An Analysis of Demand Elasticities for Fluid Milk Products in the U.S.

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Abstract:
This study examines retail fluid milk products purchase data from Nielsen 2005 home scan data. The demand for seven categories of fluid milk products were estimated: whole milk, whole flavored milk, reduced fat milk, flavored reduced fat milk, buttermilk, canned milk and all other fluid milk products. Analyses of the purchases of seven fluid milk categories based on the Nielsen 2005 home scan retail data are used to determine the roles marital status, age, race, education, female employment status and location play in the empirical estimations of aggregate demand elasticities. To derive the demand elasticities, a censored translog demand system is used. The results reveal that price and income are the main determinants of demand for fluid milk products with a few minor determinants. All own-price elasticities are greater than unity for all fluid milk categories except for the compensated reduced fat milk. All expenditure elasticities are inelastic except for reduced fat milk and most of the fluid milk categories are substitutes.

Keywords: Nielsen home scan retail data, milk demand, elasticities, fluid milk, reduced fat milk, whole milk, flavored milk, canned milk, buttermilk, non-linear AIDS, censored translog demand system

JEL Classifications: C25, D12, Q11

Introduction

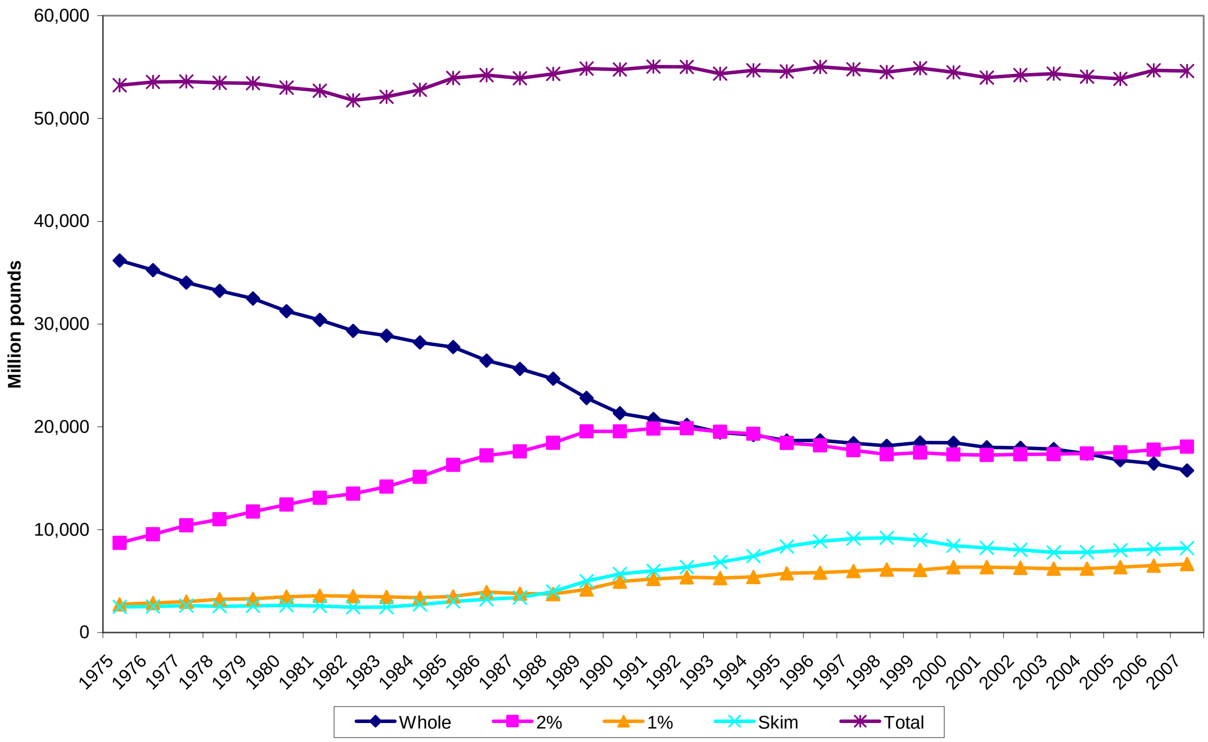
Of all milk and dairy products, fluid milk products are probably the most often discussed and analyzed, although cheese is a close second. The interest in the fluid products stems from several factors. There is a long historical record expounding the merits of milk and its products, not always from dairy cows, throughout the world. The significant role played by the fluid products in promoting health, especially of young children, is emphasized. So too is the importance of dairy products as sources of vitamins and minerals that support bone health. Taken together, one can appreciate how it is possible for many people to hold deep convictions about milk and its products. Milk and dairy products are often described as manufactured or processed products. It is the processed products, but not all of them, that are the "fluid" products considered in this study.

Fluid Milk Products

Our interest (and analysis) is focused on the fluid beverage milk products, not cream-based processed products such as half-and-half, sour creams, or yogurt. Figure 1 shows estimates of total beverage milk sales and selected individual milk category sales over the past several years. The data are defined in terms of pounds, a weight measure that can at times confuse those wishing to think in terms of volume, a more traditional way to think of liquids. Converting the weight to a liquid volume base, at least in an approximate fashion, is simple—divide the weight in pounds by 8.6 (see Appendix table 1).

Total sales have been relatively stable over the 1975- 2007 period at approximately 54 billion pounds. However, the sales trends of selected individual categories offer a different perspective that is shown clearly in Figure 1.

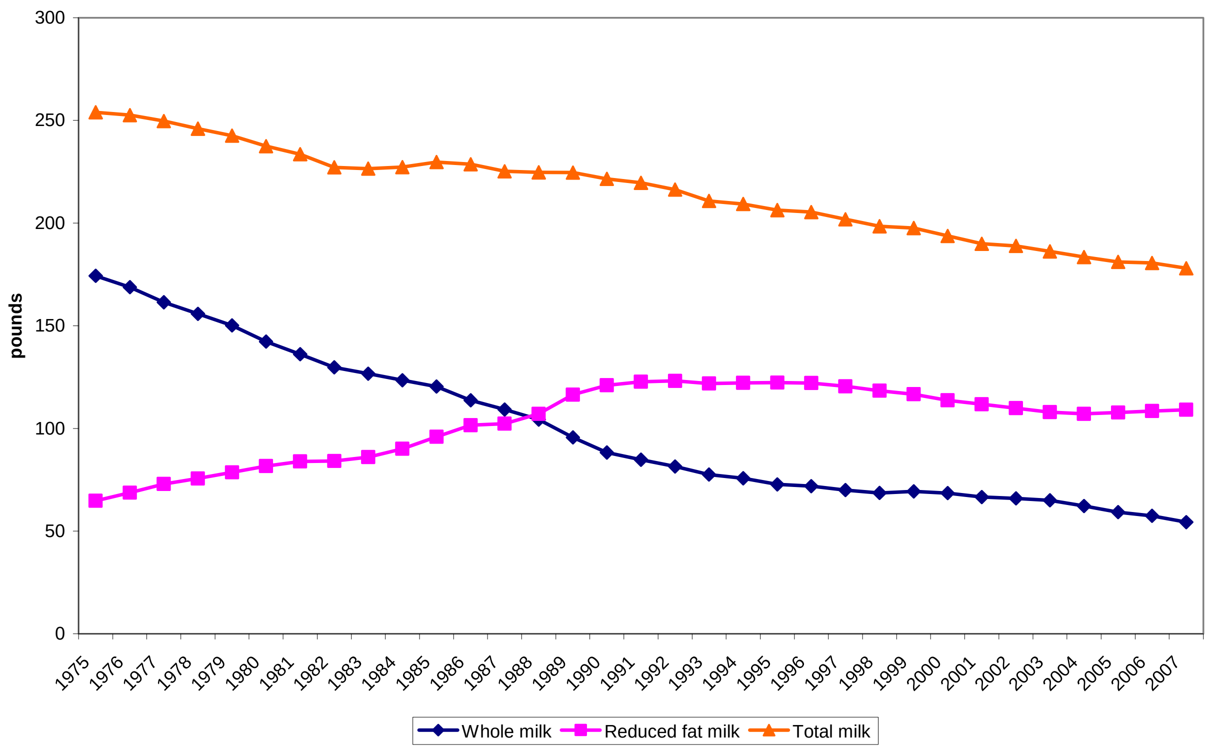
Figure 1 Total and selected category beverage milk sales, 1975 to 2007



Whole milk sales have been declining over the period while the reduced fat milk category sales (2%, 1%, and skim) have trended upward, with clear peaks for 2% and skim followed by declines. However, there have been upward sales again in both categories in the most recent years. The relatively short shelf-life of the fluid beverage milk products has certain ramifications for analysis of demand. Lacking estimates of consumer wastage on a consistent basis, it is assumed that sales of the products are equal to the demands for them.

In most product demand studies, the focus is per capita demand. Based on the sales shown in figure 1, per capita "demand" estimate, utilizing the July1 annual estimates of the total U.S. population are calculated. The three reduced fat (2%, 1%, and skim) milk categories have also been added together. The per capita demand trends are shown in Figure 2 for total milk and selected fluid beverage milk categories.

Figure 2 Per capita fluid beverage milk demand, 1975-2007



The downward per capita total demand is directly related to the relatively flat total sales and the increasing population of the United States over time. As is clearly seen, the aggregate trend masks an important point—per capita demand of the reduced fat milk(s) had been trending upward for some time but leveled off and actually declined in the early 2000s. More recent data shows an upward movement for these milk categories. However, the whole milk demand trend is continually downward over the period. Mirroring the sales data (when aggregated over the three reduced fat categories), per capita demand for the reduced fat milks surpassed the whole milk demand in 1988.

In 2005, total beverage milk sales, on a per capita basis were about 21.2 gallons. The non-flavored reduced-fat milk products represented about 59 percent of the total with 2-percent the highest at 6.9 gallons, followed by skim milk (3.1 gallons) and 1-percent (2.5 gallons). Non-flavored whole milk, at 6.6 gallons, made up about 31 percent of the total. Whole milk per capita demand fell from almost 20 gallons in 1975, a decline of almost 2/3 thirds, while the reduced fat demand has risen almost 50 percent for 2-percent, 73 percent for 1-percent, and over 138 percent for skim milk.

The variation in the demand trends suggests that any demand analyses of the products ought to examine the potential factors behind the trends. Of major interest are elasticities of demand for the various fluid milk products and the frameworks used to derive demand estimates. Other demographic factors may also be important contributing factors to the variation in demands.

Previous Analysis of Fluid Milk Markets

Analyses of fluid milk demand have taken many forms over the years and have emphasized many different factors found to influence demands. Early studies tended to consider milk as an aggregate category but as the various fluid milk types were produced and sold, more data became available to disaggregate the products. While there are differences in packaging that can be studied, the differences between demands for milks with different fat content took, and still holds, center stage. There is no effort to catalog all of the studies completed and report results—rather we referenced the key studies across a historical time period.

An early study by Boehm and Babb (1975) identified six milk categories—regular whole milk, total whole milk, 2-percent, 1-percent, skim nonfat milk, buttermilk—and a total, for analysis. Price elasticities were reported in two ways: by household and per capita. The household estimates were interpreted as long run response measures while per capita elasticities are short run. The smallest (in magnitude) of the long run responses was for 1-percent milk at -0.83 and the largest was for regular whole milk at -1.7. Per capita estimates were smaller in magnitude, ranging from -0.12 for skim nonfat milk to -1.78 for buttermilk.

Gould, Cox, and Perali (1990) specified an Almost Ideal Demand System (AIDS) model that included whole milk and lowfat milk. Demand elasticities were estimated to be 0.-324 for whole milk and 0.-437 for lowfat and expenditure elasticities were 0.658 and 0.062. In 1996, Gould again examined milk demand factors but this time there were three categories considered—whole milk, 2-percent milk , and 1-percent/skim milk. Nielsen data from April 1991 to March 1992 was used for the analysis. Own-price elasticities were estimated to be -0.803 for whole milk, -0.512 for 2-percent, and -0.593 for the 1-percent/skim category. All expenditure elasticities were close to 1.

In a study by Schmit et al., (2002), price and expenditure elasticities for three individual milk categories, whole, lowfat, and skim, along with a total milk category were determined in a study focusing on generic advertising effects. The price elasticities were derived using AC Nielson data from January 1996 to December 1999 specified in a two-step panel data model. Own-price elasticities for the three categories were -2.317 for whole milk, -0.624 for lowfat milk, and -1.489 for skim milk. Expenditure elasticities were -0.401, 0.011, and 0.412 respectively. The total milk price elasticity was smaller in magnitude, -0.243, as was the expenditure elasticity estimate, 0.034.

These analyses suggest that empirical estimation of the demand and expenditure elasticities is dependent on model specification. In particular, the definitions of categories appear to play important roles in the outcomes. For the analysis presented in this report, the basic approach is similar to those noted above—a systems modeling framework is specified and data household data is used.

Estimates of Fluid Milk Demand Elasticities

For almost three decades, the Almost Ideal Demand System (AIDS) model developed by Deaton and Muellbauer (1980b) has been one of the most widely applied approaches used to examine consumer demand for varies agricultural commodities (Jabarin, A.S. (2005); Thompson, W. (2004); Richards, T.J., A. Kagan, and X.M. Gao. (1997); Mdafri, A. (1993); Heien, D. and G. Pompelli (1988); Blanciforti, L. and R. Green (1983), etc.). The AIDS model starts from a specific cost function, and gives the share equations in an n-good system as

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln(X/P)$$

where w_i is the share associated with the *i*th good, α_i is the constant coefficient in the *i*th share equation, γ_{ij} is the slope coefficient associated with the *j*th good in the *i*th share equation,

p_j is the price on the *j*th good and βi is the real expenditure coefficient. *X* is the total expenditure on the system of goods given by

$$X = \sum_{i=1}^{n} p_i q_i$$

in which q_i is the quantity demanded for the *i*th good. *P* is the price index defined by

$$\ln P = \alpha_0 + \sum_{i=1}^{n} \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j$$

in the nonlinear AIDS model. There are seven models, whole milk, reduced fat milk, flavored whole milk, flavored reduced fat milk, buttermilk, canned milk, and other milk. The seven endogenous variables are based on purchases made, a 1 if purchased was made and 0 if not purchased. Right hand side variables for each model include region, race, education level of female head of household, employment status of male and female heads of households, and martial status which are all discrete variables (0/1). The presence of children in household is the only continuous variable in each model.

However, the biggest concern with using the nonlinear AIDS model is how it will account for non-purchased fluid milk products. Assuming that most people shop for the household once a week, it is unlikely that every person who buys food for the household will purchase whole milk, reduced fat milk, flavored whole milk, flavored reduced fat milk, buttermilk, canned milk, and other milk every time he or she shops. Because the likely occurrence is for household shoppers not to buy all three milk products each time they shop, zero purchases are recorded, which is not probably addressed by the nonlinear AIDS framework. Thus to address the 0/1 problem that often is an issue with cross-sectional retail data we employed a censored demand system.

The censored demand system uses a multivariate sample selection model developed by Yen and Lin (2006), which was estimated with a two step procedure proposed by Shonkwiler and Yen (1999). This approach accommodates zero purchases and simplifies the computational burden, while still producing consistent estimates. We followed closely the specification of Yen, Lin and Davis (2008).

We assumed that milk products are separable from all other goods. In the first step of the procedure, censoring of each commodity is governed by the following stochastic sample selection process.

$$w_i = d_i\left[f_i(x;\theta) + e_i \right], i = 1,...,n \,, \tag{1}$$

where $d_i = 1$ if $z'\gamma_i + u_i > 0$ and $d_i = 0$ if $z'\gamma_i + u_i \leq 0$, w_i is the expenditure share of the ith commodity, x and z are vectors of explanatory variables, θ and γ_i are vectors of parameters, and e_i and u_i are random errors.

Assuming the translog utility function, the translog demand system in expenditure form can be derived as:

$$w_i = \frac{\alpha_i + \sum_{j=1}^{n} \beta_{ij} \log v_j}{\sum_{j=1}^{n} \alpha_j + \sum_{k=1}^{n} \sum_{j=1}^{n} \beta_{kj} \log v_j}, i = 1,...,n \,, \tag{2}$$

where v_j are expenditure normalized prices for commodity j. Homogeneity is implied in the above equation by the use of the normalized prices for all commodities, and symmetry is imposed with the restrictions

Table 1: Variable Definitions and Sample Statistics (Sample Size = 7997)

Variable	Mean	SD
Quantities (per household)		
Whole Milk	614.73	1761.04
Reduced Fat Milk	2763.75	3608.61
Flavored Whole Milk	17.84	125.45
Flavored Reduced Fat Milk	68.90	347.16
Buttermilk	27.44	162.61
Canned Milk	38.42	131.74
Other Milk	17.33	192.19
Expenditures (dollar value)		
Whole Milk	16.22	43.81
Reduced Fat Milk	65.41	79.53
Flavored Whole Milk	0.74	5.68
Flavored Reduced Fat Milk	2.44	11.41
Buttermilk	1.07	5.92
Canned Milk	2.70	9.15
Other Milk	9.83	54.43
Prices (dollar value)		
Whole Milk	0.03	0.01
Reduced Fat Milk	0.03	0.01
Flavored Whole Milk	0.05	0.01
Flavored Reduced Fat Milk	0.05	0.01
Buttermilk	0.05	0.01
Canned Milk	0.08	0.02
Other Milk	3.99	2.69
Dummy variables (1 = yes; 0 otherwise)		
Central	0.17	
South	0.39	
White	0.77	
College Degree	0.34	
Household Size	2.34	
ChildPres	0.24	
Married	0.58	

Note: Variables above are defined as such: ChildPres = Children Presence in household.

$$\beta_{ij} = \beta_{ji} \quad \forall \quad i, j \tag{3}$$

We allowed the intercept α_i to vary with demographic variables h_ℓ such that

$$\alpha_i = \alpha_{i0} + \sum_{\ell=1}^{L} \alpha_{i\ell} h_\ell, i = 1,...n-1 \tag{4}$$

One issue with the censored system approach specified above is that the adding-up restriction cannot be imposed. Following the approach suggested by Yen and Lin (2006), we estimated the first $n-1$ equations and calculate elasticities for the nth equation using the adding-up property in demand theory. Even though the estimates are not invariant to the equation excluded, Yen and Lin (2006) showed that the elasticity estimates are stable regardless of which commodity is treated as the residual category.

The system of demand equations in share form can be written as:

$$w_i = E(w_i) + \xi_i = \Phi(z_i'\gamma_i) f_i(x;\theta) + \delta_i \phi(z_i'\gamma_i) + \xi_i, \tag{5}$$

where δ_i is the covariance between the error terms e_i and u_i, $\Phi(z_i'\gamma_i)$ and $\Phi(z_i'\gamma_i)$ are the normal cumulative distribution and probability density functions respectively, and $\xi_i = w_i - E(w_i)$ is a heteroskedastic error term, with $E(\xi_i) = 0$ (Shonkwiler and Yen, 1999). The system can be estimated using the two step procedure. First, we obtained maximum-likelihood (ML) estimates for γ_i based on binary probit for $w_i = 0$ and $w_i > 0$. Second, assuming that the disturbances (e_i, u_i) are distributed bivariate normal with cov(e_i, u_i) = δ_i, we estimated the demand parameters θ and covariances δ_i in the system

$$w_i = \Phi(z_i'\hat{\gamma}_i) f_i(x;\theta) + \delta_i \phi(z_i'\hat{\gamma}_i) + \xi_i \tag{6}$$

Table 2: Probit Estimates of the Translog Demand System

Parameter	Coeff.	Std Err
Whole Milk		
Central	-0.26***	0.04
South	0.12***	0.03
White	-0.31***	0.03
College Degree	-0.19***	0.03
Household Size	0.10***	0.02
ChildPres	-0.04	0.05
Married	-0.10***	0.03
Reduced Fat Milk		
Central	0.12***	0.06
South	-0.18***	0.04
White	0.40***	0.04
College Degree	0.22***	0.04
Household Size	-0.00	0.02
ChildPres	0.03	0.06
Married	-0.10***	0.03
Flavored Whole Milk		
Central	0.40***	0.05
South	0.43***	0.04
White	0.20***	0.05
College Degree	-0.10***	0.04
Household Size	0.08***	0.02
ChildPres	0.20***	0.06
Married	0.04	0.05
Flavored Reduced Fat Milk		
Central	0.20***	0.04
South	0.03	0.04
White	0.22***	0.04
College Degree	-0.03	0.03
Household Size	0.09***	0.02
ChildPres	0.31***	0.05
Married	0.06	0.04
Buttermilk		
Central	0.10***	0.05
South	0.40***	0.04
White	0.01	0.04
College Degree	0.09***	0.04
Household Size	-0.01	0.02
ChildPres	-0.22***	0.06
Married	0.33***	0.04

Note: Variables above are defined as such: ChildPres = Children Presence in household.

Continued -- Table 2: Probit Estimates of the Translog Demand System

Parameter	Coeff.	Std Err
Canned Milk		
Central	0.18***	0.04
South	0.27***	0.03
White	-0.14***	0.03
College Degree	0.01	0.03
Household Size	0.01	0.02
ChildPres	-0.04	0.05
Married	0.31***	0.03
Other Milk		
Central	0.00***	0.04
South	0.07***	0.03
White	0.12***	0.03
College Degree	-0.00	0.03
Household Size	-0.05***	0.02
ChildPres	0.34***	0.05
Married	0.21***	0.03

Note: Level of Statistical Significance - *** = 1%. Variables above are defined as such: ChildPres = Children Presence in household.

using iterated seemingly unrelated regressions. Demand elasticities for the n–1 goods can be derived by differentiating equation(6). Elasticities for the residual good are calculated using the adding up restriction. To derive compensated demand elasticities, we used Slutsky's equation.

The data underlying the analysis is from Nielsen Home Scan data for 2005. In this study we used the smaller subset of 7,997 households that recorded both UPC-coded and random weight products. These households reported 7,597,426 purchases in 2005. The purchase record is matched to a household record that contains information on the size and composition of the household, income, origin, age, race, gender, education and occupation of household members and market location data. Projection factors (sample weights) are provided by Nielsen to be used at the household level to provide representative estimates for the U.S. population. Seven (7) milk categories were established using the descriptions of the UPC and designated codes for each item. The categories are: 1) whole milk, 2) reduced fat milk, 3) flavored whole milk, 4) flavored reduced fat milk, 5) buttermilk, 6) canned milk, and 7) other. The first four categories are clearly beverage fluid milk products. In the U.S., canned milk is not usually considered a beverage milk product, but it could be consumed as such—the same is true of the other milk. Prices (unit values) are reported for all products after accounting for any coupons or promotions that might have been in effect. All milk purchases are aggregated over one year for each household.

Impacts of Demographic Variables

The demographic variables used by Nielsen to characterize dairy purchases are all based on a representative sample of the 2005 U.S. population. A representative sample of the U.S. population was used in the selection process of U.S. consumers who agreed to scan retail grocery receipts of purchases made during a 12 month period. Although some researchers have heavily criticized the reliability of Nielsen data, the overall accuracy of self-reported data by Homescan panelists seems to be in line with many other surveys of this type (Einav, Leibtag, and Nevo, 2008). ERS's sample contains purchase data from a representative group of 8,000 households for the year 2005. All 8,000 households that purchased fluid milk within a 12 month period were included in the analysis, whether they purchased fluid milk one time or two hundred times. Nielsen's demographic file contains sample weights (projection factors) that are used to project product purchases to the U.S. national level and these weights were used in the probit analysis described below.

For this study we analyze the impacts of demographic variables including the Central and Southern regions of the U.S., non-Hispanic Whites, female college graduates, children presence in home, size of household, and married individuals due to the effect they have had on dairy products in other studies. Studies that have analyzed dairy products in the past (Chouinard et al., 2005; Huang and Lin, 2000, and others) have used the above or similar demographic variables in their analyses. Table 1 shows the percentage of demographic variables of interest represented in the U.S. census, the Nielsen Homescan Fresh Foods panel (unweighted), and the subset of those households who purchased fluid milk as reported in the data (also unweighted).

Table 1: Share of selected demographic variables in the fluid milk analysis

Demographic Variables	2005 Census	2005 Homescan (unweighted)	Homescan Fluid Milk Purchasers
Household Size	2.6	2.4	2.3
Central Region of U.S.	22%	17%	17%
Southern Region of U.S.	36%	38%	39%
Non-Hispanic Whites	76%	76%	77%
Martial-Status: Married	53%	57%	58%
Children Present in HH	25%	24%	24%
College-Grad:Female HH	32%	34%	34%

Note: Variables above are defined as such: HH= Head of Household and College-Grad:Female HH = College-Graduate: Female Head of Household.

Consumers' decision to purchase fluid milk products are based on the sign of the demographic variables. For example, assume race is the demographic variable being examined. Also, assume Whites is (1) and Blacks, Asians, Hispanics, and other races are (0), the base. If the coefficient for Whites is positive then it is expected that people with this characteristic will purchase fluid milk. According to the probit analysis, the first step of the two-step procedure shows that the above demographic variables do play an important role in determining whether people purchase fluid milk products (table 2). These variables are statistically significant in most of the binary fluid milk models. The same demographic variables are used in the second step which consists of the maximum likelihood estimates of multivariable sample selection model (censor translog demand system). In our analysis, we found that while demographic variables are important factors and must be accounted for in the demand estimations, the major drivers of fluid milk demand are price and income. The next sections reveal and discuss the price and income elasticities related to the seven fluid milk products.

Compensated Censored Translog Demand Elasticities

The focus of this study is on demand elasticities. Estimates of the uncompensated price and expenditure elasticities derived from the censored translog demand system are presented in table 4. All own-price elasticities are negative and follow the theory of demand. Fluid milk own-price elasticities ranged from −0.52 for reduced fat milk, −1.16 for flavored reduced fat milk, −1.31 for whole milk, −1.42 for canned milk, −1.50 for buttermilk, −2.16 for flavored whole milk, to − 2.32 for other milk products. Nearly all of the own-price elasticities for fluid milk are above unity, which imply that a one percent change in price will have an impact larger than one percent on the quantity demanded of fluid milk.

As expected, there are many substitution relationships within milk products that support the conventional wisdom of consumers' traditional purchasing behaviors. Of the 42 cross-price elasticities, 33 are statistically significant. We identified several gross substitution relationships derived from the compensated demand. According to our findings, whole milk serves as a substitute for reduce-fat milk, flavored reduce-fat milk and buttermilk. Also, reduce-fat milk is a substitute for flavored reduce-fat milk and buttermilk and canned milk a substitute for whole milk, reduced fat milk, flavored whole milk, flavored reduced fat milk, and buttermilk. There are also a number of complementary relationships that are presented in the compensated demand table.

Table 4: CENSORED TRANSLOG MODEL COMPENSATED ELASTICITIES

	WHOLE	REDUCFAT	FLAV-WHOLE	FLAVREDUCFAT	BUTTERMILK	CANNED	OTHERMILK
WHOLE	-1.31***	1.04***	-0.10*	0.60***	0.94***	-0.19*	-0.98***
REDUCFAT	0.65**	-0.52***	-0.16**	0.50***	0.81***	-0.10***	-1.19***
FLAV-WHOLE	0.68***	0.44*	-2.16***	0.46	1.37***	0.07***	-0.87***
FLAVREDUCFAT	0.84***	0.70***	-0.16**	-1.16***	1.01***	-0.18	-1.05***
BUTTERMILK	0.93***	0.17	0.40	0.73***	-1.50***	-0.15	-0.58***
CANNED	0.00	0.64***	0.01	0.38**	0.81***	-1.42***	-0.42***
OTHERMILK	0.14	0.66***	-0.18*	0.31	1.13***	0.25***	-2.32***

Note: Level of Statistical Significance - *** = 1%, ** = 5%, * = 10%

Uncompensated Censored Translog Demand Elasticities

Estimates of the uncompensated price and expenditure elasticities derived from the censored translog model are presented in table 5. Like the results derived from the compensated demand, all the own-price elasticities are negative, implying an inverse relationship between the prices and quantity demanded of milk products. While all of the own-price elasticities are statistically significant for both the compensated and uncompensated demands, reduced fat milk is the only inelastic own-price elasticity of the two. According to past studies, own-price elasticities derived from the censored translog demand system for whole milk seems to be similar to those derived by Boehm and Babb (1975) and Schmit et al., (2002), while own-price elasticities derived by the censored demand for buttermilk are more inline with estimates derived by Boehm and Babb (1975).

Cross-price estimates for the censored translog model weighed more heavily on the substitution side than the complement. There are twenty-one statistically significant substitution relationships calculated using the compensated demand compared to only twelve derived using the uncompensated demand. All of the positive statistically significant cross-price elasticities derived from the uncompensated demand are inelastic and have small impacts on changes in demand for milk products given a one percent change in the price of a gross substitute. Another difference in the compensated and uncompensated demands is the number of complementary relationships. For the uncompensated demand, there are only two statistically significant negative cross-price elasticities compared to twelve complementary relationships for compensated demand. Whole milk is found to be a gross complement to other milk products and flavored reduced fat milk is a gross complement too other milk products as well.

Expenditure elasticities derived from the censored translog model are all normal goods and statistically significant at the one percent level. Reduced fat milk is the only expenditure elasticity greater than unity. For the other six fluid milk categories, a one percent change in consumers' disposable income will yield less than a one percent change in fluid milk purchased. Fluid milk expenditure elasticities vary across milk products, ranging from 0.44 for canned milk to 1.07 for reduced fat milk. The elasticity for other milk products is elastic for the uncompensated demand and inelastic for the censored translog model. The difference in the two estimates is important in that a one percent change in consumers' expenditure will have a larger or smaller than one percent change on the demand for other milk products. Whole and reduce fat milks are elastic or close to elastic and are similar to findings by Gould (1996).

Table 5: CENSORED TRANSLOG MODEL UNCOMPENSATED ELASTICITIES

	WHOLE	REDUCFAT	FLAV-WHOLE	FLAVREDUCFAT	BUTTERMILK	CANNED	OTHERMILK	EXPEND.
WHOLE	-1.71***	0.49	0.03	0.15	0.15	-0.10	0.06	0.93***
REDUCFAT	0.19***	-1.16***	0.00	-0.02	-0.10	0.01	0.02	1.07***
FLAV-WHOLE	0.33**	-0.04	-2.04***	0.07	0.69	0.15	0.03	0.80***
FLAVREDUCFAT	0.44***	0.16*	-0.03	-1.60***	0.24	-0.09	-0.03	0.91***
BUTTERMILK	0.73***	-0.11	0.46*	0.51***	-1.89***	-0.10	-0.06	0.46***
CANNED	-0.19	0.38***	0.08	0.16	0.43***	-1.37***	0.07	0.44***
OTHERMILK	-0.24***	0.14*	-0.05	-0.12*	0.39***	0.34***	-1.33***	0.88***

Note: Level of Statistical Significance - *** = 1%, ** = 5%, * = 10%

Conclusions

Empirical estimates of demand elasticities are at the heart of market analyses of food products. Many studies have reported estimates of demand elasticities for fluid milk products but they have generally been related to only a few product categories. In this study we have analyzed at-home consumption of seven different fluid milk products: whole milk, whole flavored milk, reduced fat milk, flavored reduced fat milk, buttermilk, canned milk, and all other fluid milk products. The Nielsen household home scan data used for the analysis highlighted zero purchases of product categories which could become an issue. A censored translog demand system model was specified to address that particular issue and both demographic and economic variables were included.

The model yields both compensated and uncompensated demand elasticity estimates. Our estimates of elasticities associated with the included demographic variables suggest that changes in those variables would produce only marginal changes in the aggregate demands for the fluid milk products we have defined. Price and income are clearly the main drivers of changes in fluid milk demands.

Findings indicated notable differences between estimates from the compensated and uncompensated demands specifications for own- and cross-price elasticities. Derived own-price elasticities for whole milk are similar to those reported by Boehm and Babb (1975) and Schmit et al., (2002), and the own-price elasticity for buttermilk appears to be comparable to the one estimated by Boehm and Babb (1975). Results revealed that the sizes of calculated own-price elasticities for the compensated and uncompensated models are different in size. Most of the fluid milk products for both compensated and uncompensated demands are seen to be gross substitutes, based on estimates of the cross-price elasticites, for each other. Results also indicate that all expenditure elasticities indicate that the seven products are normal goods and statistically significant. The expenditure elasticities for whole milk (0.93) and reduced fat milk (1.07) derived from the estimates provided by our censored translog demand system for fluid milks are similar to those of Gould (1996).

Information derived from an extensive database like the Nielsen retail home scan data can prove to be quite useful. Agricultural product processors, manufacturers, and marketers or food retailers may use information from studies such as this to boost sales through advertisement of specific dairy food items. For example, disaggregated fluid milk elasticities from this study can more precisely inform retailers and dairy producers on how consumers will likely respond if there is a change in the own-price of any one or some set of the defined fluid milk products. Dairy producers and retailers may also use the fluid milk expenditure elasticities to estimate the impacts declining household income and cyclical unemployment may have on milk sales that might be indicative of continued producer or retail firm viability. A disaggregated list of fluid milk information, such as own- and cross-price elasticities described above, help retailers understand product substitution and complementarity—consumers' indications of their desires for the availability of a diverse set of milk products.

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Appendix Table 1 Selected fluid milk sales by product, 1975-2007

Year	Whole milk	Lower fat: 2-percent milk	Lower fat: 1-percent milk	Skim milk	Total beverage milk 1/
	Million Gallons				
1975	4,208	1,015	319	288	6,190
1976	4,098	1,111	334	293	6,227
1977	3,958	1,212	349	304	6,232
1978	3,865	1,281	376	296	6,217
1979	3,777	1,368	382	303	6,213
1980	3,634	1,446	405	307	6,163
1981	3,535	1,522	416	300	6,128
1982	3,413	1,570	411	285	6,021
1983	3,357	1,649	402	288	6,060
1984	3,280	1,761	393	317	6,138
1985	3,228	1,896	407	350	6,272
1986	3,075	2,004	456	376	6,305
1987	2,982	2,047	441	396	6,270
1988	2,871	2,147	436	463	6,318
1989	2,654	2,274	487	582	6,380
1990	2,481	2,275	575	663	6,369
1991	2,415	2,306	606	698	6,402
1992	2,348	2,308	625	739	6,398
1993	2,263	2,271	616	796	6,323
1994	2,235	2,247	629	862	6,358
1995	2,170	2,144	670	972	6,347
1996	2,174	2,116	676	1,032	6,399
1997	2,141	2,062	695	1,063	6,370
1998	2,110	2,015	711	1,070	6,339
1999	2,147	2,034	707	1,045	6,385
2000	2,145	2,012	738	981	6,336
2001	2,094	2,008	740	956	6,277
2002	2,088	2,014	731	934	6,304
2003	2,073	2,018	721	906	6,321
2004	2,023	2,024	722	906	6,287
2005	1,949	2,038	739	928	6,263
2006	1,912	2,066	756	945	6,359
2007	1,831	2,101	773	954	6,351

Source: ERS-USDA calculations