat industry an opportunity for market strategy planning and development of promotional campaigns.

As suggested by past studies, price and income elasticities appear to be more inelastic in recent years. This suggests more price variability for a given change in quantity marketed.

There are still a number of empirical inconsistencies with theory and a need for more refined data and analytical technologies to fully understand the nature of the demand for meats.

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