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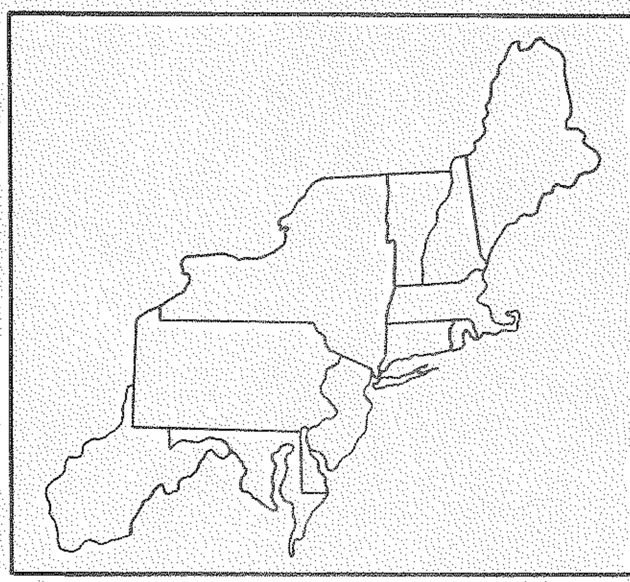

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HOUSEHOLD DEMAND FOR MANUFACTURED DAIRY PRODUCTS IN THE NORTHEAST

by

Mitchell J. Morehart*

INTRODUCTION

This study focused on estimating demand functions for selected manufactured dairy products in the Northeast. Emphasis was given to establishing a demand model which encompassed both economic and demographic aspects of consumer response. This study also examined the potential for similarities in consumer response between "hard" and "soft" Class II products.**

Previous Measures of Demand for Manufactured Dairy Products

Demand for milk and milk products has been studied extensively since early in this century. Research has focused on describing the relationship between quantity demanded of a certain product and economic factors such as price and income. This measure of consumer response often was reported as an estimated elasticity. Although methodology and time period of analyses differed among these studies, reported price and income elasticities for several dairy products are summarized in Table 1. In many cases, due to data limitations, research efforts were confined to explaining aggregate behavior. Two primary sources of information for past studies were panel data and time series records kept by the U.S. Department of Agriculture.

Perhaps the most significant contributions to the statistical analysis of demand for dairy products, prior to 1960, were those of Rojko. Rojko (13) employed both ordinary least squares and limited information maximum likelihood methods to estimate supply and demand models for the U.S. dairy industry. Demand equations were estimated for the pre-World War II and the postwar period. Postwar functions accommodated the emergence of margarine as a popular butter substitute. In each case supply was assumed pre-determined or "fixed". One implication of this assumption was the potential for measuring interrelationships among demand for various dairy products. Demand equations were formulated on a single equation basis. Both price and income elasticities were estimated for butter, American cheese and ice cream.

In a later study, Rojko (14) formulated a dairy sector model which utilized both single and simultaneous equation methods. As with earlier analysis, demand equations were developed on a single equation basis with supply assumed to be "fixed".

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** In this study, "hard" products are represented by butter and hard cheese while "soft" products include ice cream, soft cheeses and yogurt.

Table 1: Summary of Previous Price and Income Elasticity Estimates for Dairy Products.

Investigator	Item	Elasticity Price	Elasticity Income
Rojko (1924-41)/*	Butter	-0.39	0.15
	Amer. Cheese	-0.25	0.32
	Ice Cream	-1.08	0.59
Fox (1922-41)	Butter	-0.25	--
Shepherd (1920-41)	Butter	-1.30	--
Shaffer and Quack-enbush (1951-53)	Butter	-0.46	0.60
	Ice Cream	-0.86	0.83
Brandow (1955-57)	Butter	-0.85	--
	Cheese	-0.70	0.45
	Ice Cream	-0.55	0.35
Wilson and Thompson (1947-63)	Fluid Prod.	-0.31	-0.34
	Butfat. Solids	-0.43	0.60
	Nonfat Solids	-0.19	0.71
Prato (1958-68)	Milkfat	-0.19	--
	Nonmilkfat	-0.19	--
George and King (1955, 1965)	Butter	-0.65	0.27
	Cheese	-0.46	0.23
	Ice Cream	-0.53	0.32
Boehm and Babb (1972-74)/**	Butter	-0.76(-0.73)	0.17
	Proc. Cheese	-1.71(-1.80)	0.10
	Amer. Cheese	-1.44(-2.17)	0.16
Hallberg and Fal-lert (1955-73)	Amer. Cheese	-0.50	0.20
	Italian Cheese	-0.80	0.30
	Other Cheese	-0.80	0.30
	Butter	-0.70	0.30
	Ice Cream	-0.33	0.12

/* Dates given represent time period covered by data used in each study.

/** Number in parenthesis represent elasticities obtained from the time series estimation, see Boehm and Babb.

Wilson and Thompson, and Prato developed simultaneous equation models of the U.S. dairy industry for the 1947-1968 period. Using time series data, Wilson and Thompson estimated single equation demand functions. Income and price elasticities were similar to those obtained by Rojko. Prato estimated demand response within his simultaneous model using two-stage least squares. Of particular interest was his use of the partial adjustment hypothesis in an attempt to distinguish between short-run and long-run elasticities. Although no such distinction was made, short-run price elasticities generated for milkfat and solids non-fat were both approximately -0.19.

Two notable and somewhat similar studies were provided by Brandow in 1961 and George and King in 1971. Each analyzed U.S. consumer demand for several major food commodities via a demand matrix. Emphasis was given to interrelationships in product demand at all levels of the marketing system. Brandow used a 29 product matrix specification to estimate price and income elasticities for butter and American cheese for the 1955-57 period. George and King examined interrelationships among 49 commodities based on 1955 and 1965 cross-section data. Estimated elasticities were given for butter, cheese, and ice cream.

Boehm and Babb analyzed the impact of retail prices, income, and other socio-economic factors on household demand for several storable dairy products. Estimation of demand equations involved both time-series and cross-section models. Products considered were butter, nonfat dry milk, and five types of cheese. In the cross-section model, race and household composition significantly contributed to explaining variations in household purchasing rates.

Within the context of a policy simulation model, Hallberg and Fallert modeled retail demand for dairy products. Their methodology followed the simultaneous supply-demand approach with the addition of a recursive equation formulation. Of particular interest was the large number of dairy product categories incorporated into their study. Emphasis also was given to allowing for variables other than price and income to model consumer behavior when using time-series data.

In 1978, Robinson and Babb constructed a demand model for manufactured milk products in which U.S. consumption forecasts were given for the 1977-81 period. Ordinary least squares was used to estimate three separate single equation specifications. Products considered were: fresh cream, ice cream, ice milk, cottage cheese, american cheddar cheese, nonfat dry milk powder, and butter. The data were U.S.D.A. time-series records for the 1950-76 period.

METHODOLOGY

The data used in this study were the "Virginia Tech version of the 1972-1974 Bureau of Labor Statistics Consumer Expenditure Dairy Survey" (CEDS). Original collection of the data was performed by the U.S. Bureau of the Census under contract to the Bureau of Labor Statistics. As reported by Baer, the survey consisted of two distinct components each with its own collection vehicle and sample: a dairy of recordkeeping survey completed by respondents for two one-week periods from July 1972 to June 1974 and a quarterly interview survey conducted for calendar years 1972 and 1973.

Data were made available in two separate tapes. Tape 1 contained expenditure information on food and nonfood items both in aggregated and disaggregated forms. Tape 2 was comprised of expenditure, quantity, and packaging information by day of the week for food items consumed at home. Given such a large data base, errors and inconsistencies were anticipated. With this in mind, Buse developed a clean version of tape 1. Thus, data analyses at Virginia Tech consisted of combining information from tape 1 and tape 2 to form a single data set. In addition, the data were checked for inconsistencies and errors with reference to socio-economic and demographic information, expenditure, quantity and other information. Where errors were found the observation was "flagged" to leave corrective measures to the discretion of users.

Data Analysis

To arrive at the sample used in this study, several organizational steps were taken. Only those households residing in the Northeast which reported an income, and purchased at least one of the five dairy products under consideration (butter, hard cheese, soft cheese, ice cream, and yogurt), were retained from the original data base. Aggregation of similar items was necessary for ice cream and soft cheese types. Observations from households containing severe demographic response errors were then deleted from the subsample. Expenditure records were examined for each of the 4,127 remaining households. Those "flagged" as being either incomplete or outliers were removed. Expenditure records for each week of the two week dairy were combined for products which had multiple expenditures over the period. In order to obtain a figure for quantity purchased that was similar between all products, the standard quantity (units of weight) was multiplied by the number of items purchased. At the same time, expenditures per unit of product were calculated.

Since price information was not readily available, prices were determined for each commodity by dividing total expenditures by quantity purchased. All prices were then converted to price per pound. Similarly, all quantity information was retained as measured in pounds. To determine the accuracy of calculated prices for each item, average monthly prices and an average price for each of the eight possible locations of residence were tabulated.

The final task concerning development of a "clean" subsample of Northeast households purchasing dairy products was to reconstruct the data file to a fixed format. This involved retaining price and quantity information for the five dairy products as well as for substitute product groups. In addition, socio-economic and demographic information for each household accompanied the purchase information. All records for a single household were confined to one line for ease of handling and interpretation.

Empirical Demand Models

Several estimation methods have been applied to the analysis of demand for milk and milk products. Given cross section data, two contrasting approaches were applied in this study: the single equation model and the constant elasticity of demand system. The underlying properties of each procedure are presented in this section.

1) Single Equation Model

Often referred to as "the pragmatic approach," the single equation model has been the most extensively utilized estimation technique for dairy product demand. Within this methodology, those independent variables available in the data are simply specified as a linear function of quantity consumed. Most researchers then employed ordinary least squares to obtain parameter estimates by assuming classical properties for the error term. Application of this model to cross section data produces an estimate of a single point on the demand curve since prices are usually assumed to be fixed over short periods of time. However, the popularity of the single equation model, aside from its simplicity, stems from interest in determining the effect of household characteristics on product demand.

Coefficient interpretation in the single equation model is straightforward, except in the case where own-good prices have been included. Given adequate price variation among households, Kuh argues that own-price elasticities determined from household data typically represent longer term response than those of time series data. These tendencies also were considered in the cross section model of Boehm and Babb.

The validity of the single equation model is hampered by its inability to reconcile simultaneity in demand response and its failure to incorporate theoretical restrictions on parameter values. However, one may employ post estimation tests on elasticities for compliance with demand theory.

2) Constant Elasticity of Demand System (CED)

Use of a systems approach such as CED allows for interaction among commodity demands and the imposition of theoretical restrictions on coefficients prior to estimation.

The general form of a set of demand relationships for the CED system may be written:

$$(1) \quad \log Q_i = \gamma_{\phi i} + \eta_i \log Y_i + \sum_{j=1}^{n} \log P_i$$

$$(i, j=1, 2, \ldots n).$$

Coefficients obtained from this specification are own-price (ε_{ij}), cross-price (ε_{ij}) and income (η_i) elasticities. Error terms appended additively follow the usual assumptions: $E(e_i) = 0$ and $E(e_i, e_j) = w_{ij}$ where e_i denotes the disturbance term of the ith demand equation.

The variance-covariance matrix of the disturbance term is $\Omega = (w_{ij})$, a nonsingular symmetric matrix of dimension n X n. In this case the usual least squares estimators have been shown to be inappropriate (15). A favorable solution is to stack the equations and employ the Aitken estimator. This approach is otherwise known as "seemingly unrelated linear regression." To allow for parameter restrictions within the estimation procedure, one simply employs the constrained Aitken estimator.

To further enhance the contrast between approaches the sample values with zero consumption levels are retained in the estimation of the CED system. Given the consecutive two-week time period for households surveys, nonpurchases may mean that the household consumes out of inventories. This is especially relevant given the storability of such dairy products such as hard cheese. To facilitate this within the CED system a positive constant must be added to zero consumption values since the logarithm of zero is nonexistent. In this study mean values for quantities and prices were used to replace zero values. This choice was made to enable elasticities to be reflective of behavior at the mean.

Stochastic Specification of the Empirical Demand Models

In practical applications, any demand model must be embedded in a stochastic framework. That is, to account for factors not explicitly introduced in a model, a disturbance (error) term is required for each equation of the models put forth. It is assumed here that error terms enter both the single equation model and the CED system in an additive fashion and possess the classical properties.

The variables included in each model are defined with their respective labels. The labels are then utilized in the presentation of results for each product's demand equation in Part III.

1) Single Equation Specification

The general stochastic specification for the single equation demand model was given by:

$$
\begin{aligned}
(2)\quad Q_{ih} = {} & B_0 + B_1 X_{1h} + B_2 X_{2h} + B_3 X_{3ih} + B_4 X_{4sh} + \\
& B_5 X_{5sh} + \sum_{j=1}^{3} \alpha_j Z_{jh} + \sum_{j=4}^{6} \alpha_j Z_{jh} + \\
& \sum_{j=7}^{9} \alpha_j Z_{jh} + \alpha_{10} Z_{10h} + \alpha_{11h} Z_{11h} + \\
& \alpha_{12} Z_{12h} + \alpha_{13} Z_{13sh} + \alpha_{14} Z_{14sh} + \\
& \alpha_{15} A_{15h} + \alpha_{16} Z_{16h} + \alpha_{17} Z_{17h} + \\
& \alpha_{18} Z_{18sh} + \alpha_{19} Z_{19sh} + \sum_{j=20}^{22} \alpha_j Z_{jh} + \\
& \alpha_{23} Z_{23h} + \sum_{j=24}^{23} \alpha_j Z_{jh} + \sum_{j=27}^{29} \alpha_j Z_{jh} + e_{ih}
\end{aligned}
$$

where $(i = 1, 2, \ldots 5)$, $(j = 1, 2, \ldots 29)$, $(s = 1, 2, \ldots 6)$

$(h=1, 2, \ldots 4{,}127)$.

Dependent Variable

Q_{ih} = QUAN_(i): the quantity of the i^{th} dairy product, measured in lbs., purchased by the h^{th} household during the period

Independent Variables

X_{1h} = TMINC: total annual money income reported by the h^{th} household.

X_{2h} = TMINCSQ: total annual money income reported by the h^{th} household squared.

X_{3ih} = PRICE_(i): the price per pound paid by the h^{th} household for the i^{th} product.

X_{4sh} = PRICE_(s1): the price per pound paid by the h^{th} household for the s_1^{th} substitute product.[2/]

X_{5sh} = PRICE_(s2): the price per pound paid by the h^{th} household for the s_2^{th} substitute product.

Z_{jh} = LOCATION: location of the h^{th} household during the time period. There are four location classifications which are treated as intercept dummy variables.

Z_0 : excluded class; residence outside an SMSA (population $<$ 50,000).

Z_1 = LGSMSA: residence in SMSA of population $>$ one million

Z_2 = MDSMSA: residence in SMSA with population 400,000 - 999,999.

Z_3 = SMSMSA: residence in SMSA with population 50,000 - 399,999.

[2/] To determine substitute prices within the data base, season and location of residence were considered. There were seven total seasons, three per year, defined as: January-April, May-August, and September-December. There were eight location categories based on SMSA and rural/urban differences in residence. Thus, a possible total of fifty-six various average prices were computed. In many instances substitute good prices represented an aggregate of similar products.

Z_{jh} = LOCATION BY: PRICE: location of the h^{th} household with four slope dummy variables which measure price response differences.

Z_0 = : excluded class, own-price response for residents outside of an SMSA.

Z_4 = LGSMSAXP: own-price response difference for residents of SMSAS with population > one million.

Z_5 = MDSMSAZP: own-price response difference for residents of SMSAS with population 400,000 - 999,999.

Z_6 = SMSMSAXP: own-price response difference for residents of SMSAS with population 50,000 - 3999,999.

Z_{jh} = LOCATION BY: PRICE: location of h^{th} household with four slope dummy variables which measure differences in income response.

Z_0 : excluded class; the income response for residents living outside the defined SMSAS.

Z_7 = LGSMSAXI: income response difference for residents of SMSAS with population > one million.

Z_8 = MDSMSAXI: income response difference for residents of SMSAS with population 400,000 - 999,999.

Z_9 = SMSMSAXI: income response difference for residents of SMSAS with population 50,000 - 399,999.

Z_{10h} = RACE: the race of the h^{th} household head. Two race classes are defined: white and nonwhite. The excluded class was white race.

Z_{11h} = RACEXP: a slope dummy variable representing own-price response differences for nonwhites.

Z_{12h} = RACEXI: a slope dummy variable representing income response differences for nonwhites.

Z_{13sh} = RACEXP(s_1): a slope dummy variable representing differences in substitute good response for nonwhites.

Z_{14sh} = RACEXP(s_2): a slope dummy variable representing substitute good price response differences for nonwhites.

Z_{15h} = MARSTAT: the marital status of the h^{th} household head during the period. Married was the excluded class.

Z_{16h} = MARXP: a slope dummy variable representing own-price response differences for single respondents.

Z_{17h} = MARXI: a slope dummy variable representing income response differences for single respondents.

Z_{18sh} = MARXP(s_1): a slope dummy variable representing substitute price response differences for single respondents.

Z_{19sh} = MARXP(s_2): a slope dummy variable representing substitute price response differences for single respondents.

Z_{jh} = OCCUPATION: occupation of the h^{th} household head during the period. There were four occupation categories defined.

Z_0 : excluded class; unemployed or retired.

Z_{20} = WHCOL: professional, clerical or sales occupation.

Z_{21} = BLCOL: craftsman, operative or unskilled laborers.

Z_{22} = FARMER: respondents employed as farmers.

Z_{23h} = OCCUP2: employment status of the spouse of the h^{th} household head during the period. There were two categories defined as working and unemployed or retired. Nonworking was the excluded category.

Z_{jh} = EDUCATION: education level of the h^{th} household head. There were four education categories defined.

Z_0 : excluded class, no formal education.

Z_{24} = GRAMMAR: grammar school graduate.

Z_{25} = HSGRAD: high school graduate.

Z_{26} = CLGRAD: college graduate and beyond.

Z_{jh} = HOUSEHOLD COMPOSITION : the number of persons in the j^{th} age group residing at the h^{th} household during the period.

Z_{27} = ADULT: the number of persons of age twenty-one or greater.

Z_{28} = TEEN: the number of persons between ages seven and twenty.

Z_{29} = CHILD: the number of persons under age seven.

e_i = DISTURBANCE: the error term for the i^{th} demand equation.

Constant Elasticity of Demand Specifications

The stochastic specification for the constant elasticity of demand system was given as:

$$\text{(3)} \quad \ln Q_i = (\phi_{oi} + \phi_{1i} D_1 + \phi_{2i} D_2 + \phi_{3i} D_3 + \phi_{4i} D_4 + \phi_{5i} D_5 + \phi_{6i} D_6 + \phi_{7i} D_7 + \phi_{8i} D_8) + \eta_i \ln Y + \sum_{j=1}^{10} \varepsilon_{ij} \ln P_j + e_i$$

(for all i, j=1, ... 10)

Here the intercept of equation (1) is replaced by the demographic variables. Following Pallak and Wales the intercept was assumed to be a linear function of the demographic variables. This technique which allows for the inclusion of household characteristics is referred to as "translating".

Dependent Variable

Q_i = LNQUAN: the natural logarithm of quantity purchased of the i^{th} commodity measured in pounds.

Independent Variables

D_0 : rural residence, the omitted category.

D_1 = LGSMSA: residence in SMSA of population > 1 million.

D_2 = MDSMSA: residence in SMSA of population 400,000 - 999,999.

D_3 = SMSMSA: residence in SMSA with population 50,000 - 399,999.

D_4 = ADULT: number of persons residing at the i^{th} household of age twenty-one or greater.

D_5 = TEEN: number of persons residing at the i^{th} household between ages seven and twenty.

D_6 = CHILD: the number of persons residing at the i^{th} household under the age of seven.

D_7 = RACE: the race of the i^{th} household head. Two race classes are defined: white and nonwhite. The excluded class was white race.

D_8 = MARSTAT: the marital status of the i^{th} household head during the period. Married was the excluded class.

Y_i = LNTMINC: the natural logarithm of total annual money income of the i^{th} household.

P_j = LNPRICE: the natural logarithm of price paid per pound of the j^{th} product. There were ten products included in the system, five dairy products (butter, BT; hard cheese, HC; soft cheese, SC; ice cream, IC; yogurt, YG) and five substitute or complement product groups (fats & oils, FO; meats, MT; bakery products, BK; fruits, FR; snacks, SK).

EMPIRICAL RESULTS

Single Equation Results

In this section the estimated coefficients for each of the five dairy product equations are presented. Elasticities derived at mean values are provided for own-good price and income. Since cross section data were used in this analysis, estimated price elasticities reflect long-run response. Through the use of interactive dummy variables, differences in elasticities for race, marital status, and level of urbanization also were investigated. In the same context, the substitute price responses were tested for differences between whites and nonwhites as well as single and married respondents. To facilitate comparison of results between products and to maintain consistency, all variables regardless of significance, were retained in each product's equation. The power of the test for significance of difference from zero of each coefficient was set at 0.05 level. Results for each variable are discussed in light of the ceteris paribus assumption. Also, it should be noted that coefficients represented estimates of demand behavior during the 1972-1974 period.

1) Butter Equation

Results of the linear single equation demand function for butter are given in Table 2. Noted first were the low magnitudes and insignificance of both the income and income squared coefficients. The own price effect was highly significant and of the correct sign. The price of margarine and the fats and oils group price had no apparent impact on quantity demanded of butter. However, given their similarities, collinearity may have contributed to this result. Each of the substitute product price coefficients were positive as expected.

Significant intercept differences were found for residents of medium SMSAs, and households in which the spouse was employed. That is, residents of medium sized SMSAs have a larger demand for butter than those who reside in rural areas. Households with working wives have less demand for butter than those with housewives. The value of the intercept coefficient was significant and positive.

Table 2. Single Euqation Results for Butter.

DEP VARIABLE: QUAN_BT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	34	532.901	15.673553	12.139
ERROR	1026	1324.781	1.291209	
C TOTAL	1060	1857.682		
ROOT MSE		1.136314	R-SQUARE	0.2869
DEP MEAN		1.599434	ADJ R-SQ	0.2632
C.V.		71.04473	D.W.	1.765

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T FOR HO: PARAMETER=0/*
INTERCEP	1.912365	0.608351	3.144*
TMINC	.00003184564	0.0000177512	1.794
TMINCSQ	7.02451E-11	2.90227E-10	0.242
PRICE_BT	-2.731502	0.388216	-7.036*
PRICE_MG	0.075284	0.943051	0.080
PRICE_FO	0.954158	0.731933	1.304
LGSMSA	0.504348	0.432517	1.166
LGSMSAXP	-0.184917	0.441594	-0.419
LGSMSAXI	-.0000407743	.00001263761	-3.226*
MDSMSA	1.589896	0.669282	2.376*
MDSMSAXP	-1.566441	0.678825	-2.308*
MDSMSAXI	0.0000079497	.00002026754	0.392
SMSMSA	0.468545	0.598543	0.783
SMSMSAXP	-0.216030	0.633583	-0.341
SMSMSAXI	-.0000271161	.00001756439	-1.544
RACE	1.796835	1.158932	1.550
RACEXP	-2.434621	0.959206	-2.538*
RACEXI	.00000909439	.00002436276	0.373
RACEXPMG	-2.113942	3.784375	-0.559
RACEXPFO	2.622131	2.808892	0.934
MARXPMG	-1.364384	1.844229	-0.740
MARXPFO	0.539274	1.419253	0.380
MARSTAT	-0.901033	0.578159	-1.558
MARXP	1.548154	0.407001	3.804*
MARXI	-.0000042259	.00001425433	-0.296
WHCOL	-0.161875	0.120030	-1.349
BLCOL	0.175247	0.109283	1.604
FARMER	-0.220839	0.181494	-1.217
OCCUPZ	-0.185314	0.088490	-2.094*
GRAMMER	0.460451	0.410536	1.122
HSGRAD	0.404870	0.412995	0.980
CLGRAD	0.495066	0.423525	1.169
ADULT	0.368920	0.069857	5.281*
TEEN	0.118925	0.027481	4.328*
CHILD	0.091162	0.057631	1.582

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be statistically significant at the 0.05 level.

Differences in own-price response were significant in several cases. Lower own-price coefficients included residents of medium sized SMSAs, and nonwhite household heads. A larger own-price response resulted for single respondents. A significantly lower income response for larger sized SMSAs also was determined.

The number of adults and teens in a particular household had a significant impact on quantity demanded of butter. As the number of each increased, the demand for butter was higher.

Estimated price and income elasticities are contained in Table 3. The table is presented such that all possible elasticity differences between race, level of urbanization, and martial status may be examined. The base category in each case was white, married residents of non-SMSAs.

The estimated income elasticities of demand for butter ranged from -0.10 for nonwhite single residents of large SMSAs to 0.39 for nonwhite, married residents of medium SMSAs. The most pronounced differences in income elasticities were between whites and nonwhites, with those whites taking lower values. In general, the range within the base category was consistent with past estimates. Except for income elasticities for residents of large SMSAs, the results indicate butter to be a normal good.

The range in value for price elasticity estimates was quite pronounced. The most elastic response was estimated for nonwhite, married residents of medium sized SMSAs at -3.79. The most inelastic value was for white, single residents of non-SMSAs. Price elasticities were found to be lower for both whites and single respondents. Another interpretation may be that price had a greater influence on the quantity demanded of butter for nonwhites and married couples.

2) Hard Cheese Equation

The single equation results for the hard cheese group are contained in Table 4. As with butter, the coefficients associated with the income variables were insignificant. The own-price coefficient was of correct sign and highly significant. Price of meat products and bakery goods were entered as substitutes. Each was of the correct sign, but only the coefficient for the price of bakery goods was significant.

The intercept coefficient was estimated to be positive, although insignificant. A significant and positive difference in the intercept value emerged for residents of medium SMSAs. There were no significant differences in income response among race, marital status, and level of urbanization. This result further supports the apparently small impact of income on demand for hard cheese products. A negative difference in own-price response was determined for nonwhites and residents of medium SMSAs.

The number of adults and teens had a positive and significant impact on the quantity demanded of hard cheese products. The change resulting from an increase in the number of adults was found to be greater than for an equal change in the number of teens residing in a given household.

The estimated income and price elasticities for hard cheese products are presented in Table 5. Several of the income elasticities were found to be

Table 3. Estimated Income and Price Elasticities of Demand for Butter

Race, Marital Status	Lg. SMSA	Md. SMSA	Sm. SMSA	Non-SMSA
	-Income-			
White, married	-0.07	0.31	0.04	0.25
White, single	-0.10	0.28	0.004	0.22
Nonwhite, married	0.01	0.39	0.11	0.32
Nonwhite, single	-0.03	0.35	0.08	0.29
	-Price-			
White, married	-1.64	-2.42	-1.66	-1.54
White, single	-0.77	-1.55	-0.79	-0.67
Nonwhite, married	-3.01	-3.79	-3.03	-2.91
Nonwhite, single	-2.14	-2.92	-2.16	-2.04

Table 4. Single Equation Results for Hard Cheeses.

DEP VARIABLE: QUAN_HC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	34	922.092	27.120349	15.760
ERROR	2084	3586.292	1.720869	
C TOTAL	2118	4508.384		
ROOT MSE		1.311819	R-SQUARE	0.2045
DEP MEAN		1.618246	ADJ R-SQ	0.1916
C.V.		81.06428	D.W.	1.945

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0/*
INTERCEP	1.009293	0.575940	1.752
TMINC	.00001605781	.00001168265	1.375
TMINCSQ	-1.53055E-12	1.59433E-10	-0.010
PRICE_HC	-1.764483	0.225806	-7.814*
PRICE_MT	0.231215	0.341257	0.678
PRICE_BK	2.348996	0.878988	2.672*
LGSMSA	-0.349569	0.335342	-1.042
LGSMSAXP	0.440630	0.250188	1.761
LGSMSAXI	-.0000121782	.0000101759B	-1.197
MDSMSA	1.393271	0.478201	2.914*
MDSMSAXP	-0.785037	0.347815	-2.257*
MDSMSAXI	-.0000275246	.00001602576	-1.718
SMSMSA	-0.023678	0.403977	-0.059
SMSMSAXP	0.238945	0.304078	0.786
SMSMSAXI	-.0000165559	.00001421704	-1.165
RACE	0.983261	1.247568	0.788
RACEXP	-0.683316	0.335263	-2.038*
RACEXI	-0.00001447	0.0000178092	-0.813
RACEXPMT	0.235451	1.547450	0.152
RACEXPBK	-0.949892	3.041873	-0.312
MARXPMT	0.190326	0.737775	0.258
MARXPBK	0.529053	1.593704	0.332
MARSTAT	-0.392403	0.768217	-0.511
MARXP	-0.023719	0.210471	-0.113
MARXI	-.0000091688	.00001100977	-0.833
WHCOL	0.072205	0.094848	0.761
BLCOL	0.093560	0.088138	1.062
FARMER	-0.100838	0.147795	-0.682
OCCUP2	0.032259	0.069909	0.461
GRAMMER	0.309184	0.323875	0.955
HSGRAD	0.368277	0.324789	1.134
CLGRAD	0.480760	0.332339	1.447
ADULT	0.273554	0.059734	4.580*
TEEN	0.157125	0.021135	7.434*
CHILD	0.075878	0.043706	1.736

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be statistically significant at the 0.05 level.

Table 5. Estimated Income and Price Elasticities of Demand for Hard Cheeses.

Race, Marital Status	Lg. SMSA	Md. SMSA	Sm. SMSA	Non-SMSA
		-Income-		
White, married	0.21	-0.09	-0.01	0.12
White, single	-0.05	-0.16	-0.08	0.05
Nonwhite, married	-0.08	-0.20	-0.11	0.18
Nonwhite, single	-0.15	-0.27	-0.18	-0.06
		-Price-		
White, married	-1.01	-0.75	-1.17	-1.34
White, single	-0.99	-0.74	-1.15	-1.33
Nonwhite, married	-1.54	-1.29	-1.70	-1.88
Nonwhite, single	-1.05	-1.27	-1.68	-1.86

negative, particularly for residents of medium and small SMSAs. This divergence from theoretical expectations is largely due to the insignificance of the income coefficient. Positive elasticities were estimated for all members of the base except the category nonwhite single residents and for white married residents of large SMSAs.

Price elasticities of demand for hard cheese products ranged from -0.74 to -1.88. Price response for nonwhites was more elastic than those of whites. Similarly, larger price elasticities were estimated for small and non-SMSA residents. Thus, price had a greater influence on the demand for hard cheese products for nonwhites and residents of less densely populated areas. Inelastic price responses occurred for both single and married, white residents of medium SMSAs.

3) Soft Cheese Equation

Results of the single equation demand function for soft cheese products are contained in Table 6. Estimated income coefficients were again insignificant. Own-price effects were significant and of the proper sign. The prices for fruits and snack products were included as substitute goods. The estimated coefficient for the price of fruits assumed a negative value indicating a complementary relationship. However, the coefficient was determined to be insignificant. The price of snack products had a positive coefficient which was significant.

Intercept differences were significant for residents of both large and small SMSAs. Each coefficient was positive with the larger value estimated for small SMSAs. Price response differences also were significant for residents of small SMSAs.

The remaining significant coefficient was for the number of adults. This indicated that as the number of adults increased in a particular household the quantity demanded of soft cheese products increased.

Income and price elasticities for soft cheese products are given in Table 7. The majority of income elasticities were estimated to be negative. However, given the insignificance of income effects this may not be indicative of the true income response.

Estimated price elasticities, on the other hand, were of anticipated sign. Values ranged from -0.15 for nonwhite, single residents of non-SMSAs to -1.46 for white, married residents of small SMSAs. In general, residents of small SMSAs were more responsive to price changes than residents of other urbanization levels. Price elasticities were consistently lower for nonwhite respondents. Elasticity values also were found to be lower for single respondents.

4) Ice Cream Equation

Estimated coefficients and corresponding statistical measures pertaining to the single equation demand function for ice cream products are contained in Table 8. The only economic variable which had a significant impact for the base group was the price of ice cream. The intercept was significant, its value estimated as 7.17. No other significant intercept differences emerged.

Table 6. Single Equation Results for Soft Cheeses.

DEP VARIABLE: QUAN_SC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	34	442.245	13.007192	6.274
ERROR	1005	2083.556	2.073191	
C TOTAL	1039	2525.801		
ROOT MSE		1.439858	R-SQUARE	0.1751
DEP MEAN		1.661358	ADJ R-SQ	0.1472
C.V.		86.66751	D.W.	1.836

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0/*
INTERCEP	0.626124	1.125508	0.556
TMINC	-.0000063754	.00001856928	-0.343
TMINCSQ	9.52666E-11	3.20573E-10	0.297
PRICE_SC	-1.408293	0.328741	-4.284 *
PRICE_FR	-1.555393	1.415403	-1.099
PRICE_SK	1.164685	0.496652	2.345 *
LGSMSA	0.828693	0.335584	2.469 *
LGSMSAXP	-0.338025	0.376174	-0.899
LGSMSAXI	-.0000210511	.00001381484	-1.524
MDSMSA	0.670322	0.536534	1.249
MDSMSAXP	-0.310303	0.589754	-0.526
MDSMSAXI	-.0000236965	.00002344982	-1.011
SMSMSA	1.986691	0.468442	4.241 *
SMSMSAXP	-1.945840	0.549604	-3.540 *
SMSMSAXI	-.0000392875	.00002331594	-1.685
RACE	-2.816397	5.479223	-0.514
RACEXP	0.675125	0.609184	1.108
RACEXI	-.0000099633	0.0000294829	-0.338
RACEXPFR	1.357997	14.541248	0.093
RACEXPSK	1.698825	2.304400	0.737
MARXPFR	0.527412	2.694653	0.196
MARXPSK	-0.728144	0.944798	-0.771
MARSTAT	-0.044152	1.129414	-0.039
MARXP	0.350826	0.323536	1.084
MARXI	.00001643331	.00001355287	1.213
WHCOL	0.003600836	0.149771	0.024
BLCOL	-0.047239	0.143224	-0.330
FARMER	0.431547	0.229014	1.884 *
OCCUP2	-0.017954	0.112856	-0.159
GRAMMER	0.681933	0.849327	0.803
HSGRAD	0.737904	0.851378	0.867
CLGRAD	0.936890	0.857179	1.093
ADULT	0.304443	0.095746	3.180 *
TEEN	0.042021	0.036093	1.164
CHILD	-0.054782	0.075543	-0.725

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be statistically significant at the 0.05 level.

Table 7. Income and Price Elasticities of Demand for Soft Cheese.

Race, Marital Status	Lg. SMSA	Md. SMSA	Sm. SMSA	Non-SMSA
		-Income-		
White, married	-0.22	-0.23	-0.35	-0.046
White, single	-0.09	-0.11	-0.23	0.079
Nonwhite, married	-0.28	-0.30	-0.42	-0.114
Nonwhite, single	-0.16	-0.18	-0.30	0.011
		-Price-		
White, married	-0.76	-0.75	-0.46	-0.61
White, single	-0.63	-0.62	-1.33	-0.48
Nonwhite, married	-0.44	-0.43	-1.14	-0.29
Nonwhite, single	-0.31	-0.29	-1.01	-0.15

Table 8. Single Equation Results for Ice Cream.

DEP VARIABLE: QUAN_IC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	34	18176.608	534.606	16.569
ERROR	1448	46720.588	32.265600	
C TOTAL	1482	64897.196		
ROOT MSE		5.680282	R-SQUARE	0.2801
DEP MEAN		7.287134	ADJ R-SQ	0.2632
C.V.		77.94946	D.W.	1.812

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T FOR HO: PARAMETER=0/*
INTERCEP	7.168559	3.234698	2.216 *
TMINC	.00009432535	.00005906702	1.597
TMINCSQ	-1.06702E-09	8.75296E-10	-1.219
PRICE_IC	-14.411690	1.602738	-8.992 *
PRICE_BK	-2.554226	4.866222	-0.525
PRICE_SK	0.055537	2.017212	0.028
LGSMSA	-0.898876	1.011827	-0.888
LGSMSAXP	0.913307	1.968015	0.464
LGSMSAXI	.00001088223	.00004934032	0.221
MDSMSA	0.598857	1.496951	0.400
MDSMSAXP	2.630144	2.849278	0.923
MDSMSAXI	-0.00016364	.00008342607	-1.962 *
SMSMSA	1.044966	1.221091	0.856
SMSMSAXP	-3.377807	2.517385	-1.342
SMSMSAXI	-0.000011973	.00006812493	-0.176
RACE	-7.481565	6.290833	-1.189
RACEXP	-8.794247	3.344818	-2.629 *
RACEXI	0.0001778234	0.0001040601	1.709
RACEXPS	-17.779334	8.091367	-2.197 *
RACEXPB	54.306720	13.964740	3.889 *
MARXPS	-0.461201	4.341799	-0.106
MARXPB	-2.566457	9.165696	-0.280
MARSTAT	0.241388	3.475160	0.069
MARXP	4.471156	1.910413	2.340 *
MARXI	-.0000064255	0.0000570997	-0.113
WHCOL	-0.226454	0.505027	-0.448
BLCOL	0.175222	0.478167	0.366
FARMER	0.522275	0.742137	0.704
OCCUP2	-0.102193	0.356913	-0.286
GRAMMER	2.730673	2.577230	1.060
HSGRAD	2.779627	2.579862	1.077
CLGRAD	2.372949	2.597502	0.914
ADULT	0.781775	0.317892	2.459 *
TEEN	0.823918	0.104710	7.869 *
CHILD	0.458821	0.221163	2.075 *

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be statistically significant at the 0.05 level.

Although neither substitute good coefficient was significant for whites, those of nonwhites were found to be significant. Bakery goods seem to be a strong complement to ice cream for nonwhites. On the other hand, the substitute relationship for snacks was quite pronounced.

Price response differences were significant for race and marital status. The effect of price on quantity demanded of ice cream for nonwhites was found to be lower than for whites. Single respondents were estimated to be more responsive to ice cream prices. Income response was significantly different and lower for residents of medium SMSAs than for non-SMSA inhabitants.

Each of the three household composition variables produced significant, positive coefficients. The increase in quantity demanded of ice cream was estimated to be greatest when the number of teens increased.

Income and price elasticities calculated for ice cream products are given in Table 9. Income elasticities ranged in value from -0.14 to a high of 0.50. The largest differences in income response were found between whites and nonwhites, where the greatest impact on quantity demanded occurred for nonwhites. In general income elasticity values indicate ice cream to be a normal good.

Price elasticities were larger for both nonwhite and married respondents. The most price responsive group was nonwhite and married residents of small SMSAs, while the lowest occurred for white, single occupants of medium SMSAs.

5) Yogurt Equation

As yogurt was a relatively new product during the period covered by the data, its demand response was not well known. Thus, interpretation of results in Table 10 for the single equation specification was done with no preconceived notion of true tendencies. As has been the case, income coefficients were insignificant. Own-price effects for the base group were significant and held the proper sign. As a substitute good, the coefficient for the price of snack products was positive and significant, while the price of fruits exhibited no apparent substitute relationship.

The remaining significant coefficients all pertained to positive price response differences. Residents of medium and large SMSAs demanded a larger quantity of yogurt than occupants of lower levels of urbanization. Married respondents also demanded larger quantities than did single persons when both experienced equal changes in yogurt prices.

Estimated income and price elasticities for yogurt are presented in Table 11. Several income elasticities retained negative values, particularly for nonwhite respondents. Perhaps yogurt is considered an inferior good by nonwhites. Price elasticities for yogurt also displayed inconsistency in terms of sign. Price response for all non-SMSA residents was estimated to be elastic.

Constant Elasticity of Demand System Results

This section contains results for the constrained constant elasticity of demand (CED) system. Discussion here was confined to the five dairy products at issue in this study. Since estimated coefficients for the CED system are

Table 9. Income and Price Elasticities of Demand for Ice Cream.

Race, Marital Status	Lg. SMSA	Md. SMSA	Sm. SMSA	Non-SMSA
		-Income-		
White, married	0.19	-0.12	0.15	0.17
White, single	0.18	-0.14	0.14	0.16
Nonwhite, married	0.50	0.19	0.46	0.48
Nonwhite, single	0.49	0.18	0.45	0.47
		-Price-		
White, married	-0.61	-0.54	-0.81	-0.65
White, single	-0.41	-0.33	-0.61	-0.45
Nonwhite, married	-1.01	-0.93	-1.21	-1.05
Nonwhite, single	-0.81	-0.73	-1.01	-0.85

Table 10. Single Equation Results for Yogurt.

DEP VARIABLE: QUAN_YG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	34	612.945	18.027784	3.120
ERROR	293	1693.070	5.778395	
C TOTAL	327	2306.014		
ROOT MSE		2.403829	R-SQUARE	0.2658
DEP MEAN		2.683498	ADJ R-SQ	0.1806
C.V.		89.57818	D.W.	2.86

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0/*
INTERCEP	2.143708	2.868307	0.747
TMINC	.00004662536	.00005037755	0.926
TMINCSQ	-2.16632E-10	7.67972E-10	-0.282
PRICE_YG	-10.961096	1.666993	-6.575 *
PRICE_SK	3.593474	1.391297	2.583 *
PRICE_FR	0.452532	3.867313	0.117
LGSMSA	-2.243582	1.306005	-1.718
LGSMSAXP	5.668601	1.923257	2.947 *
LGSMSAXI	-.0000289166	.00004117431	-0.702
MDSMSA	-2.297737	2.317205	-0.992
MDSMSAXP	8.426182	4.230308	1.992 *
MDSMSAXI	-0.000155531	0.000100932	-1.541
SMSMSA	-0.488640	1.711092	-0.286
SMSMSAXP	3.328440	2.416942	1.377
SMSMSAXI	-.0000956066	.00005886589	-1.624
RACE	5.865774	13.345702	0.440
RACEXP	0.140402	6.334621	0.022
RACEXI	-.0000840992	0.0001076668	-0.781
RACEXPSK	2.724137	7.764726	0.351
RACEXPFR	-23.553822	32.878469	-0.716
MARXPSK	-2.271514	3.152597	-0.721
MARXPFR	6.139520	7.986144	0.769
MARSTAT	-2.964473	3.849964	-0.770
MARXP	5.542183	1.966548	2.818 *
MARXI	0.0000032029	.00003273241	0.098
WHCOL	0.108697	0.494488	0.220
BLCOL	0.064172	0.486925	0.132
FARMER	1.590542	0.862745	1.844
OCCUP2	0.086910	0.344484	0.252
GRAMMER	1.292125	1.759739	0.734
HSGRAD	1.148792	1.749448	0.657
CLGRAD	1.342397	1.747117	0.768
ADULT	0.329605	0.266075	1.239
TEEN	-0.055265	0.117402	-0.471
CHILD	-0.241382	0.234092	-1.031

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be statistically significant at the 0.05 level.

Table 11. Income and Price Elasticities of Demand for Yogurt.

Race, Marital Status	Lg. SMSA	Md. SMSA	Sm. SMSA	Non-SMSA
	-Income-			
White, married	0.10	-0.63	-0.28	0.27
White, single	0.12	-0.61	-0.26	0.29
Nonwhite, married	-0.38	-1.11	-0.77	-0.22
Nonwhite, single	-0.36	-1.09	-0.75	-0.20
	-Price-			
White, married	-1.06	-0.51	-1.54	-2.21
White, single	0.05	0.61	-0.42	-1.09
Nonwhite, married	-1.04	-0.48	-1.46	-2.18
Nonwhite, single	0.08	0.63	-0.39	-1.06

themselves elasticities, coefficient interpretation primarily addressed the issue of elasticity value. Again, elasticities represent long-run response since they were estimated using cross-section data. The contrast to single equation estimation consisted of: (1) differences in functional form; (2) error related simultaneity; (3) the inclusion of zero expenditure households, and, (4) the imposition of additivity (Cournot aggregation) and homogeneity constraints.* Restrictions were imposed at the sample means of the average budget shares of each commodity. It was assumed here that the ten commodities of which the CED system was comprised constituted a complete system, since the sum of expenditures was equal to total expenditures for the system.

Tests for statistical significance of the individual coefficients are large sample approximations and uncompensated for restrictions imposed. However, for lack of a better measure, the t-values still provided a relative indication of a variable's contribution to explaining demand behavior. Therefore, interpretation of CED system results proceeded as though the t-values correctly measured significance. Again, the power of the test was set at the 0.05 level under the null hypothesis. Since the equations were estimated within a system via the "seemingly unrelated" approach, no measures of individual equation performance were provided.

1) Butter System Equation

The estimated coefficients, standard errors and corresponding t-ratios for the constrained CED system estimation of butter demand are presented in Table 12. The income elasticity of demand was found to be significant, but negative. The negative value for the income coefficient implies that butter was considered an inferior good. The own-price elasticity was of the correct sign and highly significant. The inelastic value indicates that quantities demanded of butter were not greatly influenced by the price of butter.

Several of the commodity prices completing the system were found to be statistically significant. Goods hypothesized as substitutes for butter were: yogurt, fats and oils, fruits, and snacks.** The smallest cross-price elasticity value was that of fats and oils. Bakery product prices were determined to be complementary.

Significant intercept components included residents of large SMSAs and family composition. The consumption of butter was estimated to be lower for large SMSA residents than for other levels of urbanization. As the number of adults, teens, or children in a particular household increased the quantities demanded of butter would increase, with the largest impact occurring for a change in the number of adults.

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* The symmetry constraint was withheld due to the cumbersome calculations required for its imposition. Specifically, the number of restrictions required for symmetry to hold were 45 ($\frac{1}{2}$ k [k-1]), where k = 10, i.e., the number of goods in the system (9).

** Note margarine was included in the fats and oils category.

Table 12. Constant Elasticity of Demand System Results for Butter.

MODEL: BUTTER
DEP VAR: LOGQBT

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T RATIO/*
INTERCEPT	0.998148	0.093978	10.6210*
LGSMSA	-0.036994	0.015696	-2.3569*
MDSMSA	0.015938	0.022489	0.7087
SMSMSA	-0.011589	0.018715	-0.6192
ADULT	0.040740	0.011978	3.4013*
TEEN	0.015451	0.004674566	3.3054*
CHILD	0.018680	0.008845285	2.1118*
RACE	0.018597	0.021925	0.8482
MARSTAT	-0.00406866	0.017541	-0.2320
LOGINC	-0.036087	0.008531839	-4.2297*
LOGPBT	-0.665015	0.037084	-17.9324*
LOGPHC	0.014456	0.023287	0.6208
LOGPSC	0.00705709	0.026396	0.2674
LOGPIC	0.0001536166	0.017223	0.0089
LOGPYG	0.246492	0.044288	5.5656*
LOGPFO	0.093599	0.028327	3.3042*
LOGPMT	-0.012438	0.017573	-0.7078
LOGPBK	-0.054084	0.016180	-3.3426*
LOGPFR	0.223353	0.042855	5.2118*
LOGPSK	0.182513	0.051763	3.5259*

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be significant at the 0.05 level.

2) Hard Cheese System Equation

Results for the hard cheese equation are contained in Table 13. The estimated income elasticity was positive and significant, but low in magnitude. The own-price elasticity was highly significant and of anticipated sign. The inelastic value implies a small impact on quantity demanded when hard cheese prices change.

Significant substitute products for hard cheese included yogurt, fruits, and snacks. Of these goods, snack prices held the largest impact on quantities of hard cheese purchased. Cross-price elasticities ranged in value from -0.046 to 0.286.

The number of children and the number of teens in a household were the only intercept components estimated to be significant. Both coefficients were positive but low in magnitude.

3) Soft Cheese System Equation

Table 14 contains the constrained CED system results for soft cheese product demand. The impact of income on quantities demanded of soft cheese was positive but low in magnitude. Own-price response was found to be inelastic and highly significant.

Ice cream, fats and oils, fruit, and snack cross-price elasticities were statistically significant and had positive values. Hence, soft cheese demand response would be opposite to the direction in price change for these goods.

Significant intercept differences were found for residents of small SMSAs and for nonwhite respondents. The demand for soft cheese was determined to be higher for persons living in small SMSAs than that for other levels of urbanization. The intercept coefficient for race indicates that nonwhites have a higher demand for soft cheese than do whites. The intercept value itself was positive and significant.

4) Ice Cream System Equation

The constrained CED system results for ice cream are presented in Table 15. The income elasticity of demand for ice cream was determined to be positive and significant. The low value of the coefficient indicates income has a small impact on quantities demanded of ice cream. The own-price elasticity was of the proper sign and highly significant. The inelastic value for ice cream price response indicates a small impact on demand when its price changes.

Several of the other goods contained in the system had significant cross-price effects. Among those exhibiting a substitute relationship were: yogurt, fats and oils, butter, fruits and snacks. The largest cross-price elasticity value was that of snack products at 0.25.

The only significant intercept difference was for residents of large SMSAs. The coefficient value indicates a larger demand for ice cream when residing in large SMSAs versus other levels of urbanization. The intercept value was found to be positive and significant.

Table 13. Constant Elasticity of Demand System Results for Hard Cheese.

MODEL: HARDCH
DEP VAR: LOGQHC

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T RATIO/*
INTERCEPT	-0.083020	0.144492	-0.5746
LGSMSA	-0.018592	0.024163	-0.7694
MDSMSA	0.005723565	0.034620	0.1653
SMSMSA	-0.013486	0.028810	-0.4681
ADULT	0.013012	0.018436	0.7058
TEEN	0.036025	0.007195508	5.0065*
CHILD	0.027999	0.013617	2.0563*
RACE	-0.032194	0.033751	-0.9539
MARSTAT	0.032528	0.026999	1.2048
LOGINC	0.083053	0.013109	6.3358*
LOGPBT	0.019099	0.057088	0.3346
LOGPHC	-0.697941	0.035849	-19.4691*
LOGPSC	-0.040993	0.040634	-1.0088
LOGPIC	-0.010190	0.026513	-0.3843
LOGPYG	0.232967	0.068178	3.4170*
LOGPFO	0.041529	0.043607	0.9524
LOGPMT	-0.030527	0.027051	-1.1285
LOGPBK	-0.046531	0.024907	-1.8682
LOGPFR	0.163253	0.065971	2.4746*
LOGPSK	0.286281	0.079685	3.5927*

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be significant at the 0.05 level.

Table 14. Constant Elasticity of Demand System Results for Soft Cheese.

MODEL: SOFTCH
DEP VAR: LOGQSC

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T RATIO/*
INTERCEPT	0.283712	0.134302	2.1125*
LGSMSA	0.007873138	0.022424	0.3511
MDSMSA	0.040198	0.032128	1.2512
SMSMSA	0.052474	0.026737	1.9626*
ADULT	-0.021450	0.017112	-1.2535
TEEN	-0.00785353	0.006678364	-1.1760
CHILD	-0.013132	0.012637	-1.0392
RACE	0.070429	0.031322	2.2485*
MARSTAT	-0.00666582	0.025060	-0.2660
LOGINC	0.028086	0.012195	2.3031*
LOGPBT	0.006904115	0.052980	0.1303
LOGPHC	0.015552	0.033269	0.4675
LOGPSC	-0.750940	0.037710	-19.9135*
LOGPIC	0.065239	0.024605	2.6514*
LOGPYG	0.056324	0.063272	0.8902
LOGPFO	0.131627	0.040469	3.2526*
LOGPMT	0.012051	0.025105	0.4800
LOGPBK	0.002195238	0.023116	0.0950
LOGPFR	0.161313	0.061224	2.6348*
LOGPSK	0.271649	0.073951	3.6734*

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be significant at the 0.05 level.

Table 15. Constant Elasticity of Demand System Results for Ice Cream.

MODEL: ICECRM
DEP VAR: LOGQIC

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T RATIO/*
INTERCEPT	0.866185	0.116787	7.4168*
LGSMSA	0.047505	0.019499	2.4362*
MDSMSA	-0.00440463	0.027938	-0.1577
SMSMSA	0.011680	0.023249	0.5024
ADULT	0.017107	0.014880	1.1496
TEEN	0.009985636	0.005807294	1.7195
CHILD	-0.00433099	0.010988	-0.3941
RACE	0.033794	0.027237	1.2407
MARSTAT	0.054739	0.021791	2.5120*
LOGINC	0.029275	0.010604	2.7607*
LOGPBT	0.119732	0.046070	2.5989*
LOGPHC	0.050539	0.028930	1.7470
LOGPSC	0.004968052	0.032791	0.1515
LOGPIC	-0.857560	0.021396	-40.0806*
LOGPYG	0.209309	0.055019	3.8043*
LOGPFD	0.083357	0.035190	2.3687*
LOGPMT	-0.017318	0.021830	-0.7933
LOGPBK	-0.016560	0.020101	-0.8239
LOGPFR	0.146216	0.053239	2.7464*
LOGPSK	0.248042	0.064305	3.8573*

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be significant at the 0.05 level.

5) Yogurt System Equation

Table 16 contains results for the constrained CED system estimation of yogurt demand. The income coefficient was quite small in magnitude and statistically insignificant. Unlike the other demand results for income under the constrained CED system, income had no apparent effect on the quantity of yogurt demanded. The own-price elasticity was found to be significant. The inelastic value indicates a small impact on quantities demanded of yogurt with a change in its price.

Many of the remaining goods in the system had a significant cross-price interaction with yogurt demand. Substitute relationships were determined for butter, hard cheese, ice cream, fats and oils, fruits and snacks. The cross-price effects for the other dairy products were quite small ranging from 0.04 to 0.08. The largest cross-price effect was estimated for snacks, as would be expected given the nature of yogurt as a food product. Interestingly, a complementary cross-price effect occurred for bakery goods.

No significant intercept differences emerged. The intercept itself was estimated to be positive and was found to be statistically significant. Thus, demand response for white, married residents of non-SMSAs (the base group) was representative of all race, marital status, and urbanization levels.

SUMMARY

Given household data, two contrasting approaches have been used to investigate the nature of butter, hard cheese, soft cheese, ice cream, and yogurt demand in the Northeast. Each estimation technique possessed certain merits discussed individually below. An empirical comparison of both models is provided as a basis for future investigation of the proper structure of household demand for dairy products.

Evaluation of Single Equation Results

The "fit" of the single equation demand functions to the data were typical of those achieved in cross section regression. Adjusted R^2 values ranged from 0.15 for the soft cheese equation to 0.26 for both the butter and ice cream functions. In a similar application of the single equation model, the highest R^2 value achieved by Boehm and Babb was 0.19. All tests for the significance of the regression equations (F-test) were statistically significant. Mean square error values were reasonable; the largest occurred for the ice cream equation at 32.27.

The insignificance of income, occupation, and education in explaining demand behavior highlighted the similarities in coefficient results across all demand equations. Perhaps correlation among these variables contributed to their overall insignificance. However, inclusion of each variable afforded a true measure of their impact on consumption behavior. With few exceptions, own-good price, race, marital status, and household consumption were the significant determinants of demand for all dairy products. The influences of race and marital status were most pronounced in own-price response differences. Overall, whites and single person households were found to be less concerned with changes in own-good price than their respective counterparts. The number of adults, teens, or children residing in a particular household generally had a

Table 16. Constant Elasticity of Demand System Results for Yogurt.

MODEL: YOGURT
DEP VAR: LOGQYG

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T RATIO/*
INTERCEPT	0.771634	0.063782	12.0980 *
LGSMSA	0.016357	0.010650	1.5359
MDSMSA	0.011709	0.015259	0.7674
SMSMSA	0.011186	0.012698	0.8810
ADULT	-0.00124381	0.008127165	-0.1530
TEEN	-0.00348606	0.00317174	-1.0991
CHILD	-0.00368201	0.006001513	-0.6135
RACE	0.019219	0.014876	1.2919
MARSTAT	0.007880138	0.011902	0.6621
LOGINC	0.006990308	0.005791324	1.2070
LOGPBT	0.080185	0.025162	3.1868 *
LOGPHC	0.040379	0.015800	2.5556 *
LOGPSC	0.007968755	0.017910	0.4449
LOGPIC	0.040014	0.011686	3.4242 *
LOGPYG	-0.570677	0.030050	-18.9912 *
LOGPFD	0.040670	0.019220	2.1161 *
LOGPMT	0.013160	0.011923	1.1037
LOGPBK	-0.022336	0.010978	-2.0345 *
LOGPFR	0.163576	0.029077	5.6256 *
LOGPSK	0.200070	0.035121	5.6965 *

/* The asterisk following the T-ratio indicates the estimated coefficient was determined to be significant at the 0.05 level.

positive impact on quantities demanded of all products. There were no apparent similarities in factors determining demand for either "hard" or "soft" product groups. One might conclude the single equation model was not well equipped to handle an investigation of this type of product interaction.

Elasticity values for the base group (white, married residents of non-SMSAs) generally fell within the range of previous estimates. To illustrate, the butter income elasticity of demand for the base group was estimated at 0.25, while the range of previous estimates was between 0.15 and 0.60. Similarly, price elasticity values of the base group for hard cheese (-1.34) and soft cheese (-0.61) were within the range of previous measures of cheese price elasticity (-0.25 to -1.71). The elastic response for hard cheese types and inelastic price response for soft cheeses was also consistent with past analyses.

To summarize, application of the single equation model allowed for the separate determination of price, income, and sociodemographic impacts on each product's demand. Furthermore, the large degrees of freedom enabled testing for both intercept and slope differences in demand response associated with household characteristics for each product through use of dummy variables. The results suggest that price and income response differed between race, marital status, and level of urbanization. Price response differences were also tested for substitute goods through use of interactive dummy variables. This test was determined to be significant for the ice cream function, where it was shown that the influence of snack and bakery good prices on quantities demanded of ice cream were different between white and nonwhite races. Finally, the results indicated the single equation model is best suited for those interested in exploring the role of sociodemographic variables on product demand. More importantly, the specification allows for a multitude of tests on income and price response differences between households.

Constant Elasticity of Demand System Performance

One drawback of a "systems approach," such as the CED system, is that measures of individual equation performance were not readily available. Thus, the evaluation of individual equation results derived here were based on the validity of parameter estimates. On the other hand, a weighted coefficient of determination and weighted mean square error were available measures for assessing the entire system. The R^2 reported for the system was 0.13 and the mean square error was estimated at 1.21.

With the exception of the estimated income elasticity of demand for butter, all price and income elasticities conformed to theoretical expectations. Price elasticity values for each dairy product were less than unity indicating an inelastic own-price response. Given this result, one might conclude that, over the long-run, changes in the prices of dairy products have a small impact on quantities demanded. The majority of income elasticity values were estimated to be positive but low in magnitude in comparison with previous estimates.

The influence of sociodemographic factors varied across all equations, although similarities between "hard" and "soft" product types were found. In particular, household composition had a significant impact on demand for "hard" products while it did not for "soft" products. The estimated coefficient for race was negative for "hard" products but positive for "soft" product types.

The large number of significant cross-price elasticities estimated for each product suggests that perhaps determination of product interation was enhanced through implementation of the CED system. Similarities between all dairy products included the positive effect of fruit and snack prices on demand response. That is, fruit and snack prices emerged as complements to each of the dairy products investigated. Several significant cross-price effects also were found among the dairy products themselves. For example, yogurt prices had a positive impact on quantities demanded of butter, hard cheese, and ice cream.

Due to the nonavailability of diagnostic measures, the CED system results were difficult to evaluate. The large number of significant variables and the presence of few unreasonable parameter estimates for individual product equations indicates this was a viable modeling approach. Two notable benefits to this approach were the direct estimation of elasticities and its ability to gauge product interactions.

An Empirical Comparison of Demand Models

Theoretical and analytical properties contributing to the contrast between the single equation and CED system approach were herein previously treated. The question remains, however, as to the degree to which empirical results reflect the contrast in methodologies. Comparison of coefficient values were limited to those variables common to both methods of estimation. Additional criteria for comparison included computational burden and the computer costs associated with each approach.

Regarding price and income estimates, the most notable differences occurred in the significance of income response. The effect of income was determined to be insignificant for all products under single equation estimation, while under the CED system all income parameters were found to be significant. With the exception of soft cheese and ice cream, estimated own-price elasticities for the single equation model were elastic or greater than unity.* On the other hand, own-price elasticities for all products in the CED system were estimated to be inelastic.

Several similarities emerged between approaches in terms of intercept differences associated with sociodemographic factors. Significant intercept differences occurred for household composition variables in both butter and hard cheese equations of each model. A positive intercept difference was estimated for small SMSA residents in each soft cheese equation. Yogurt equation results for both approaches produced no significant intercept differences. The direction of cross-price effects were consistent between models for butter, ice cream, and yogurt. Meat and bakery products exhibited a substitute relationship for hard cheese types in the single equation model, while a complementary relationship occurred in the CED system results. The effect of fruit prices were opposite (in sign) between estimation methods for soft cheese demand.

Estimation of the CED system was far more cumbersome due to the imposition of theoretical constraints and the addition of substitute good equations necessary to complete the system. However, once established, computer time was

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* Own-price elasticities, generated through the single equation approach, which were used for comparison are those of the base group.

less expensive for estimation of the CED system than for the five single equation demand functions. Cost differences are primarily attributed to the larger number of variables contained in the single equation model.

The comparison of empirical results demonstrated that the choice of estimation method greatly influenced coefficient estimates. This was especially prevalent for the parameters associated with economic variables, where dramatic differences were encountered. No effort was made here to rationalize empirical differences, as the analytics required are beyond the scope of this study. Obviously, the choice of demand model ultimately depends on the researchers' objectives and data availability.

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