ESTIMATING THE CENSORED DEMAND FOR U.S. CHEESE VARIETIES USING PANEL DATA: IMPACT OF ECONOMIC AND DEMOGRAPHIC FACTORS

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Abstract

The United States cheese consumption has grown considerably over the years. Using Nielsen Homescan panel data for calendar years 2005 and 2006, this paper examines the effect of economic and socio-demographic factors on the demand for disaggregated cheese varieties. In this study, we estimated the censored demand for 14 cheese varieties and identified the respective own-price and cross-price elasticities. Also, non-price factors were determined affecting the purchase of each variety as well as the impact of generic dairy advertising. Results revealed that most of the natural cheese varieties have an elastic demand while the processed cheese products exhibited inelastic demands. Strong substitution and complementarity relationships were identified as well, and a two quarter carry-over effect of advertising was observed for most of cheese demands. Results also showed that household demographics affected the demands differently, depending on the nature of the cheese varieties.

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Background

The United States is one of the largest producers of cheese in the world, with more than 25% of the manufactured share in the world. Cheese is, in fact, the dairy product category with the largest economic value in the United States. It overtook fluid milk as the largest user of raw milk in the late 1990s and by 2007, the total value of all cheese products manufactured was $30 billion according to the U.S. Census Bureau. The U.S. consumption of cheese also increased over the years passing from 29 pounds per capita in 1999 to 32.9 pounds in 2009, meaning that Americans consumed over 10 billion pounds of cheese in 2009.

An understanding of factors influencing consumer sensitivity to price changes for different cheese categories is very important for the long-term growth and profitability of U.S. dairy industry. As producers and retailers seek to maximize cheese revenue and profit, pricing decisions are made on a regular basis. These decisions are based on the analysis of price elasticities and the interrelationships of these elasticities among cheese varieties.

It is important to identify products that have inelastic demands and can sustain price increases. As well, it is important to identify products that can best stimulate total category sales. Finally, it is important to identify appropriate discount levels that maximize sales while simultaneously providing desired levels of profit (Huang *et al.* 2007).

Objectives

This study focuses on estimating cheese demand relationships to identify particularly own-price and cross-price elasticities not only among broad cheese categories such as natural

cheese and processed cheese, but also among varieties within these categories. In particular, we plan to estimate demand relationships for Mozzarella, Colby, Cheddar, Swiss, and others, as natural cheese varieties, slices, snack, loaves and cream cheese as processed cheeses, and other cheese varieties, namely, Ricotta, cottage cheese, specialty/imported cheese and grated or shredded cheese.

We estimate the demands for 14 different cheese varieties existing in the U.S. market and obtain the associated matrix of unconditional and conditional own price, cross-price and income elasticities for each cheese variety. We also identify the effect of different demographic and socioeconomic variables as well as the impact of advertising and promotion expenditures on dairy products on the demand of these cheese varieties. We use data from the Nielsen Homescan Panel of U.S. households for the calendar years 2005 and 2006, the most recent dataset available at the time of this study, and consider only the households that purchased a cheese product at least once each year.

Literature Review

The demand for cheese products has been studied applying different theoretical frameworks and estimating several empirical models, depending on the objective of the analysis and the nature of the data used. Gould, Cornick and Cox (1994) used household panel data and estimated generalized Tobit system estimator to address the censored nature of expenditure. This study compared the demand of full-fat versus reduced-fat within three cheese categories: natural American cheese, processed American cheese, and cottage cheese. Cross-price relationships between different cheese varieties were not taken into account in this research and own-price elasticities were not reported (just the coefficients). However unconditional (and conditional)

income elasticities were reported: 0.057 (0.056) for natural cheese, -0.054 (-0.052) for processed cheese, and -0.242 (-0.209) for cottage cheese.

Gould and Lin (1994) used a Heckman sample selection model to estimate at-home demand for four cheese categories, natural American cheese, other natural cheese, American and other processed cheese, and processed snack. For the two natural cheese categories, purchase probability was found to be positively related to income. However, a negative relationship was found between income and the likelihood of purchase an American or other processed cheese. Nonetheless, when estimating the conditional demand for cheese, household income only impacted the other natural cheese category. The income elasticity obtained was 0.266. All own-price coefficients implied elastic price responses, except for American and other processed cheese category.

Schmit *et al.* (2002) identified the effects of generic advertising on the household demand for fluid milk and cheese. Cheese was disaggregated into American, mozzarella, processed, and other cheese categories. Their approach extended the traditional two-step approach with sample selection to panel data following a procedure similar to the two-step censored demand system approach of Shonkwiler and Yen (1999). The first stage is represented by single equation probit models followed by a second-stage system estimation procedure accounting for cross-equation correlation. The conditional own-price elasticities were statistically significant for all cheese categories: -0.488 for total cheese, -0.875 for American, -2.619 for Mozzarella, -1.194 for processed, and -1.191 for other cheese. Household income elasticities were mostly positive and slightly larger for cheese than for fluid milk. Only the processed cheese category had a negative income effect.

Davis *et al.* (2010) examined retail purchase data for 12 dairy products and margarine from the Nielsen 2007 Homescan data. A censored demand system used by Dong *et al.* (2004) and based on a variation of the Amemiya-Tobin framework was employed to estimate the demand elasticities and the impacts of selected demographic and socioeconomic variables on the demand. All cheese cross-price elasticities were found to be positive meaning that strong substitution relationships exist among these cheese categories. The uncompensated own-price elasticities were estimated to be -1.73 for natural cheese, -0.99 for processed cheese, and -1.68 for cottage cheese. The expenditure elasticities were positive for all cheese categories; however, expenditure had greater effect on purchases of cottage cheese and natural cheese compared to processed cheese.

Davis *et al.* (2011) used a censored demand model to identify price and non-price factors affecting the demand for six cheese varieties: natural, cottage, processed, grated, shredded, and other cheeses. This study followed the Dong *et al.* (2004) approach in using the Tobit system estimator but also the mapping rule suggested by Wales and Woodland (1983). Results revealed that all the own-price and expenditure elasticities for the six cheese varieties were elastic. Shredded cheese and cottage cheese were identified as the most elastic, with own-price elasticities of -3.77 and -2.59 respectively, and natural cheese as the product with the highest expenditure effect (1.05). The authors established also strong substitution relationships among all cheese products since all the conditional cross-price elasticity estimates were found to be positive and mostly significant.

Contribution to Existing Literature

Several works have determined elasticities in the cheese industry but most of them have used cross-sectional data (Gould 1992; Gould and Lin 1994; Davis *et al.* 2010; Davis *et al.*

2011). If panel data were used, the information was aggregated at the store level demand (Arnade *et al.* 2007; Kim and Cotterill 2008). Consequently, the first contribution of our approach is the use of panel type of data at the household level which allows us to account for household level heterogeneity and control for the observed differences in household behavior.

The second contribution to the literature is the consideration of 14 cheese varieties, whereas previous works only consider aggregate cheese categories (Schmit *et al.* 2003; Arnade *et al.* 2008; Davis *et al.* 2010). In addition, most of the time, when using panel data, the literature overlooked the interdependence of demand for different cheese varieties. That is, only income and own-price elasticities were provided without examining their substitutability or price interactions (Gould *et al.* 1994; Schmit *et al.* 2002). This study accounts for the cross-price effects in the demand of each cheese variety.

Moreover, this analysis differs from the previous studies in the way it considers the censored nature of cheese purchases. While other studies dealing with cheese demand simply ignored it or just used highly aggregated data to avoid the censoring problem (Fousekis and Revell 2005; Huang et al. 2007), this analysis considers this issue explicitly and assures a more consistent estimation without any loss of information due to aggregation.

Another contribution to the literature is related to the nature of the data and the model used. During non-purchase periods, cheese prices are unobserved. In this study, missing prices are imputed for each household using a regression model of the logarithm of price on selected variables. Variables such as the type of store (grocery store, convenience store etc…) or the type of product (private label or national brand) are used in price imputation for the first time. Importantly, this price imputation is a way to correct for the potential endogeneity problem attributed to prices.

In addition to the effect of demographics, location and seasonality on the demand for different cheese varieties, this essay investigates the impact of generic dairy advertising as well. The only study that had ever included the effect of advertising when analyzing cheese demand was Schmit *et al.* (2002, 2003); however, the cheese categories considered were not as broad as the 14 cheese varieties analyzed in this study. Four cheese categories were considered in Schmit *et al.* (2002) and only two aggregate categories were considered in Schmit *et al.* (2003).

Empirical Model

In previous studies of cheese demand, single-equation Tobit models have been used to account for the fact that not all households purchase cheese (Gould 1992). Tobit systems also were used (Gould *et al.* 1994; Davis *et al.* 2011), and Heckman sample selection models were employed as well (Gould and Lin 1994). However, none of those studies accounted for the panel structure of the data. Schmit *et al.* (2002) accounted for panel structure but used a sample selection model applied to panel data. In the present analysis, the demand for 14 cheese varieties is examined within an econometric model that recognizes both the panel nature of data and the censored nature of cheese purchases over time. We adopt a random effects panel Tobit approach:

$$(1) \qquad y_{it}^{*} = \beta' x_{it} + u_{it} \qquad i = 1,2,\dots,N \quad t = 1,2,\dots,8$$

$$(2) \qquad u_{it} = v_i + \epsilon_{it} \qquad v_i \sim N(0,\sigma_v^2) \qquad \epsilon_{it} \sim N(0,\sigma_\epsilon^2)$$

The observed variable, the quantity of cheese purchased by household i during the quarter t, is given by:

$$(3) \qquad y_{it} = \begin{cases} y_{it}^{*} & if\ y_{it}^{*} > 0 \\ 0 & otherwise \end{cases}$$

and x_{it} is the vector of explanatory variables.

In general the common error term u_{it} in equation (2) could be correlated over time. Here we consider the error components model which splits the error u_{it} into a time-invariant individual random effect (RE) v_i, and a time-varying random error term: ϵ_{it} .

If we assume the independence between the v_i's and the ϵ_{it}'s, the likelihood contribution for each individual is given by:

$$(4) \quad l_{it} = \int_{-\infty}^{\infty} \left[\frac{1}{\sigma_\epsilon} \phi \left(\frac{y_{it} - \beta' x_{it} - v_i}{\sigma_\epsilon} \right) \right]^{d_{it}} . \left[\Phi \left(\frac{-\beta' x_{it} - v_i}{\sigma_\epsilon} \right) \right]^{(1-d_{it})} f(v_i, \sigma_i) dv_i$$

where d_{it} equals 1 for uncensored observations and zero for censored observations, ϕ and Φ are respectively the probability density function and the cumulative distribution function of the standard normal distribution, and $f(v_i, \sigma_i)$ is normal density with mean v_i and standard deviation σ_i.

For the T observations we have for each household i we obtain the following likelihood contribution:

$$(5) \quad L_i = \int_{-\infty}^{\infty} \left\{ \prod_{t=1}^{t=T} \left[\frac{1}{\sigma_\epsilon} \phi \left(\frac{y_{it} - \beta' x_{it} - v_i}{\sigma_\epsilon} \right) \right]^{d_{it}} \left[\Phi \left(\frac{-\beta' x_{it} - v_i}{\sigma_\epsilon} \right) \right]^{(1-d_{it})} \right\} f(v_i, \sigma_i) dv_i$$

According to Bruno (2004) we see that the likelihood function for the whole sample is the product of the contribution L_i over the N individuals and the log-likelihood is:

$$(6) \quad \mathcal{L} = \sum_{i=1}^{N} \ln (L_i)$$

However, equation (6) is far more complicated than in the case of a simple cross-sectional Tobit or a time series model. The likelihood function for individual i is an integral of a product instead of just a product, and the log operator cannot be carried through the integral sign (Bruno 2004). Nonetheless, the assumptions of the applicability of the random effects model greatly simplify the computation of the likelihood.

Explanatory Variables

In this study, different cheese demands were estimated accounting for the 14 cheese varieties analyzed. These 14 varieties were separated into three cheese categories: natural cheese, processed cheese, and other varieties. All cheese demands shared the same set of 28 explanatory variables that included household income; household size; presence of children; age and education level of the household head; race and ethnicity; location; quarterly variables to account for seasonality; and generic advertising expenditures associated with all dairy products. However, the own- and cross-price variables changed according to the category to which the variety belongs.

For natural cheeses, the explanatory variables included the variables for the price of each of the five varieties forming this category (Mozzarella, Colby, Cheddar, Swiss, and Remaining natural) plus two aggregate price variables accounting for processed cheese and "other varieties" category. Any processed cheese demand included explanatory variables accounting for the price of the 4 processed cheese varieties (processed Slices, loaves, snacks, and cream cheese) plus two other variables, aggregate price for natural cheese category and aggregate price for the "other varieties" category. Finally, for the varieties labeled as "other varieties", the set of explanatory variables included the prices of the five cheese varieties (Ricotta, grated, Specialty/imported, shredded, and cottage cheese) and two more price variables accounting for aggregate natural and processed cheese categories.

As in Capps and Park (2002), a logarithmic transformation of advertising expenditures was employed to ensure diminishing marginal returns. We also used a free-form distributed lag to account for the effects of advertising over a period of time. We opted for three quarterly lags since Clarke (1976) concluded that most of the cumulative effects of advertising for frequently

purchased products are captured within three to nine months. Logarithmic transformations of household income and all cheese price variables also were used to capture potential non-linear relationships with the quantity of cheese purchased.

Marginal Effects and Elasticities Calculation

In the context of the nonlinear Tobit model, the coefficients β cannot be interpreted directly. Instead, we compute the marginal effects of the explanatory variables on either $P(y_{it}>0 \mid x_{it})$, $E(y_{it} \mid x_{it}, y_{it}>0)$ or $E(y_{it} \mid x_{it})$. We adopt the McDonald and Moffit decomposition (1980) to the panel structure of our data.

The unconditional prediction of y_{it} is given by

$$E(y_{it}) = x_{it}\beta\ \Phi\left(\frac{x_{it}\beta}{\sigma}\right) + \sigma\ \phi\left(\frac{x_{it}\beta}{\sigma}\right) \qquad \sigma = \sqrt{\sigma_v^2 + \sigma_\epsilon^2} \tag{7}$$

The conditional prediction of y_{it} is given by

$$E(y_{it}^*) = E(y_{it} \mid y_{it} > 0) = x_{it}\beta + \sigma\ \phi\left(\frac{x_{it}\beta}{\sigma}\right) \Big/ \Phi\left(\frac{x_{it}\beta}{\sigma}\right) \tag{8}$$

The unconditional marginal effect of x_{it} is then

$$\frac{\partial E(y_{it})}{\partial x_{it}} = \Phi\left(\frac{x_{it}\beta}{\sigma}\right) \frac{\partial E(y_{it}^*)}{\partial x_{it}} + E(y_{it}^*)\ \partial\Phi\left(\frac{x_{it}\beta}{\sigma}\right) / \partial x_{it} = \Phi\left(\frac{x_{it}\beta}{\sigma}\right)\beta \tag{9}$$

The conditional marginal effect of x_{it} is

$$\frac{\partial E(y_{it}^*)}{\partial x_{it}} = \beta\left[1 - \frac{x_{it}\beta}{\sigma}\ \phi\left(\frac{x_{it}\beta}{\sigma}\right) \Big/ \Phi\left(\frac{x_{it}\beta}{\sigma}\right) - \phi\left(\frac{x_{it}\beta}{\sigma}\right)^2 \Big/ \Phi\left(\frac{x_{it}\beta}{\sigma}\right)^2\right] \tag{10}$$

Marginal effects were calculated at the mean of the respective explanatory variables.

Using equations (9) and (10) we computed the unconditional and conditional own-price, cross-price and income elasticities as follows:

$$\epsilon_{p_{ij}} = \frac{\partial E(q_i)}{\partial p_j}\frac{\bar{p}_j}{\bar{q}_i} = \left(\frac{\partial E(q_i)}{\partial lnp_j}\frac{\partial lnp_j}{\partial p_j}\right)\frac{\bar{p}_j}{\bar{q}_i} = \frac{\partial E(q_i)}{\partial lnp_j}\frac{1}{\bar{q}_i} = \Phi\left(\frac{\bar{x}_i\beta}{\sigma}\right)\frac{\beta_{ij}}{\bar{q}_i} \tag{11}$$

$\epsilon_{p_{ij}}$ is the unconditional price elasticity of cheese j considering the demand for cheese i, where β_{ij} is the coefficient estimate of the logarithmic transformation of the price of cheese j and $\bar{q}_i$ is the unconditional sample mean of the quarterly quantity purchased of cheese i. The conditional price elasticity is expressed as:

$$(12) \qquad \epsilon^*_{p_{ij}} = \frac{\partial E(q_i^*)}{\partial ln p_j}\frac{1}{\bar{q}_i^*} = \frac{\beta_{ij}}{\bar{q}_i^*}\left[1 - \frac{\bar{x}_i\beta}{\sigma}\,\phi\left(\frac{\bar{x}_i\beta}{\sigma}\right)\Big/\Phi\left(\frac{\bar{x}_i\beta}{\sigma}\right) - \phi\left(\frac{\bar{x}_i\beta}{\sigma}\right)^2\Big/\Phi\left(\frac{\bar{x}_i\beta}{\sigma}\right)^2\right]$$

where $\bar{q}_i^*$ is the conditional sample mean of the quarterly quantity purchased of cheese i.

Data

The data used in this analysis are based on the Nielsen Homescan Panel of U.S. households. Households constituting the panel used hand-held scanners to record purchase information, including date of purchase, UPC code, total expenditure and quantities purchased. The household sample size consisted of 38,040 households for the year 2005, and 36,923 for the year 2006, the most recent dataset available at the time of this study.

Cheese purchase information was combined with a set of annual household demographic data (Table 1) and aggregated into 14 different cheese varieties. The quantities purchased and expenditures were therefore aggregated by household on a quarterly basis. Finally, we kept only households that purchased at least one cheese product during calendar year 2005 and at least another cheese product during the calendar year 2006. Our final dataset consisted on a panel data with 235,056 observations: 29,382 households over 8 quarter time periods.

Prices are not observed directly in the dataset. An estimate of price, the unit value, is obtained by dividing the reported expenditures, less any coupon value redeemed, by the quantity purchased.

Several explanatory variables were used in addition to the prices of different cheese varieties to estimate the demand of our 14 cheese varieties. Demographic factors, as well as

household composition variables were used to characterize these demands. Other variables were included to control for geographic and seasonal variation.

Censoring and Price Imputation

Due to the panel nature of data, and the high degree of disaggregation among the cheese varieties considered, we observe a high degree of censoring among the quarterly amount of cheese purchased by household for each cheese variety. Table 2 shows the degree of censoring for each cheese variety considered in this study.

The overall cheese varieties exhibit an average censoring degree of almost 75%. However, if we decide to aggregate natural cheese varieties into one cheese category and processed cheese varieties into another category the censoring degree drops dramatically. The degree of censoring for these categories was found to be 40% for natural cheese category and 26.4% for processed cheese category.

In previous studies, unobserved cheese prices during non-purchase periods have either been ignored or imputed by taking the mean price or unit value. According to Dunn et al. (2011) these strategies may be misguided. Furthermore, our sample is so highly censored that using mean values would probably result in extremely low variation in prices.

In this study, we impute prices for non-purchase observations for each household using 14 regression models of the logarithm transformation of cheese variety prices on regional dummy variables, the year of purchase, seasonal variation (quarterly based dummies), household income to account for quality, the nature of product (private label or national brand), and the type of channel or retailer (grocery store, drugstore, mass merchandiser supercenter, club, convenience store or other). These estimations used the transaction based data set before

building the quarterly panel data set based on household purchases. Details of the regression results associated with prices are presented in Bouhlal (2012).

Besides recovering unobserved price values, the price imputation procedure also was considered to correct for potential endogeneity problems. This potential endogeneity is raised by the way prices (unit values) are constructed in our models. While the dependent variable is the quantity purchased by households, prices of cheese product were introduced as an explanatory variable even though quantity enters in its formulation (unit values are expenditures divided by quantities purchased). Due to the high degree of censoring of most of cheese varieties investigated, imputed prices work then as instrumental variables for all the unobserved prices and help therefore in reducing the magnitude of the potential price endogeneity issue.

Estimation and Empirical Results[*]

The estimation of the random effects panel Tobit models was performed using the software package *Stata* (version 11.0). *Stata* provides a built-in xttobit command that estimates the random effects model by taking advantage of the Gauss-Hermite quadrature for the likelihood computation as suggested in Buttler and Moffit (1982).

In this paper, we are not interpreting each one of the 14 varieties demand estimation by itself in detail since we are interested, in the first place, in investigating the relationships among different cheese varieties, and subsequently, interested in comparing and showing the differences between the 14 varieties when it comes to demographic and economic factors. These demand estimations are discussed in Bouhlal (2012).

[*] For all our interpretations, we chose to consider a statistical significance level of 5%. We could have opted for a significance level of 1% instead, since we are using a very large sample.

Price Elasticities

In this study we are interested in analyzing the impact of change in the price of a cheese variety on the quantity purchased of not only the same variety but also the other cheese varieties. We compute the own- and cross-price elasticities for each variety demand and we combined them by categories (natural, processed…). We notice that the interrelationships between different cheese varieties depend on which variety demand we are considering; however, we also observe some common characteristics that varieties within the same category share. In this paper we are including a selection of elasticity interpretations for illustrative purpuses. The full substitution and complement product analysis for each cheese variety is detailed in Bouhlal 2012.

Natural Cheese Varieties

The natural cheese category includes five varieties: Mozzarella, Colby, Cheddar, Swiss, and remaining natural cheese. As exhibited in Table 3, with the exception of Cheddar, all these varieties have an elastic demand, since their unconditional own-price elasticities are greater than one in absolute value. The highest unconditional own-price elasticity belongs to the American Colby variety with a -5.0. The conditional own-price elasticities are all below 1 in absolute value, exhibiting inelastic conditional demands. That is, once the household is already buying any natural cheese products, the price of this product does not have much effect on the amount of cheese purchased.

Considering the statistical significance and the sign of the cross-price elasticities we determined which varieties are substitutes and which are complements according to the variety considered and its demand estimated coefficients. Cheddar for example has two substitutes, the aggregate processed cheese category and shredded cheese, with a positive statistically significant unconditional (conditional) cross-price elasticities of 0.020 (0.005) and 0.047 (0.012)

respectively. The unconditional (conditional) cross-price elasticities for Mozzarella, Swiss, remaining natural, and cottage cheese were found to be negative, meaning that these varieties are complements for Cheddar. Swiss cheese and remaining cheese category exhibited an unconditional elasticity of -0.08, and Mozzarella and Cottage cheese displayed an elasticity of -0.07.

We notice that for any demand, the absolute values of the elasticities drop greatly when considering conditional elasticities. The implication is that the price of substitutes of complements has less effect on the quantities bought of any natural cheese variety when the household is already buying these products.

Processed Cheese Varieties

Processed cheese category includes four varieties: processed slices, loaves, snacks, and cream cheese. All these varieties but loaves have an inelastic demand. Processed slices exhibits an unconditional own-price elasticity of -0.41, the snack variety displays an unconditional elasticity of -0.51, and cream cheese -0.61while the loaves variety exhibits an elastic unconditional demand with an elasticity of -1.2 as shown in Table 4. A 1% increase in the price of cream cheese induces a 0.61% (less than 1%) decrease in the quantity of cream purchased, whereas the same increase in loaves price brings the quantity purchased of loaves down by 1.2% (more than 1%).

As shown in Table 4, the analysis of the demand for processed slices reveals that this variety has no substitute within the cheese varieties considered in this study. However, this analysis shows that processed slices have several complements. The aggregate natural cheese category was found to be a complement for processed slices with unconditional cross-price

elasticity of -0.03. Grated and shredded cheese varieties was found to be complement as well, nonetheless, the cottage cheese showed the highest unconditional elasticity, -0.08.

Other Cheese Varieties

This category contains 5 cheese varieties, Ricotta, grated cheese, specialty/imported cheese, shredded cheese, and cottage cheese. The demand for the first 3 varieties was found to be elastic, with unconditional own-price elasticities of -3.89, -2.24 and -1.51 respectively (Table 5). Cottage cheese variety exhibited an inelastic demand with an elasticity of -0.83, while shredded cheese was found to have a very inelastic demand with an unconditional own-price elasticity of -0.38.

Income Elasticities

In this study, we are interested on the effect of household income on the quantity purchased of the different cheese varieties considered. As shown in Table 6, only the loaves variety was not affected by changes in household income. Most of the other cheese varieties exhibit behavior consistent with a normal good. That is, the quantity purchased of the variety considered increases when household income increases, and the demand falls when household income decreases.

As shown in Table 6, Specialty/imported cheese variety exhibited the highest unconditional income elasticity among the 14 studied cheese varieties. The unconditional income elasticity of this variety was found to be 0.34, meaning that a 1% increase in the household income leads to 0.34% increase in this household demand for specialty/imported cheese products. This percentage drops to 0.05% when considering household already purchasing specialty/imported cheese products. Ricotta and Mozzarella cheese varieties also exhibit relatively high unconditional income elasticities with a value of 0.22.

We notice that high unconditional income elasticities for these varieties does not imply that the same cheese products would necessarily exhibit high conditional income elasticities as well. The shredded cheese variety has unconditional income elasticity of 0.12, lower than Ricotta's unconditional income elasticity of 0.22; however, its conditional income elasticity was found to be 0.05, considerably higher than 0.01, the conditional income elasticity of Ricotta cheese variety. The ranking of the magnitude of household income effect on the demand among the different cheese variety depends greatly on whether these varieties are already being purchased by the household or not.

Processed slices were the only cheese variety showing a statistically significant negative income elasticity in this study. This finding implies that households tend to purchase less processed slices when their income increases, meaning that processed cheese is an inferior good. Processed slices might be perceived then as a lower quality product and households tend to switch to different varieties as soon as their economic situation improves.

Advertising Expenditure Elasticities

In this study, contemporaneous and 1,2, and 3-lag advertising expenditure variables were considered as explanatory variables to investigate the effect of generic dairy advertising expenditure on the quantity purchased of each of the 14 cheese varieties. Table 7 shows the advertising elasticities calculated using each demand coefficient estimates for the advertising variables. We also calculated the long-term advertising expenditure elasticities by summing the statistically significant elasticities for each cheese variety. Results showed that advertising expenditures impacted the quantity of cheese product purchased for all the varieties except for Ricotta cheese.

Eight varieties exhibited a significant advertising effect for the contemporaneous and the 2-lag advertising variables (2 quarters later) on the quantity of cheese purchased. These varieties are: all the natural cheese varieties except Mozzarella; two processed varieties: slices and loaves; grated cheese, and cottage cheese. For most of these varieties, the impact of advertising expenditure after 2 quarters was considerably greater than the contemporaneous effect.

Only 3 varieties showed a statistically significant effect of the generic dairy advertising expenditure on cheese purchased quantities after one quarter (1-lag advertising expenditure variable). These varieties are Mozzarella, loaves and snacks.

In addition to specialty/imported cheese products, two other cheese varieties exhibited a statistically significant effect of the 3-lag advertising expenditure variable: Mozzarella and the processed variety snacks. We notice that for the three varieties the impact of the advertising expenditure on the demand for cheese is more important after 3 quarters.

The Impact of Demographics on Cheese Demand

Other than the price of the different cheese varieties, household income and generic dairy advertising expenditure variables, several groups of variables had been added to our models to control for the effect of demographics on the demand of each cheese variety. The presence of children and the age of household head had the least number of significant coefficient estimates across the 14 investigated cheese varieties. In this section we mostly interpreted the values of unconditional marginal effects for the other demographic factors. The same procedure could be used to interpret the values of conditional marginal effects as well. We observed that the difference between conditional and unconditional values for demographics are small compared to the same differences observed when analyzing prices, income, and advertising effects.

Household Size

For both Swiss cheese and snack variety, the only household size variable that was statistically significant is hhsize1 as shown in Table 8. For all the other cheese varieties we observe a positive relationship between household size and the quantity of cheese purchased by household, the only exceptions being specialty/imported cheese products.

Education Attainment of Household Head

Except for American Colby, all the natural cheese varieties exhibited a significant positive relationship between education level of the household head and the quantity of cheese purchased. Considering Mozzarella products, Table 9 shows that, compared to households with household heads that are college graduates, households with heads that have less than high-school education purchased 2.3 ounces less, household heads with only high-school diploma purchased 1.62 ounces less, and household heads with some college education purchased 0.63 ounces less Mozzarella cheese products on average.

For processed cheese varieties, the demand estimation results showed that for processed slices and loaves, the quantity of cheese products purchased decrease with the increase of education level of the household head. The opposite was observed when considering snacks and cream cheese varieties. Ricotta, specialty/imported cheese, and cottage cheese varieties exhibited the same education impact as did natural cheese products. For these varieties, the quantity of cheese products purchased increased with the increase of household head education as well.

Race of Household Head

In this study we considered dummy variables to account for the effect of race on the demand of each cheese variety, Caucasian, African-American and Oriental, with the reference category being all other races.

Across all cheese varieties, Caucasian households were found to purchase more quantity of cheese products than other races, the reference category, holding all other factors constant (Table 10). African-American and Oriental households also exhibited the same pattern across all cheese varieties, purchasing on average less than households that belong to the reference category. However, we could differentiate between two distinct groups of cheese varieties.

The first group, including American Colby, Cheddar, Swiss, remaining natural cheese category, and shredded cheese variety, African-American households exhibited a higher coefficient estimate than Oriental households. For these cheese varieties, the difference between the quantity purchased by African-American household and other races households (reference category) was smaller, on average, than the difference between the quantity purchased by Oriental household and the reference category. For example, considering Cheddar products, African-American households purchased, on average, 1.69 ounces/quarter less than the reference category households, while Oriental households purchased, on average, 7.90 ounces/quarter less than the same households, holding all other variables constant.

On the other hand, for the second group of cheese varieties, including Mozzarella, snacks, grated cheese, specialty/imported cheese, and cottage cheese, African-American households exhibited a lower coefficient estimate than Oriental households.

Ethnicity of Household Head

Within natural cheese varieties, Hispanic households purchased more Mozzarella and the remaining natural cheese category than non-Hispanic households (Table 10). Hispanic households purchased, on average, 1.62 ounces more Mozzarella per quarter than non-Hispanic households; however, they purchased 1.45 and 0.21 ounces/quarter less Cheddar and Swiss cheese, on average, than non-Hispanic households, holding all the other variables constant.

All processed cheese varieties exhibited a negative impact of being Hispanic on the quantity of cheese purchased. Hispanic households purchased, on average, 1.07 and 1.05 ounces per quarter less of cream cheese and loaves, respectively, than non-Hispanic households.

Household Location

For all natural cheese varieties, except American Colby, the West was the region where household purchased more cheese products. For Mozzarella and Cheddar cheese products, the West was followed by the East region; however, in the East region households purchased less cheese product when considering Swiss cheese or the remaining natural cheese category. As shown in Table 11, households located in the East (South) consumed, on average, 1.56 (3.35) ounces of Mozzarella less than households living in the West region, and 0.32 (0.10) ounces less of Swiss cheese products.

The opposite effect of the West region is observed when considering the processed cheese varieties. For most of these varieties, households located in the West region purchased less cheese products than households located anywhere else. Households located in the South presented the highest coefficient estimates for most of processed cheese varieties. They purchased, respectively, 7.18 ounces and 1.30 ounces of processed slices and loaves more than households located in the West.

Seasonality

When considering natural cheese varieties, we observe that for Mozzarella and American Colby products, the fourth quarter was the period when household purchase less cheese products, while the highest quantities were purchased during the third quarter. As shown in Table 12, households purchased, on average, 0.11 (0.08) ounces more of Mozzarella (Colby) in the first quarter than during the fourth quarter and 0.58 (0.26) ounces more of the same cheese product in

the third quarter than in the fourth quarter. For the other natural cheese varieties we observe the opposite. For these varieties, the fourth quarter exhibited the highest quantities purchased. The lowest quantities were recorded during the first quarter, followed by the second quarter, then the third.

All processed cheese varieties except processed sliced revealed higher purchased quantities during the fourth quarter. The quarter with the lowest purchases depended on each variety. Grated cheese, specialty/imported cheese, and shredded cheese demand estimations exhibited higher purchases during the fourth quarter as well. However, cottage cheese had it lowest quantities purchased during this same quarter while revealing the highest quantities throughout the third quarter.

Single Equations vs. System of Equations

In this analysis we chose to estimate 14 equations individually to account for the demand for the disaggregate cheese varieties considered. Each equation was a random effects panel Tobit. To determine if a gain would have been made had we decided to use a seemingly unrelated regressions (SUR) approach instead, we retrieved the residuals from each equation and calculated the variance-covariance matrix of the residuals of all cheese varieties. Then we obtained the correlation matrix of the residuals given that:

$$\rho_{X,Y} = \frac{cov(X,Y)}{\sqrt{var(X)var(Y)}} \tag{14}$$

All the correlation coefficients were very small, most of them less than 0.1 in absolute value terms, which means that the residuals associated with the 14 demand equations are not very correlated. We conclude then that estimating the demands as a system of equation SUR instead of single equations would not have resulted in considerable statistical gains, considering the magnitude of the elements of the correlation matrix.

Conclusions

In this study we estimated the demand for 14 disaggregate cheese varieties to investigate different relationships between these varieties within and outside their respective categories, but also to differentiate them by quantifying and comparing the impact of different factors such as advertising, demographics, and seasonality, on the unconditional and conditional purchase of each variety. We found that some cheese varieties share the same characteristics within their respective categories (natural, processed, other). But at the same time for each variety, demand is very differentiable. The same factors influence the purchase differently depending on the cheese variety considered.

We found that demands for natural cheese varieties generally are elastic while most processed cheese varieties revealed inelastic demands. The interrelationships depended mostly on which variety demand is considered; however, we could distinguish among varieties that have many substitutes/complements and other that almost did not have any. For example, processed slices did not have any substitute product, while cottage cheese was a complement for most of the varieties.

When considering household income, most of the varieties were found to be normal goods except processed slices. Income had more effect on the demand for natural cheese varieties, relatively little effect on the demand for cheese loaves, and higher impact on the demand of specialty/imported products. Generic dairy advertising expenditures also had different impact on demands, but mostly impacted the demand in the contemporaneous quarter and two quarter later. Generic dairy advertising had no significant effect on the demand of Ricotta products.

All other demographics affected the demands according to the nature of the cheese varieties. But for most of the varieties, household size, education attainment and being Caucasian had a positive impact on the demand. In contrast with findings of Davis *et al.* (2010) racial/ethnic factors were found to be important. African-American and Oriental household purchased less cheese products, and Hispanics bought more specialty/imported cheese products. Location factors were found to be important as well. More purchases of natural cheese varieties occured in the West region, and more purchases of processed varieties occured in the South. Almost all cheese varieties experienced higher purchases during the fourth quarter; however, this same quarter revealed the lowest volumes when considering Mozzarella and processed slices.

In this study we succeeded in characterizing each of the 14 disaggregate variety demands and in demonstrating that the demands for different cheese varieties are very differentiable. Results from this study could be used by cheese manufacturers and marketers in implementing new or revising current marketing strategies and in the development of new products targeted to various household segments.

Despite the fact that we showed that using a SUR approach, not much statistical gains would be made, the next step for further research is to estimate a demand system accounting for the panel nature of data and the censoring issue. This step would be a logical extension to our analysis where advantage would be taken from parameter restrictions to reflect homogeneity and Slutsky symmetry, and results of both studies could be compared. Another extension would be the use of more recent data and investigate the potential changes in demand over time.

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Table 1. Definition of Variables Other than Prices Used in the Demand Estimation

Variable Group	Variable Name	Type	Definition
Household Income	lnhhinc	Continuous+	the logarithmic transformation of the income of the household head
Advertising Expenditures	lnadv	Continuous	the logarithmic transformation of advertising expenditure in the current quarter
	lnl1adv	Continuous	the logarithmic transformation of advertising expenditure in the previous quarter
	lnl2adv	Continuous	the logarithmic transformation of advertising expenditure 2 quarters earlier
	lnl3adv	Continuous	the logarithmic transformation of advertising expenditure 3 quarters earlier
Household Size	hhsize1	Binary	the household consists of one person living alone
	hhsize2	Binary	the household consists of 2 members
	hhsize3	Binary	the household consists of 3 members
	hhsize4	Binary	the household consists of 4 members
	hhsize5more	Binary*	the household consists of 5 members or more
Age	age_und25	Binary	the age of the household head is under 25 years
	age_2535	Binary	the age of the household head is between 25 and 35 years
	age_3545	Binary	the age of the household head is between 35 and 45 years
	age_4555	Binary	the age of the household head is between 45 and 55 years
	age_5565	Binary	the age of the household head is between 55 and 65 years
	age_ovr65	Binary*	the age of the household head is over 65 years
Educational Attainment	edu_lesshs	Binary	the level of education of the household head is less than high school
	edu_hs	Binary	the household head has graduated from high school
	edu_somecol	Binary	the household head attended some college courses
	edu_colnmore	Binary*	the household head has graduated from college
Race	Black	Binary	the household head is African-American
	White	Binary	the household head is Caucasian
	Oriental	Binary	the household head is Asian
	Otherace	Binary*	the household head belong to other race
Ethnicity	Hisp	Binary	the household head is Hispanic

Table 1. Continued

Variable Group	Variable Name	Type	Definition
Region	East	Binary	the household is from the Northeast
	South	Binary	the household is from the South
	West	Binary*	the household is from the West
	Central	Binary	the household is from the Midwest
Presence of children	child05	Binary	households has children under 6 years old
	chil612	Binary	households has children aged between 6 and 12 years old
	child1317	Binary	households has children aged between 13 and17years old
	nochildund18	Binary*	households has no children under 18 years old
Seasonality	Q1	Binary	Quarter 1, January to March
	Q2	Binary	Quarter 2, April to June
	Q3	Binary	Quarter 3, July to September
	Q4	Binary*	Quarter 4, October to December

* used as the reference category when estimating the models
+ The continuous variable for income was developed by replacing the income categorical variables by the category mean values.

Table 2. Degree of Censoring[†] for Different Cheese Variety Purchases

Cheese variety	Observations	Degree of censoring (%)
Mozzarella	46,898	80.05
Colby	12,928	94.5
Cheddar	86,674	63.13
Swiss	28,996	87.66
Remaining Natural	57,323	75.61
Processed Slices	112,522	52.13
Loaves	27,137	88.46
Snack	37,813	83.91
Cream Cheese	99,861	57.52
Ricotta	18,921	91.95
Grated	43,459	81.51
Specialty/Imported	42,615	81.87
Shredded	121,297	48.4
Cottage	89,658	61.86
Aggregate natural	140,963	40.03
Aggregate processed	172,968	26.41
Aggregate others	177,709	24.4

[†] The degree of censoring = [1- (number of observation/ total sample size)]*100

Table 3. Unconditional and Conditional Own-Price and Cross-Price Elasticities for Natural Cheese Varieties

	Mozzarella		Colby		Cheddar		Swiss		Remaining Natural	
	uncond	cond	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Mozzarella	**-1.083**	**-0.235**	**0.122**	**0.026**	0.006	0.001	-0.017	-0.004	0.004	0.001
Colby	0.034	0.001	**-5.015**	**-0.214**	-0.022	-0.001	**0.243**	**0.010**	0.011	0.000
Cheddar	**-0.073**	**-0.020**	0.002	0.000	**-0.918**	**-0.246**	**-0.078**	**-0.021**	**-0.079**	**-0.021**
Swiss	**0.065**	**0.012**	**0.404**	**0.074**	**0.082**	**0.015**	**-1.163**	**-0.213**	**0.118**	**0.022**
Rem. Natural	-0.003	-0.001	**0.090**	**0.016**	0.020	0.003	-0.001	0.000	**-1.737**	**-0.305**

	Agg. Processed		Ricotta		Grated		Specialty/Imported		Shredded		Cottage	
	uncond	cond	uncond	cond	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Mozzarella	**0.122**	**0.027**	**-0.153**	**-0.033**	**0.082**	**0.018**	0.006	0.001	**0.168**	**0.036**	**-0.072**	**-0.016**
Colby	0.019	0.001	**0.239**	**0.010**	**0.203**	**0.009**	**0.124**	**0.005**	**0.079**	**0.003**	-0.045	-0.002
Cheddar	**0.020**	**0.005**	-0.016	-0.004	-0.015	-0.004	-0.014	-0.004	**0.047**	**0.012**	**-0.073**	**-0.020**
Swiss	**0.081**	**0.015**	**0.089**	**0.016**	**0.047**	**0.009**	-0.004	-0.001	**0.057**	**0.010**	0.007	0.001
Rem. Natural	**0.065**	**0.011**	**0.087**	**0.015**	0.051	0.009	**-0.035**	**-0.006**	**0.056**	**0.010**	-0.025	-0.004

The bold values are the statistically significant at 5% significance level.

Table 4. Unconditional and Conditional Own-Price and Cross-Price Elasticities for Processed Cheese Varieties

	Proc. Slices		Loaves		Snack		Cream Cheese	
	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Processed Slices	**-0.407**	**-0.147**	0.005	0.002	-0.020	-0.007	-0.020	-0.007
Loaves	-0.005	0.000	**-1.213**	**-0.115**	**0.124**	**0.012**	**-0.074**	**-0.007**
Snack	**0.034**	**0.006**	**0.347**	**0.058**	**-0.513**	**-0.086**	**0.055**	**0.009**
Cream Cheese	**0.027**	**0.008**	**0.171**	**0.054**	**0.053**	**0.017**	**-0.611**	**-0.192**

	Agg. Natural		Ricotta		Grated		Specialty/Imported		Shredded		Cottage	
	uncond	cond	uncond	cond	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Processed Slices	**-0.029**	**-0.010**	0.025	0.009	**-0.054**	**-0.020**	-0.004	-0.001	**-0.021**	**-0.008**	**-0.076**	**-0.027**
Loaves	**-0.038**	**-0.004**	**0.083**	**0.008**	**0.088**	**0.008**	**0.153**	**0.014**	**-0.091**	**-0.009**	0.005	0.000
Snack	0.007	0.001	0.001	0.000	**0.094**	**0.016**	**0.167**	**0.028**	0.011	0.002	-0.010	-0.002
Cream Cheese	**-0.044**	**-0.014**	**-0.050**	**-0.016**	0.006	0.002	**0.028**	**0.009**	**0.039**	**0.012**	**-0.029**	**-0.009**

The bold values are the statistically significant at 5% significance level.

Table 5. Unconditional and Conditional Own-Price and Cross-Price Elasticities for the Other Cheese Varieties

	Ricotta		Grated		Specialty/Imported		Shredded		Cottage	
	uncond	cond	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Ricotta	**-3.983**	**-0.231**	**0.258**	**0.015**	**0.312**	**0.018**	**0.130**	**0.008**	**0.072**	**0.004**
Grated	**0.338**	**0.070**	**-2.236**	**-0.463**	**0.213**	**0.044**	0.037	0.008	**0.083**	**0.017**
Specialty/Imported	**0.283**	**0.042**	**0.246**	**0.036**	**-1.508**	**-0.224**	**0.118**	**0.017**	**0.153**	**0.023**
Shredded	0.029	0.011	**-0.041**	**-0.016**	**0.064**	**0.025**	**-0.380**	**-0.147**	**-0.090**	**-0.035**
Cottage	0.029	0.008	**-0.065**	**-0.018**	-0.010	-0.003	0.015	0.004	**-0.834**	**-0.226**

	Agg. Natural		Agg. Processed	
	uncond	cond	uncond	cond
Ricotta	**-0.143**	**-0.008**	**0.100**	**0.006**
Grated	**0.071**	**0.015**	**0.173**	**0.036**
Specialty/Imported	**0.165**	**0.024**	**0.243**	**0.036**
Shredded	**0.023**	**0.009**	0.006	0.002
Cottage	-0.009	-0.003	**0.045**	**0.012**

The bold values are the statistically significant at 5% significance level.

Table 6. Unconditional and Conditional Household Income Elasticities

	Household Income	
	uncond	Cond
Mozzarella	0.217	0.047
Colby	0.119	0.005
Cheddar	0.070	0.019
Swiss	0.101	0.018
Remaining Natural	0.183	0.032
Processed Slices	-0.092	-0.033
Loaves	**-0.019**	**-0.002**
Snack	0.099	0.017
Cream Cheese	0.094	0.029
Ricotta	0.220	0.013
Grated	0.060	0.012
Specialty/Imported	0.341	0.051
Shredded	0.118	0.046
Cottage	0.047	0.013

The bold values are the statistically non-significant elasticities at 5% significance level.

Table 7. The Statistically Significant Unconditional and Conditional Advertising Expenditure Elasticities

	Generic Advertising Expenditure									
	adv		l1adv		l2adv		l3adv		Long-Run Elasticity	
Variety	uncond	cond	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Mozzarella	X	X	0.025	0.006	0.061	0.013	0.075	0.016	0.161	0.035
Colby	0.573	0.024	X	X	0.538	0.023	X	X	1.111	0.047
Cheddar	0.067	0.018	X	X	0.127	0.034	X	X	0.195	0.052
Swiss	0.060	0.011	X	X	0.082	0.015	X	X	0.143	0.026
Remaining Natural	0.038	0.007	X	X	0.052	0.009	X	X	0.090	0.016
Processed Slices	0.134	0.048	X	X	0.149	0.054	X	X	0.283	0.102
Loaves	0.100	0.009	0.042	0.004	0.121	0.011	X	X	0.263	0.025
Snack	X	X	0.027	0.004	X	X	0.067	0.011	0.093	0.016
Cream Cheese	X	X	X	X	0.107	0.034	X	X	0.107	0.034
Ricotta	X	X	X	X	X	X	X	X	X	X
Grated	0.050	0.010	X	X	0.072	0.015	X	X	0.123	0.025
Specialty/Imported	X	X	X	X	X	X	0.093	0.014	0.093	0.014
Shredded	X	X	X	X	0.040	0.016	X	X	0.040	0.016
Cottage	0.060	0.016	X	X	0.048	0.013	X	X	0.108	0.029

Table 8. Unconditional and Conditional Marginal Effects of Household Size Variables

	Household Size							
	hhsize1		hhsize2		hhsize3		hhsize4	
Cheese Variety	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Mozzarella	-4.875	-5.304	-2.700	-2.937	-1.563	-1.701	-0.678	-0.737
Colby	-0.756	-0.586	-0.411	-0.319	-0.295	-0.228	**-0.138**	**-0.107**
Cheddar	-7.848	-5.707	-3.395	-2.469	-2.257	-1.641	-1.529	-1.112
Swiss	-0.452	-0.672	**-0.086**	**-0.128**	**-0.028**	**-0.042**	**0.003**	**0.005**
Remaining Natural	-3.544	-2.548	-2.316	-1.665	-1.125	-0.809	-0.707	-0.508
Processed Slices	-20.315	-15.326	-10.665	-8.046	-5.451	-4.113	-2.116	-1.596
Loaves	-3.634	-2.971	-1.895	-1.550	-1.309	-1.071	-0.400	-0.327
Snack	-0.607	-0.631	**-0.034**	**-0.035**	**-0.063**	**-0.065**	**0.052**	**0.054**
Cream Cheese	-7.585	-5.599	-3.883	-2.866	-2.975	-2.196	-1.102	-0.813
Ricotta	-1.533	-1.106	-0.873	-0.630	-0.473	-0.341	**-0.030**	**-0.021**
Grated	-1.880	-2.107	-0.921	-1.032	-0.501	-0.561	-0.193	-0.216
Specialty/Imported	-0.657	-0.538	**-0.151**	**-0.124**	-0.261	-0.213	**0.056**	**0.046**
Shredded	-18.820	-14.097	-10.246	-7.675	-6.075	-4.551	-2.205	-1.652
Cottage	-10.452	-7.434	-4.190	-2.980	-2.953	-2.100	**-1.297**	**-0.922**

The bold values are the statistically non-significant elasticities at 5% significance level.

Table 9. Unconditional and Conditional Marginal Effects of Education Variables

	Education Level of Household Head					
	edu_lesshs		edu_hs		edu_somecol	
Cheese Variety	uncond	cond	uncond	cond	uncond	cond
Mozzarella	-2.377	-2.586	-1.619	-1.762	-0.634	-0.690
Colby	**-0.010**	**-0.008**	0.170	0.132	0.145	0.113
Cheddar	-2.169	-1.577	-2.008	-1.460	-0.739	-0.538
Swiss	-0.380	-0.564	-0.196	-0.290	-0.067	-0.099
Remaining Natural	-1.076	-0.773	-0.424	-0.305	**-0.182**	**-0.131**
Processed Slices	6.745	5.089	5.075	3.829	3.143	2.371
Loaves	**0.732**	**0.598**	0.709	0.580	0.545	0.446
Snack	-0.286	-0.298	-0.068	-0.070	**0.046**	**0.047**
Cream Cheese	-1.522	-1.123	**0.066**	**0.049**	0.725	0.535
Ricotta	-0.632	-0.456	-0.343	-0.247	**-0.144**	**-0.104**
Grated	**-0.044**	**-0.049**	**-0.020**	**-0.022**	**0.021**	**0.024**
Specialty/Imported	-1.286	-1.051	-1.019	-0.833	-0.465	-0.380
Shredded	-2.004	-1.501	0.854	0.640	1.002	0.750
Cottage	-3.880	-2.760	-2.212	-1.573	-0.982	-0.698

The bold values are the statistically non-significant elasticities at 5% significance level.

Table 10. Unconditional and Conditional Marginal Effects of Race and Ethnicity Variables

	Race of Household Head						Ethnicity	
	white		black		oriental		hispanic	
Cheese Variety	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Mozzarella	0.871	0.948	-4.861	-5.289	-2.006	-2.183	1.619	1.762
Colby	**0.072**	**0.056**	-0.266	-0.206	-0.389	-0.302	**-0.094**	**-0.073**
Cheddar	**0.632**	**0.460**	-1.695	-1.233	-7.898	-5.744	-1.447	-1.052
Swiss	0.336	0.499	-0.700	-1.039	-0.309	-0.459	-0.212	-0.314
Remaining Natural	0.603	0.433	-1.742	-1.252	-2.041	-1.467	0.894	0.643
Processed Slices	**1.409**	**1.063**	**-1.452**	**-1.095**	-5.950	-4.489	**-0.767**	**-0.578**
Loaves	0.567	0.463	-1.191	-0.974	-2.024	-1.655	-1.048	-0.857
Snack	0.191	0.199	-1.300	-1.352	-0.676	-0.703	-0.565	-0.588
Cream Cheese	1.808	1.334	-4.024	-2.970	**-0.767**	**-0.566**	-1.073	-0.792
Ricotta	**0.336**	**0.242**	-0.482	-0.347	**-0.448**	**-0.323**	**0.204**	**0.147**
Grated	0.476	0.534	-0.756	-0.847	-0.559	-0.626	**0.050**	**0.056**
Specialty/Imported	0.318	0.260	-1.266	-1.036	**-0.338**	**-0.277**	1.069	0.875
Shredded	4.060	3.041	-3.468	-2.597	-8.115	-6.079	-3.909	-2.928
Cottage	5.376	3.824	-8.469	-6.023	-6.011	-4.276	**-1.232**	**-0.876**

The bold values are the statistically non-significant elasticities at 5% significance level.

Table 11. Unconditional and Conditional Marginal Effects of the Location Variables

	Region					
	East		Central		South	
Cheese Variety	uncond	cond	uncond	cond	uncond	cond
Mozzarella	-1.557	-1.694	-1.993	-2.168	-3.353	-3.648
Colby	0.288	0.223	0.904	0.701	0.713	0.553
Cheddar	-5.461	-3.972	-10.527	-7.656	-5.580	-4.058
Swiss	-0.321	-0.477	-0.221	-0.328	-0.098	-0.146
Remaining Natural	-3.205	-2.304	-2.139	-1.538	-2.280	-1.639
Processed Slices	3.834	2.892	6.930	5.228	7.181	5.418
Loaves	-0.458	-0.374	0.770	0.630	1.589	1.299
Snack	-0.115	-0.120	0.350	0.364	0.619	0.644
Cream Cheese	1.456	1.075	1.031	0.761	**-0.157**	**-0.116**
Ricotta	**-0.207**	**-0.149**	-1.211	-0.874	-2.116	-1.526
Grated	0.743	0.833	**-0.017**	**-0.019**	**-0.020**	**-0.023**
Specialty/Imported	-0.577	-0.471	-0.949	-0.776	-0.677	-0.553
Shredded	-4.061	-3.042	6.409	4.801	2.595	1.944
Cottage	-7.970	-5.669	-2.534	-1.802	-8.243	-5.863

The bold values are the statistically non-significant elasticities at 5% significance level.

Table 12. Unconditional and Conditional Marginal Effects of the Seasonality Variables

	Quarter					
	Q1		Q2		Q3	
Cheese Variety	uncond	cond	uncond	cond	uncond	cond
Mozzarella	**0.111**	**0.120**	**0.126**	**0.137**	0.576	0.627
Colby	0.076	0.059	0.115	0.089	0.260	0.202
Cheddar	-1.158	-0.842	-0.982	-0.714	-0.755	-0.549
Swiss	-0.053	-0.079	-0.037	-0.055	**0.033**	**0.049**
Remaining Natural	-0.421	-0.303	-0.266	-0.191	-0.202	-0.146
Processed Slices	1.513	1.142	2.657	2.005	2.847	2.148
Loaves	-0.426	-0.348	-0.970	-0.793	-0.862	-0.705
Snack	-0.697	-0.725	-0.773	-0.804	-0.770	-0.801
Cream Cheese	-4.902	-3.619	-4.420	-3.263	-4.539	-3.351
Ricotta	0.240	0.173	-0.183	-0.132	0.253	0.182
Grated	**-0.020**	**-0.022**	-0.336	-0.376	-0.194	-0.217
Specialty/Imported	-0.437	-0.358	-0.374	-0.306	-0.387	-0.316
Shredded	-0.877	-0.657	-2.339	-1.752	-2.208	-1.654
Cottage	2.123	1.510	2.626	1.867	2.959	2.105

The bold values are the statistically non-significant elasticities at 5% significance level.