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Long-Term Growth in U.S. Cheese Consumption May Slow

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Abstract

Cheese production and markets have emerged as important elements of the dairy industry over the past three decades. Three approaches were taken to assess factors affecting U.S. cheese consumption. The first showed the upward trend in total cheese consumption over time in a supply-and-use framework. The second approach examined consumption using selected demographic and economic factors and Nielsen 2005 Homescan data. Income, age, racial/ethnic factors, location, and gender influence cheese consumption in different, but significant, ways. Lastly, an analysis of Nielsen 2005 retail Homescan survey data was used to estimate cheese demand and expenditure elasticities. Own-price elasticities for all cheese products were statistically significant and elastic. Expenditure elasticities for all cheese products were also statistically significant, but only expenditures for American, cottage, and other cheeses were found to be elastic. The current White majority (the major consumers of cheese) of the population is expected to shrink as other groups grow in size. So, while U.S. per capita cheese consumption has more than doubled since the mid-1970s, future growth may slow as the U.S. population changes.

Keywords: Cheese, cheese consumption, Nielsen retail Homescan data, elasticities of demand, per capita use, socioeconomic characteristics

Acknowledgments

Introduction

Cheese sales are a key economic component of the U.S. dairy industry. As consumer demand for cheese products has risen over time, more of the milk produced on American dairy operations has been allocated to making a variety of cheeses. About 188.9 billion pounds of milk were marketed in the United States in 2008, and 127 billion pounds were used in the manufacture of dairy products. Cheese production (not including cottage cheese) took about 65 percent (82 billion pounds) of the milk used for manufactured products. Continued growth in cheese consumption is a key factor in determining a positive market outlook for the U.S. dairy industry.

For the overall U.S. dairy industry to continue its growth trend, an increase in cheese consumption would be key. However, a change in the makeup of the U.S. population may reduce demand for cheese. Our findings show that Whites purchased more total cheese in 2005 than other races or ethnic groups in the United States. To the extent that the non-White population is forecast to increase more rapidly than the White population, average per capita cheese consumption in the United States may reflect a shift toward patterns of lower cheese consumption (U.S. Department of Commerce, 2008).

Cheese sales and consumption are influenced by many factors. Among them are:

1. the availability of more cheese varieties

2. expanded cheese use by fast-food and pizza restaurants

3. increased use of cheese as an ingredient by both food manufacturers and home cooks

4. increased consumption of "cheese rich" ethnic foods such as Italian and Mexican dishes (Manchester and Blayney, 1997)

Emphasis on the nutritional benefits of milk and dairy products also has contributed to changes in cheese consumption. Cheese retains milk's calcium content and is one of three dairy products recommended for good health and nutrition.[1]

[1] See www.cnpp.usda.gov/DGAs 2005Guidelines.htm for more information.

This report uses three methods to analyze cheese demand and consumption. The first is a historical trend of traditional supply-and-use information at a very aggregate level. The second utilizes Homescan data to link purchases with various sociodemographic and economic factors. The third examines retail sales data, along with sociodemographic and economic factors, to generate estimates of key demand measures—price and expenditure elasticities.

Cheese Consumption More Than Doubled in 30 Years

The historical approach is based on supply-and-use (S&U) calculations that are a major component of ERS market analysis. The S&U approach is basically an accounting framework. Food supply and utilization data, also known as food disappearance data, measures the flow of raw and semi-processed food commodities through the U.S. marketing system. (See www.ers.usda.gov/foodconsumption for more details.) The data are neither a direct measure of actual consumption nor of the quantity of food actually ingested. The total amount available for domestic consumption is generally estimated as the residual after exports, and yearend inventories are subtracted from the sum of production, beginning inventories, and imports. The use of conversion factors allows for some subsequent processing, trimming, spoilage, and shrinkage in the distribution system. However, the estimates also include residual uses for which data are not available (such as miscellaneous nonfood uses, and changes in retail and consumer stocks). Domestic total use is divided by population to give per capita use estimates, which can be used as proxies for domestic consumption.

Most of the cheese consumed in the United States fits into two broad categories: "American" types and "other-than-American" types. The American category comprises four varieties of cheese: Cheddar, Colby, Monterey, and Jack. The other-than-American types are primarily Italian varieties such as Mozzarella, Parmesan, Provolone, Ricotta, Romano, and others) but also includes Hispanic, Swiss, and other varieties. Estimates of the U.S. annual

Figure 1

Per capita consumption of selected dairy products, 1975-2008

Pounds of products consumed   Gallons of fluid milk
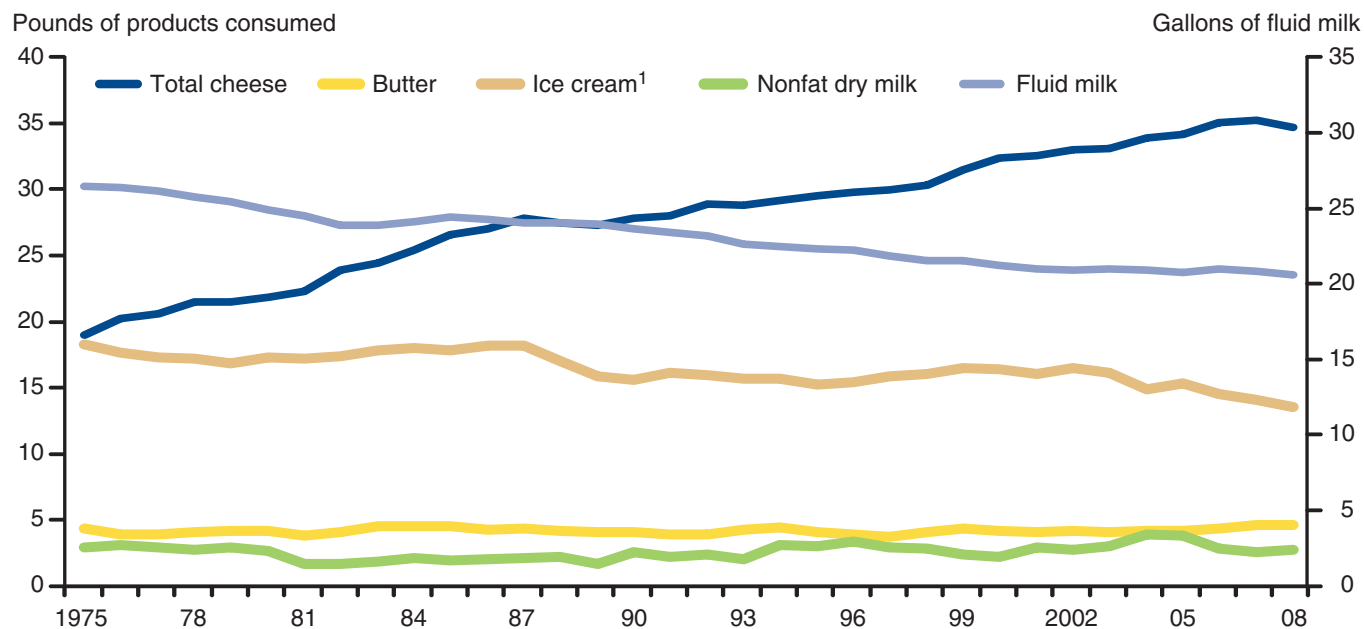
[1]Ice cream = regular hard varieties.

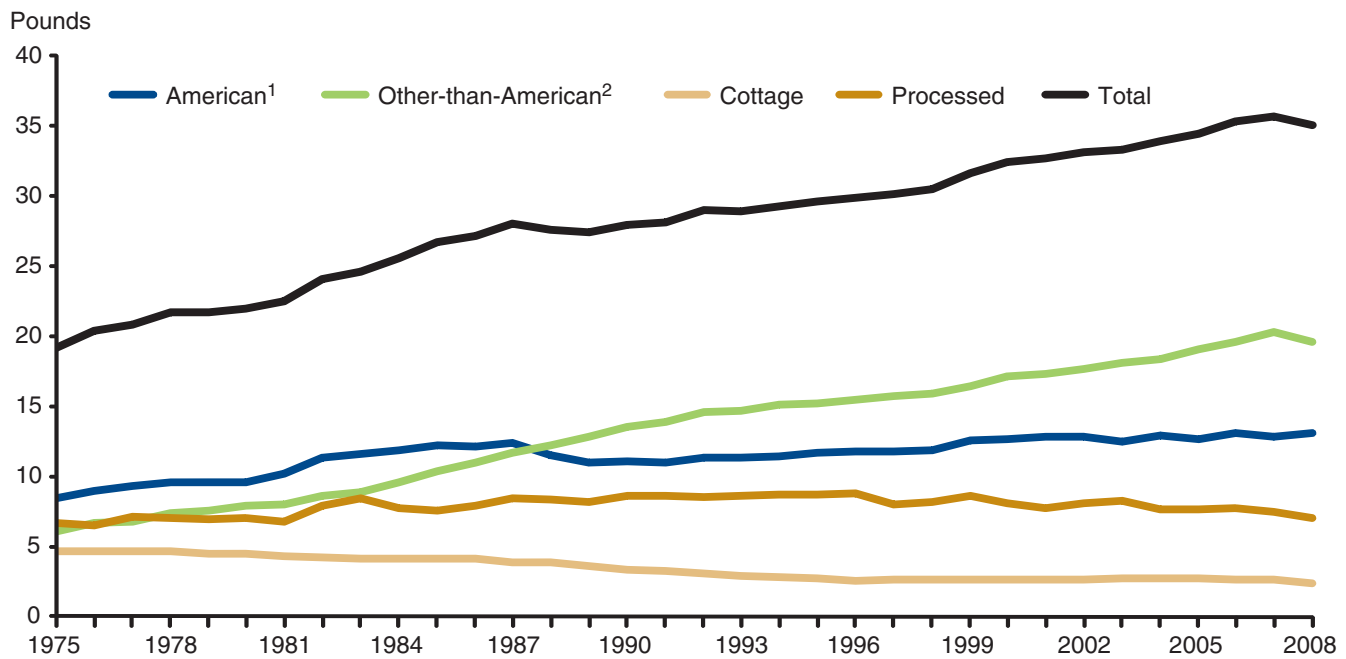Source: USDA, Economic Research Service.

per capita use of American and other-than-American cheeses taken together have trended steadily upward, from slightly over 14 pounds in 1975 to 32 pounds in 2008. While total per capita cheese use has been increasing, per capita use of other manufactured dairy products and fluid milk has declined (a result of declining proportions of total milk being made into those products). In this study, three ERS cheese categories are examined: American, other-than-American, and cottage cheese. Total cheese is defined as the sum of those three categories. (The Nielsen Homescan data use five cheese categories: American, Italian, cottage, processed, and other. See page 5 for more details.)

While total cheese use has trended upward, interesting trends of the four cheese categories (fig. 2) are observed. Most notable is the growth in consumption of other-than-American cheese.

The declining per capita use of cottage cheese has been offset by the combined upward trend of American and other-than-American cheeses, sometimes together called natural cheeses. Natural cheeses are produced directly from milk or, in some cases, whey. Since 1987, American cheese consumption has slowly increased, while other-than-American consumption has risen more rapidly, although 2008 preliminary estimates show a decline. The trends suggest that increased cheese consumption was driven mostly by natural-cheese sales.

Given the importance of cheese in the mix of U.S. dairy products, these aggregate data are useful for assessing general trends. In the following two sections, we examine household survey data to provide added insights about cheese consumers.

Figure 2
Disaggregating total per capita cheese consumption, 1975-2008

[1]American cheeses are Cheddar, Colby, Monterey, and Jack.
[2]Other-than-American cheeses include Mozzarella, Parmesan, Provolone, Ricotta, Swiss, Hispanic varieties, and others.
Source: USDA, Economic Research Service.

Consumer Characteristics and Cheese Demand

To analyze the different factors affecting U.S. cheese consumption, we used the Nielsen retail Homescan data (see box, "Nielsen Homescan Data"). These data only contain retail purchases for at-home use. Thus, one of the limitations to using the Nielsen data is cheese consumed away from home at establishments such as fast food restaurants, dine-in restaurants, cafeterias, schools, etc., is not included. If the products being analyzed have a significant away-from-home consumption, estimated economic measures such as per capita consumption or elasticities must be evaluated with that in mind.

The Nielsen Homescan data were parsed based on five cheese categories: American, Italian, cottage, processed, and other cheeses.[2] In 2005, according to Nielsen Homescan, consumers purchased approximately 10.86 pounds of cheese per capita, excluding dishes containing cheese or meals purchased with cheese in them. By category, consumers purchased 1.27 pounds of American cheese, 1.81 pounds of cottage cheese, 1.13 pounds of Italian cheese, 3.80 pounds of processed cheese and 2.85 pounds of other cheeses per person in 2005. The per capita purchase[3] of cheese was calculated by dividing the total weight of cheese purchased per category by the U.S. population in 2005. The rest of this report will analyze cheese consumption patterns across various sociodemographic and economic factors including income, location, ethnicity, and population composition (age and gender).

[2] Other cheeses, as defined by Nielsen Homescan, are cheeses that don't fall into the American, Italian, cottage, or processed categories.

[3] Per capita cheese purchases are not the same as per capita cheese consumption.

Nielsen Homescan Data

The 2005 Nielsen Homescan data contain demographic and food purchase information for a nationwide panel of representative households. Each household in the panel is given a handheld scanning device to scan at home all food items purchased at any retail outlet. Some households record only universal product code (UPC)-coded foods while others scan both UPC-coded and random weight items. The UPC barcode is a familiar entry on consumer goods and is one of the principal technological developments, along with store computers, that made modern scanner data possible. In this study, we used the smaller subset of 8,216 households that recorded both UPC-coded and random weight products. These households reported 7,597,426 purchases in 2005, including 900,100 dairy products. Each purchase record contains data on product characteristics, quantity purchased, price paid with and without promotions, date of purchase, store, and brand information. Each panel household provides information on the size and composition of the household, income, origin, age, race, gender, education level, and occupation of household members. Market location data are also available for each household. Projection factors (sample weights) are provided by Nielsen to be used to generate national estimates. Per capita cheese consumption by sociodemographic characteristics and income is derived by dividing national estimates by U.S. population (see appendix A).

Households With Incomes of $70,000–$99,999 Bought the Most

Nielsen separates household income into 16 different income ranges. For convenience, household income was combined into eight categories in this study. The majority of households had income earnings that ranged from $20,000 to $99,999. Households with incomes ranging from $70,000 to $99,999 bought more cheeses overall than other income groups did, and they were the chief consumers of processed and other cheese products among the groups (fig. 3). Households with income ranging from $10,000 to $19,999 were the main consumers of Italian cheese. The smallest amount of cheese products purchased during 2005 was bought by Americans whose households incomes ranged from $50,000 to $69,999.

Whites Were the Predominant Purchasers

The 2005 Nielsen survey contains questions that ascertain household consumers' race and ethnicity. The four races used in the survey that cover the total U.S. population included Whites, Blacks, Asians, and other races (including Hispanics). Whites dominated the market in 2005 retail cheese sales, purchasing over 12 pounds of cheese per capita with processed cheese as the primary cheese of choice. Asians and Blacks purchased about the same amount of total cheese during the observed period, which was less than the total cheese purchased by Whites. The second-leading cheese-purchasing category was other races (including Hispanics) with other cheese types being the top cheese products purchased (table 1).

Figure 3
Per capita cheese purchases of all cheese types, by household income

Pounds bought per household

Household income
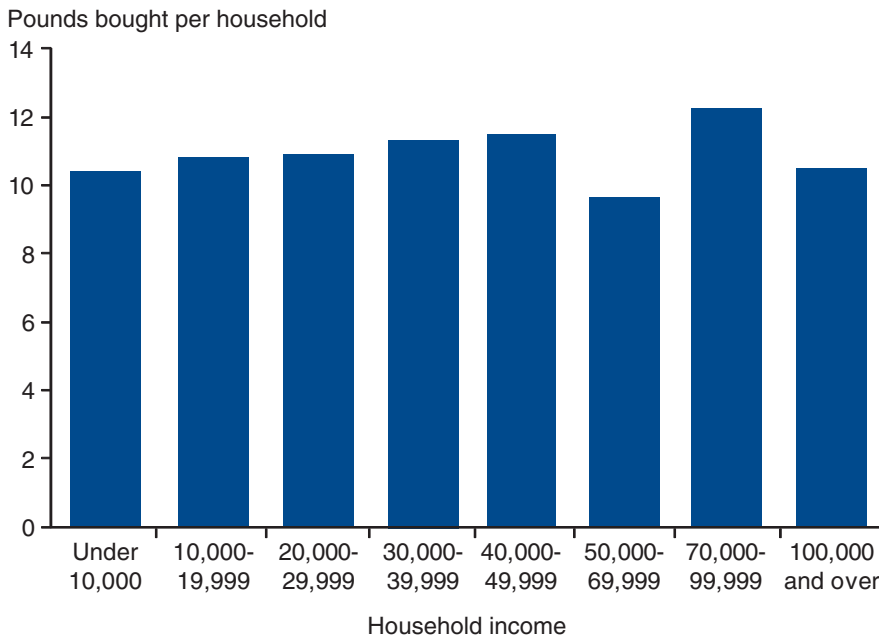
All cheese types = American, Italian, processed, cottage, and other as defined by Nielsen.

Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.

Source: USDA, Economic Research Service.

Table 1
Per capita cheese purchases 2005, by race

Race	Other[1]	Processed	Total
		Pounds	
White	3.13	4.23	12.20
Black	1.48	2.65	5.92
Asian	1.97	2.02	5.98
Other (including Hispanics)	2.76	2.60	8.61

[1] Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.

Source: USDA, Economic Research Service, based on data from 2005 Nielsen Homescan.

All per capita calculations were performed by ERS.

Midwestern Households Bought the Most by Region

The Nielsen data represent four regions that account for the total U.S. population. Results reveal that the Midwest led the Nation in retail cheese purchases in 2005. People residing in the Midwest purchased more processed cheese than they did other cheese categories (table 2). Italian cheese was eaten more in the Northeast than any other region, according to the Nielsen data. In the Nielsen data, household members from the West region were the second-largest cheese buyers. Processed cheese, followed by other cheeses (including non-Italian varieties) were the leading two cheeses consumed in the South.

Households Headed by Females With High School Degrees and by Males With Postcollege Degrees Were Leading Purchasers

Male heads of household with professional degrees were the leading purchasers of cheese followed closely by males who completed only a Bachelor's degree (appendix table 1). Other cheeses were the cheese products purchased most often by both college and postcollege graduates (fig. 4). Theoretically, their preference was not unusual given that the other-cheese category includes a high proportion of specialty cheeses that are normally more expensive than cheeses in the other categories. The second-leading cheese product purchased by postcollege and college graduates was processed cheese. Male heads of household who obtained high school degrees and those who had some college experience ranked third and fourth in total cheese purchases, with processed cheese accounting for the largest share of total cheese purchased (see appendix table 1).

In the Nielsen data, head of household educational achievement was separated into seven categories. Figure 5 shows the per capita cheese purchased by female heads of household by educational achievement according to Nielsen 2005 Homescan retail data. Females who obtained only a high school diploma were the leading purchasers of cheese followed by female college graduates (see appendix table 1). The type of cheese purchased the most by female high school graduates was processed cheese, but other cheeses were purchased slightly more by female college graduates.

Table 2
Per capita cheese purchases 2005, by region

Region	American[1] cheese	Italian	Cottage	Other[2]	Processed	Total cheese
			Pounds			
Northeast	1.15	1.94	1.39	2.19	3.48	10.16
Midwest	0.96	0.89	2.76	3.33	4.49	12.44
South	1.26	0.87	1.40	2.73	4.15	10.40
West	1.72	1.12	1.87	3.11	2.81	10.63

[1]American cheeses are Cheddar, Colby, Monterey, and Jack.

[2] Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.

Source: USDA, Economic Research Service, based on data from 2005 Nielsen Homescan survey.

All per capita calculations were performed by ERS.

Figure 4
Per capita cheese purchases by male heads of households

Head of household level of education

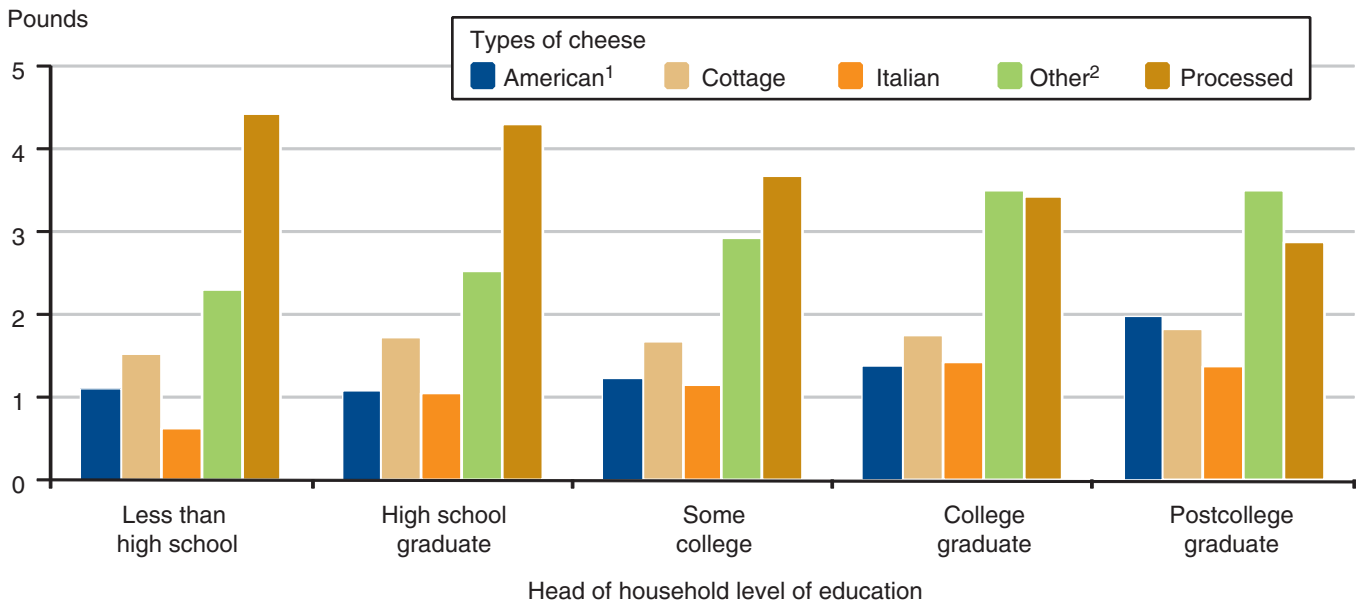[1]American cheeses are Cheddar, Colby, Monterey, and Jack.

[2]Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.

Source: USDA, Economic Research Service, based on data from 2005 Nielsen Homescan survey.

All per capita calculations were performed by ERS.

Of all the different educational levels, both female and male heads of household who had less than a high school diploma purchased the least amount of cheese (see appendix table 1). Given this finding, strategies targeted at these two groups may be needed to help increase dairy consumption to satisfy the 3-Every-Day requirement for good health.

Young Females and Older Males Were Among the Biggest Buyers

Nielsen divides the head of household age into 10 categories. Female household heads under 25 years old dominated cheese purchases on a per capita basis, while male heads of household ages 65 and older were the top

Figure 5
Per capita cheese purchases by female heads of households

Pounds

[1]American cheeses are Cheddar, Colby, Monterey, and Jack.
[2]Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.
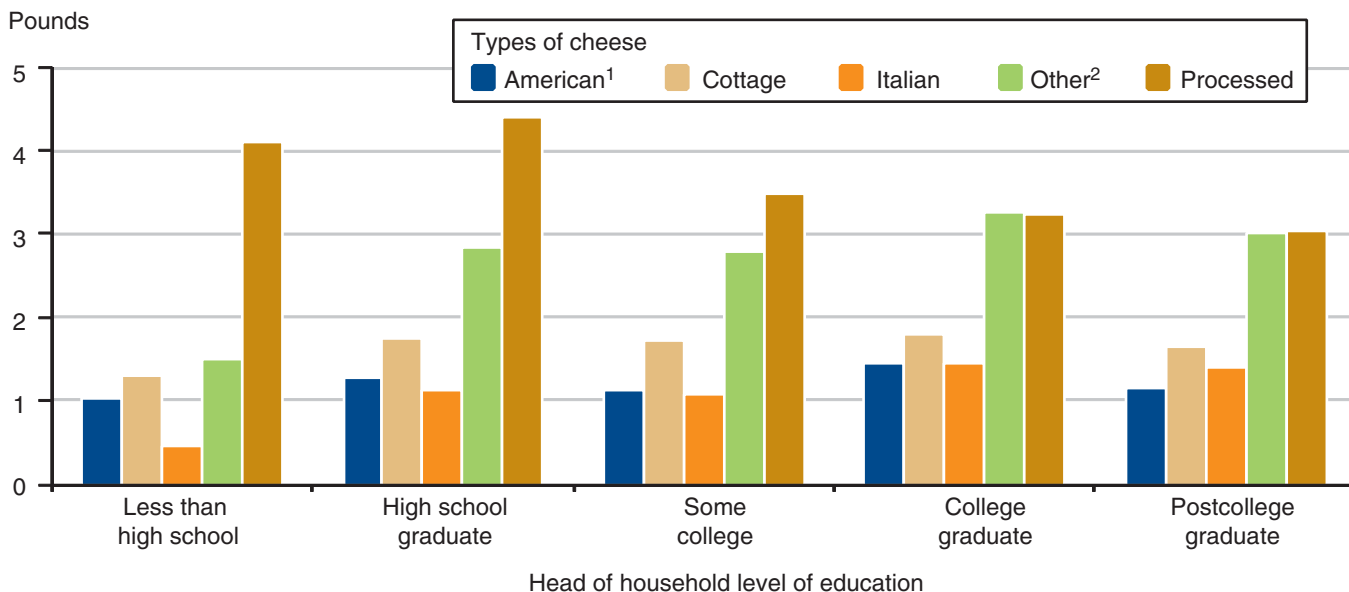Source: USDA, Economic Research Service, based on data from 2005 Nielsen Homescan survey.
All per capita calculations were performed by ERS.

purchasers of processed cheese (see appendix table 1). Cottage cheese was the primary cheese of choice for females 25 years and younger; in contrast, men 65 years and older purchased more processed cheese than they did cottage, American, Italian, or other cheese varieties. Female heads ages 65 years and older and females ages 55 to 64 were close second- and third-leading buyers of total cheese. Among the females in the two oldest age categories, processed cheese was the product most purchased. For male heads of household, those who purchased the second- and third-largest share of total cheese were males, ages 55 to 64 and 35 to 39, whose primary choice of cheese was processed cheese also. Among male heads of households, total cheese purchases were lowest for those 29 and younger, while for female heads of households, total cheese purchase was lowest for those 35 to 39 years old (see appendix table 1). The lowest amount of cheese purchased by female household heads was more than twice as much as that purchased by male heads, which may imply that male heads from ages 25 to 29 are satis-fying their 3-Every-Day requirement by purchasing other dairy foods not captured by Nielsen Homescan data, or it could mean that a strategic plan could be successful in increasing intake of dairy, in this instance cheese by male household heads of household ages 25 to 29.

Among the five types of cheese, more female heads of households ages 45 to 49 and male heads of households ages 55 to 64 bought more processed cheese than they did any another type (figs. 6 and 7). Next to processed cheese, other cheeses seem to be strong favorites among male and female household heads ages 25 to 64. After 64 years of age, both males and females heads of household appear to have a greater preference for processed and cottage cheeses.

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Figure 6
Per capita cheese purchases by females

Pounds

¹American cheeses are Cheddar, Colby, Monterey, and Jack.
²Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.
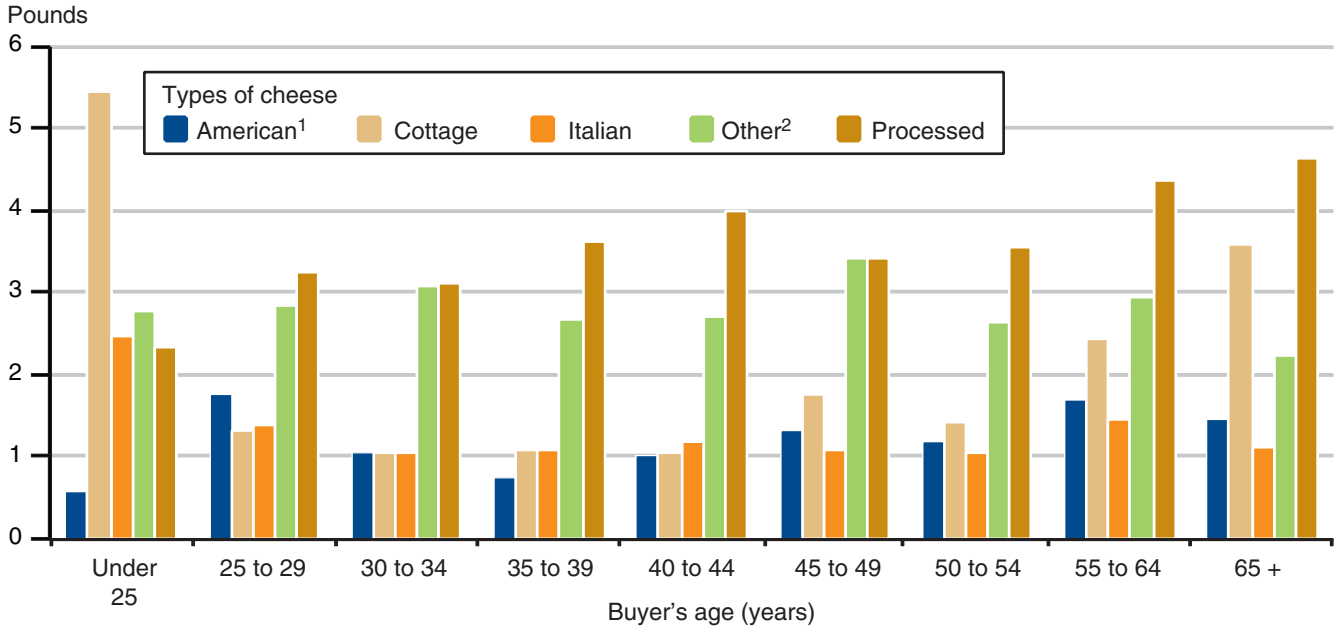Source: USDA, Economic Research Service, based on data from 2005 Nielsen Homescan survey.
All per capita calculations were performed by ERS.

Figure 7
Per capita cheese purchases by males
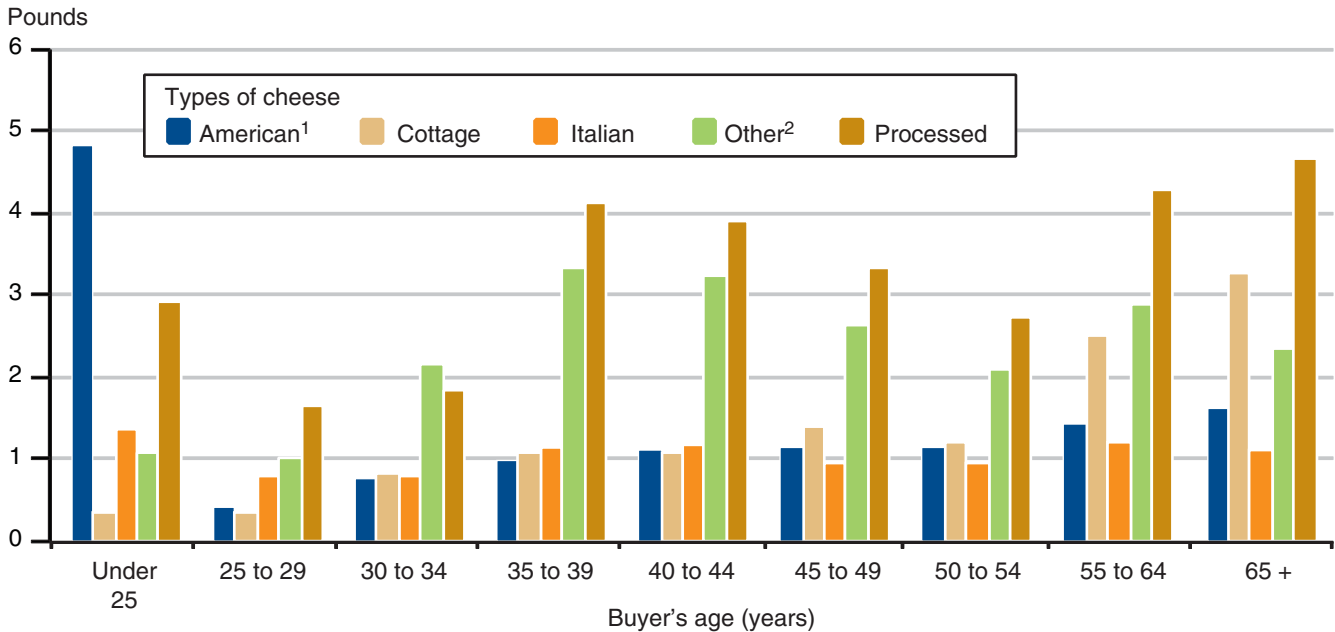
Pounds

¹American cheeses are Cheddar, Colby, Monterey, and Jack.
²Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.
Source: USDA, Economic Research Service, based on data from 2005 Nielsen Homescan survey.
All per capita calculations were performed by ERS.

Price and Expenditure Elasticities for 2005 Retail Cheese Purchases

Product demand analysis relies on the estimation of several measures of economic relationships, including expenditure and price elasticities. In this study, a censored almost ideal demand system (AIDS) model developed by Dong, Gould, and Kaiser (2004) is employed to derive elasticity estimates. The model estimation is an Amemiya-Tobin approach that imposes an adding-up constraint in both latent and observed expenditure shares. Both homogeneity and symmetry conditions were imposed. A simulated probability procedure is used in the model estimation to evaluate the high order probability integrals. A censored demand system was specified and employed to estimate U.S. cheese demand using 2005 Nielsen retail Homescan data. More details can be found in appendix B.

The censored demand system provides both own-price and cross-price elasticity estimates, along with expenditure elasticities. Exogenous variables such as household size, two female age categories, and the presence of children in the home are some of the factors accounted for in the cheese demand system. The uncompensated (Marshallian) estimates indicate that the demand for American, Italian, cottage, processed, and other cheese types are very responsive to changes in their own-price (table 3).

All of the own-price elasticities for cheese were statistically significant and greater than 1. Theoretically, a 1-percent change in the price of any of the five types of cheese will have a larger than 1-percent change in quantity demanded,[4] making consumers major beneficiaries of declines in the price of cheese products. Cottage cheese showed the greatest responsiveness to changes in own-price, while the smallest change in quantity demanded due to a change in own-price was displayed by other cheese types.

[4] An elasticity of an aggregated product category is generally less than the individual elasticities of products used in the aggregation.

Results also show strong substitution relationships among all cheese categories. American cheese is a substitute for Italian, cottage, processed and other types of cheeses and vice versa. All cheese types estimated in this study serve as a substitute for one another, which logically implies that consumers are willing to substitute a cheese of choice for another cheese product if its price increase causes consumers to exceed their cheese budget or if the cheese of

Table 3

Uncompensated price elasticities and expenditure elasticities

Cheese types	American[1]	Italian	Cottage	Processed	Other[2]	Expenditure elasticities
American	−2.15***	0.16***	0.22***	0.38***	0.33***	1.06***
Italian	0.20***	−2.14***	0.26**	0.50***	0.31***	0.87***
Cottage	0.25***	0.27***	−2.53***	0.49***	0.34***	1.20***
Processed	0.15***	0.16***	0.18***	−1.73***	0.30***	0.94***
Other	0.14***	0.09***	0.12***	0.32***	−1.69***	1.02***

[1] American cheeses are Cheddar, Colby, Monterey, and Jack.

[2] Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.

Note: Level of statistical significance - *** = 1 percent.

Source: USDA, Economic Research Service, based on data from 2005 Nielsen Homescan survey.

choice is unavailable. Additionally, findings reveal that all expenditure elasticities for the five types of cheese are positive, but cottage and American cheeses show the greatest level of responsiveness to changes in cheese expenditures. These findings indicate that the demand for cheese will rises with consumers' expenditure. Based on the estimated demand elasticities, assuming all other things held constant, the dairy industry would benefit from those increases in consumers' food expenditures, which translate into higher cheese expenditures.

Conclusions and Implications for the Future

This report uses market, Homescan, and survey data in three ways to examine facets of U.S. cheese consumption. The aggregate historical S&U approach is able to provide information for longer term questions of whether cheese production and consumption might remain important driving forces in the dairy industry of the United States. The generally upward long-term patterns of cheese consumption (for both individual products and in total) contrast sharply with declining or relatively flat trends for fluid milk products and other manufactured dairy products. Although slowing somewhat in recent years, total cheese use has grown steadily since 1975, with the impetus coming mostly from sales of natural cheese, in particular those of the other-than-American types. It remains to be seen if the sharp economic downturn beginning late in 2008 and gradually rebounding now will significantly alter the long-term trends. Milk producers, cheese manufacturers, and dairy product marketers all recognize the importance of cheese products and seek information as to what factors influence cheese consumption.

The empirical results indicate that the uncompensated own-price elasticities for the five identified cheese categories are all negative, statistically significant, and large. The estimated cross-price elasticities exhibit substitutability among the categories, a result that would likely be expected. Expenditure elasticities are positive (signifying that cheese consumption increases with expenditure, and vice versa), greater or close to 1, and statistically significant.

Given these general outcomes, what can be said about demand for cheese into the future? Economic and demographic factors such as consumer income, regional population, and age may give some indication. Over the past 8 years, per capita personal income has increased annually (U.S. Department of Commerce, 2010). Based on estimated expenditure elasticities, to the extent increases in consumers' food expenditure transfers into higher cheese expenditures then it is expected that total cheese consumption also will rise.

Race and ethnicity are important factors that may have significant impacts on cheese purchases and consumption. Our findings show that Whites purchased more total cheese in 2005 than other races or ethnic groups in the United States. To the extent that the non-White population is forecast to increase more rapidly than the White population, average per capita cheese consumption in the U.S. may reflect a shift toward patterns of lower cheese consumption (U.S. Department of Commerce, 2008). The implication behind this change in ethnic demographics is a possible per capita reduction in cheese purchases and consumption.

Regional population is another factor that has affected cheese purchase and consumption in the past and will likely play some role in the future. As the results suggest, there are regional differences in cheese consumption, and assuming the U.S. total population continues to grow, where that growth takes place can affect the magnitude of cheese consumption. For example, if the South and Northeast are expected to have the largest increase in population over the next decade, then one can expect that there will be a greater

demand for processed cheese, and other cheeses (the non-Italian varieties), all else being equal.

A final factor that may influence future cheese consumption is age. Improved medical treatments have allowed people to live longer and, in some cases, healthier lives. As people grow older, most tend to adjust their lifestyles, including their diets. As Baby Boomers move into the 60-years-old and older age group, it is expected that they will continue to consume cheese to obtain the vitamin D and/or calcium needed for strong bones. The Nielsen data indicate that per capita total cheese purchases for male heads of household ages 65 and older are highest among all male heads of household and female heads of household ages 65 and older are second-highest among all female heads of household. The expectations of more cheese being consumed by that age group also would suggest more milk needed for cheese. Stronger increases, or perhaps even a gradual increase in total cheese production, would require processing/manufacturing adjustments for both cheese and milk.

Future patterns of cheese consumption have implications for the dairy industry, particularly given the large (and growing) share of U.S. milk production that has been used to manufacture cheese products. If consumer expenditure and/or total population should grow and demand for dairy products other than cheese remain as they are, the dairy industry will need to adjust to the growing demand for cheese. However, there are some limitations to this study, particularly with using the Nielsen retail Homescan data. First, Nielsen Homescan data reports only purchases of cheese and not processed foods with cheese as an ingredient, which means that the data do not include the cheese used as an ingredient in frozen dinners or pizzas, canned foods, or snack foods. Second, the Nielsen data exclude cheese consumed away from home, at fast-food restaurants, white-linen restaurants, or cafeterias. Cheese is particularly important for fast-food and pizza restaurants—cheeseburgers and double-cheese pizzas are essential menu items at many regional and national chain restaurants. Thus, the findings derived in this study should be used with these limitations in mind.

References

Ballenger, Nicole, and James Blaylock. 2003. "Consumer-Driven Agriculture: Changing U.S. Demographics Influence Eating Habits," *Amber Waves* 1(2):28-33, USDA, Economic Research Service. Available at: www.ers.usda.gov/Amberwaves/April03/Features/ConsumerDrivenAg.htm/

Dong, D., B.W. Gould, and H. Kaiser. 2004. "Food Demand in Mexico: An Application of the Amemiya-Tobin Approach to the Estimation of a Censored Food System," *American Journal of Agricultural Economics*, 86(2004):1094-1107.

Green, R. and J. Alston. 1990. "Elasticities in AIDS Models," *American Journal of Agricultural Economics*, 72(May 1990):442-445.

Lin, Biing-Hwan, Jayachandran N. Variyam, Jane Allshouse, and John Cromartie. 2003. *Food and Agricultural Commodity Consumption in the United States: Looking Ahead to 2020*. USDA, Economic Research Service, AER-835. Available at: www.ers.usda.gov/publications/aer835/

Manchester, Alden, and Donald P. Blayney. 1997. *The Structure of Dairy Markets*, USDA, Economic Research Service, AER-757. Available at: www.ers.usda.gov/publications/aer757/

Miller, James J., and Don P. Blayney. 2006. *Dairy Backgrounder*. USDA, Economic Research Service, LDPM-145-01. Available at: www.ers.usda.gov/Publications/LDP/2006/07Jul/LDPM14501/

Phaneuf, D.J., C.L. Kling, and J.A. Herriges (2000). "Estimation and Welfare Calculations in a Generalized Corner Solution Model with an Application to Recreation Demand," *Review of Economics and Statistics* (82)83-92.

U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. 2005. *Backgrounder: 2005 Dietary Guidelines for Americans*. Available at: http://www.cnpp.usda.gov/dg2005/index.html/

U.S. Department of Commerce, Bureau of Economic Analysis, National Economic Accounts. Per Capita Personal Income; selected years. 1970, 1980, 1990, 2000. Available at: http://www.bea.gov/national/nipaweb/TableView.asp?SelectedTable=58&Freq=Qtr&FirstYear=2008&LastYear=2010/

U.S. Department of Commerce, U.S. Census Bureau, Population Division. 2008. *Percent of the Projected Population by Race and Hispanic Origin for the United States: 2010 to 2050*. Available at: http://www.census.gov/population/www/projections/files/nation/summary/np2008-t6.xls

U.S. Department of Commerce, U.S. Census Bureau. 2000. *Statistical Abstract of the United States*. Available at: http://www.census.gov/prod/www/statistical-abstract-us.html/

U.S. Department of Commerce, U.S. Census Bureau. 1995, 2000, 2005. *Current Population Survey*. March Supplement.

Appendix A

Per capita cheese purchases by types of cheese, selective demographics

	Types of cheese					
	American[1]	Cottage	Italian	Other[2]	Processed (canned & dehydrated)	Total
	Ounces					
Buyers by:						
Income						
Under $10,000	1.18	0.74	1.45	4.86	2.19	10.43
$10,000 to 19,999	1.26	0.81	2.26	4.11	2.36	10.80
$20,000 to 29,999	1.17	0.90	1.89	4.16	2.77	10.89
$30,000 to 39,999	1.33	1.00	2.00	4.09	2.92	11.34
$40,000 to 49,999	1.37	1.30	1.82	4.07	2.91	11.47
$50,000 to 69,999	1.14	1.10	1.43	3.30	2.65	9.62
$70,000 to 99,999	1.49	1.63	1.90	3.73	3.51	12.27
$100,000 & over	1.37	1.42	1.54	2.77	3.40	10.50
Race						
White	1.35	2.21	1.28	3.13	4.23	12.20
Black	0.99	0.39	0.41	1.48	2.65	5.92
Asian	0.94	0.39	0.66	1.97	2.02	5.98
Other	1.10	1.03	1.12	2.76	2.60	8.61
Region						
East	1.15	1.39	1.95	2.19	3.48	10.16
Midwest	0.96	2.76	0.89	3.33	4.49	12.43
South	1.26	1.39	0.87	2.73	4.15	10.40
West	1.72	1.87	1.12	3.11	2.81	10.63
Education – female head of household						
Less than high school	1.03	1.30	0.47	1.50	4.09	8.39
High school graduate	1.26	1.75	1.12	2.82	4.39	11.34
Some college	1.13	1.71	1.08	2.79	3.47	10.18
College graduate	1.45	1.78	1.46	3.25	3.22	11.16
Postcollege graduate	1.14	1.64	1.39	3.01	3.04	10.22
Education – male head of household						
Less than high school	1.10	1.53	0.64	2.31	4.43	10.01
High school graduate	1.10	1.73	1.07	2.53	4.31	10.74
Some college	1.25	1.69	1.17	2.93	3.69	10.73
College graduate	1.39	1.75	1.44	3.52	3.45	11.55
Postcollege graduate	1.98	1.83	1.38	3.52	2.90	11.61

Appendix table 1
Per capita cheese purchases by types of cheese, selective demographics - Continued

	Types of cheese					
	American[1]	Cottage	Italian	Other[2]	Processed (canned & dehydrated)	Total
	——————————————— Ounces ———————————————					
Buyers by:						
Age – female head of household (years)						
Under 25	0.56	5.46	2.45	2.76	2.32	13.55
25 to 29	1.76	1.32	1.40	2.85	3.23	10.56
30 to 34	1.03	1.04	1.05	3.07	3.11	9.30
35 to 39	0.73	1.07	1.06	2.68	3.63	9.17
40 to 44	1.00	1.06	1.17	2.69	3.99	9.91
45 to 49	1.33	1.77	1.08	3.40	3.43	11.01
50 to 54	1.19	1.43	1.03	2.64	3.55	9.84
55 to 64	1.67	2.43	1.44	2.94	4.37	12.85
65 +	1.44	3.59	1.12	2.23	4.63	13.01
Age –male head of household (years)						
Under 25	4.83	0.36	1.35	1.08	2.93	10.55
25 to 29	0.42	0.35	0.80	1.01	1.65	4.24
30 to 34	0.75	0.81	0.79	2.15	1.84	6.34
35 to 39	0.98	1.07	1.15	3.34	4.12	10.66
40 to 44	1.11	1.10	1.18	3.24	3.91	10.52
45 to 49	1.15	1.40	0.95	2.64	3.33	9.47
50 to 54	1.16	1.21	0.95	2.10	2.74	8.16
55 to 64	1.44	2.50	1.21	2.90	4.29	12.34
65 +	1.61	3.29	1.11	2.36	4.67	13.04

[1]American cheeses are Cheddar, Colby, Monterey, and Jack.
[2] Other cheeses, as defined by Nielsen Homescan, are cheeses that do not fall into the American, Italian, cottage, or processed categories.
Note: See "Nielsen Homescan Data" box, page 5 for an explanation of methodology.

Source: USDA, Economic Research Service, based on data from 2005 Nielsen survey.

Appendix B

The Estimation of a Censored AIDS Model

Suppose the AIDS model based on the latent shares for M cheese products is defined as follows:

$$(A1) \quad S^* = A + \gamma \ln P + \theta \ln Y + e$$

where S^* is a vector of the M latent expenditure shares on cheese products, P is a vector of M prices, and $Y = \dfrac{y^*}{P^*}$, the deflated total expenditures, with y^* as total expenditures, P^* as a translog price index, and e is a vector of the M equation error terms. Incorporating household demographic variables are accomplished through translating the intercept in A1. That is, the intercept is defined as: $A = \alpha + \beta X$, where X is a vector of N demographic characteristics. Equation parameters are θ (M x 1), α (M x 1), β (M x N), and γ (M x M symmetric), where θ is the slope of the expenditure and γ is the slopes of the prices.

Given the budget constraint, the latent shares must sum to 1 (adding up). This adding-up condition can be attained through parameter restrictions. Theoretical constraints such as homogeneity and symmetry can also be imposed on A1. The adding-up restriction implies that the joint density function of e is singular. Consequently, one of the M latent share equations must be dropped during estimation. By dropping any equation from the estimation, we assume that the remaining $M - 1$ share equations' error terms, e in A1, are distributed multivariate normal with a joint probability density function.

The mapping of the vector of latent shares, S^*, to observed shares, S, must take into account that (1) the elements of S lie between 0 and 1, and (2) sum to 1 for each observation. The following mapping rule imposes these two characteristics:

$$(A2) \quad S_i = \begin{cases} \dfrac{S_i^*}{\sum\limits_{j \in \Omega} S_j^*}, & \text{if} \quad S_i^* > 0, \\ \\ 0, & \text{if} \quad S_i^* \leq 0, \end{cases} \quad , \quad (i = 1, 2, \cdots, M)$$

where Ω is a set of all positive shares' subscripts. The way A2 maps S^* to S is simple and has the property that the resulting density function is independent of whatever set of elements in S^* is used in its derivation.

By assuming that at least one cheese product is purchased, one can write the likelihood function for each household according to its observed purchase pattern (regime). Consistent and efficient model estimates can be obtained by maximizing the sum of log likelihood function over all households. Since the likelihood function contains high order probability integrals, the simulated probability procedure is used in model estimation.

Given the parameter estimates of γ and θ, demand elasticities of the latent system defined by A1 can be derived using the formula provided by Green and Alston (1990). Homogeneity and symmetry are held in these elasticities. Demand elasticities of the observed system defined by A2 can be obtained using a simulation procedure developed by Phaneuf, Kling, and Herriges (2000) and later applied by Dong, Gould, and Kaiser (2004). Homogeneity still holds in the elasticities of the observed system because the budget constraint (adding up) is imposed in both latent and observed systems. However, symmetry no longer holds in the observed system due to the non-negativity rule of matching given by A2. Further details can be found in Dong, Gould, and Kaiser (2004).