A RETROSPECTIVE AND PROSPECTIVE ANALYSIS OF THE DEMAND FOR CHEESE VARIETIES IN THE UNITED STATES

A Dissertation

by

YASSER BOUHLAL

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2012

Major Subject: Agricultural Economics

A Retrospective and Prospective Analysis of the Demand for Cheese Varieties in the United States

A RETROSPECTIVE AND PROSPECTIVE ANALYSIS OF THE DEMAND FOR CHEESE VARIETIES IN THE UNITED STATES

A Dissertation

by

YASSER BOUHLAL

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Approved by:

Chair of Committee,	Oral Capps, Jr.
Committee Members,	David A. Bessler
	Ximing Wu
	Manuelita Ureta
Head of Department,	John P. Nichols

May 2012

Major Subject: Agricultural Economics

ABSTRACT

A Retrospective and Prospective Analysis of the Demand for Cheese Varieties in the United States. (May 2012)

Yasser Bouhlal, B.S. Institut Agronomique et Vétérinaire Hassan II; M.S. Mediterranean Agronomic Institute of Zaragoza

Chair of Advisory Committee: Dr. Oral Capps, Jr.

The United States cheese consumption has grown considerably over the years. Using Nielsen Homescan panel data for calendar years 2005 and 2006, this dissertation examines the effect of economic and socio-demographic factors on the demand for disaggregated cheese varieties and on the cheese industry in general. In the first essay, 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.

The second essay examined the impact of retail promotion on the decision to purchase private label processed cheese products using a probit model. A strong negative relationship was found between national brand manufacturer couponing activity and the private label purchase decision. Therefore, national brand couponing appears to be an effective strategy for manufacturers to deter private label growth. This analysis also shows that the decision of purchasing a private label cheese product is influenced by socio-demographic characteristics of the household, namely household income and size, age and education level of the household head, race, ethnicity, and location.

In the third study, the feasibility of fortifying processed cheese with omega-3 is investigated. This ex-ante analysis took into account the market conditions and evaluates the increase in the demand for processed cheese needed to offset the costs of fortification in order to maintain the profitability of manufacturers like Kraft. Initially, the censored demand for processed cheese products is estimated using panel data; subsequently, the profitability of manufacturing such product is determined.This analysis shows that, within reasonable market conditions and reasonable marginal costs, the fortification of processed cheese products with omega-3 fatty acids indeed is feasible from a profitability standpoint to manufacturers.

DEDICATION

This dissertation is dedicated to the friendship and memory of my dear cousin Omar Daoud (1973-2011) who departed this world much too soon.

ACKNOWLEDGEMENTS

I am heartily thankful to my advisor and Committee Chair, Oral Capps, Jr., whose encouragement, supervision and support from the preliminary to the concluding level enabled me to develop an understanding of econometrics and demand analysis.

The other members of my dissertation committee, David A. Bessler, Ximing Wu and Manuelita Ureta, have generously given their time and expertise to better my work. I thank them for their contribution and their support.

My thanks must go also to Richard A. Dunn and Ariun Ishdorj for sharing their research insights that supported and expanded my own work.

I must acknowledge as well the many friends, colleagues, students, faculty and staff members who assisted, advised, and supported my study and research efforts over the years.

My deepest gratitude goes to my parents, my brother and my sister for their unflagging love and encouragement throughout my life.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

TABLE Page

TABLE Page

CHAPTER I

INTRODUCTION

Motivation

The demand for cheese is one of the most notable factors influencing the dairy industry in the United States. Cheese is 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 nineties and according to the U.S. Census Bureau, by 2007, the total value of all cheese products manufactured was $30 billion. Total U.S. cheese production in 2010, excluding cottage cheese, was 10.4 billion pounds, 3.6 percent more than 2009. 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 (Figure 1). According to the Food and Agricultural Policy Research Institute (FAPRI), the consumption of cheese in the United States will continue to growth to reach 34.2 pounds per capita by 2019. More than 400 varieties are available from the U.S. cheese industry; however, mozzarella and cheddar are the leading varieties with 33.4% and 31% of the U.S. production in 2010 (Figure 2).

Cheese consumption continues to increase thanks to its versatility and adaptability to recipes, but also due other factors such as mainstream acceptance of ethnic cooking as stated by the Agricultural Marketing Resource Center (AGMRC). These ethnic cuisines such as Italian and Mexican use typically more cheese in their preparation.

This dissertation follows the style of *American Journal of Agricultural Economics*.

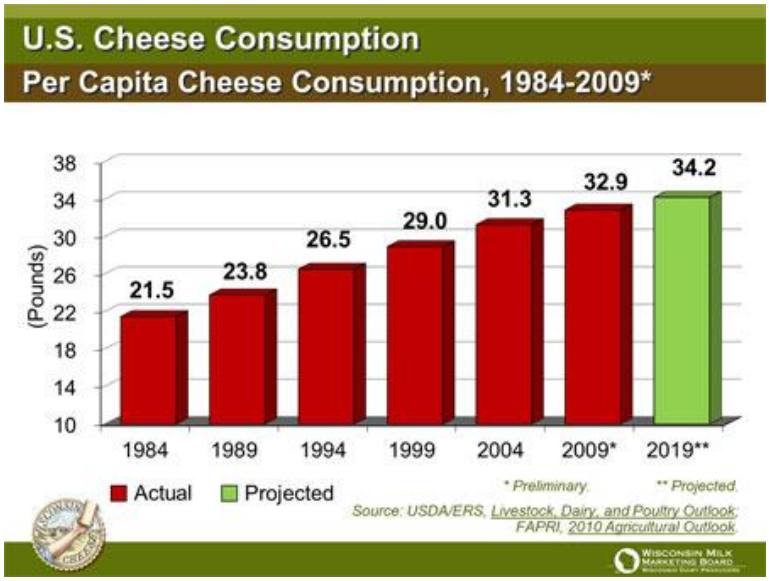

Figure 1. Per Capita Cheese Consumption in the United States

At the retail level, private label brands (store brands) account for 35% of total market share. Over the years, private label products have gained more importance within the cheese market. Many experts believe that this growth trend will continue since these products often provide good quality at reasonable prices.

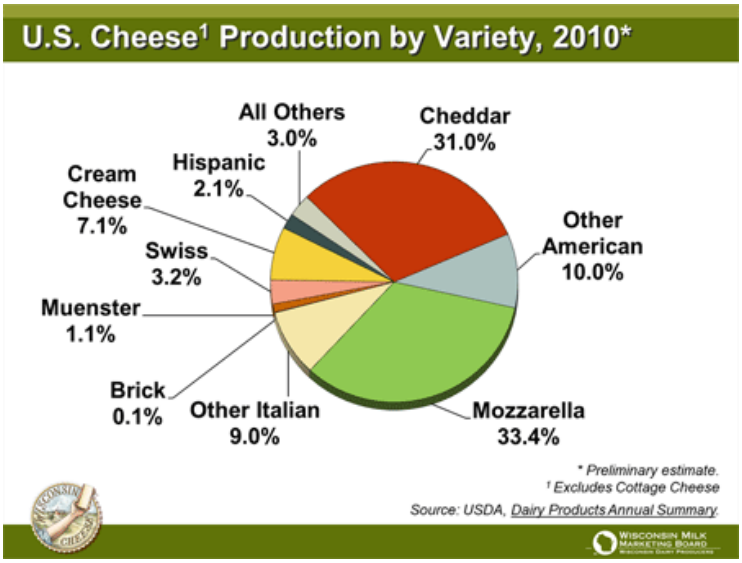

Figure 2. Cheese Production by Variety in the United States

In addition to food product quality and prices, consumers have developed over the years a growing awareness about the impact of nutrition on their health and general well-being. Nowadays, several food products are displaying added health benefits and enhanced therapeutic properties, most of the time acquired through fortification procedures. Recent reports have targeted dairy foods as having a high potential for growth in the fortification business.

In this dissertation, we mainly investigate and discuss questions related to these three tendencies: growth and importance of the U.S. cheese industry, the expansion of the market share of the private label products, and the increasing awareness among consumers toward healthy diet and nutritional issues.

Problem Statement

To insure the long-term growth and profitability of U.S. cheese industry, it is extremely important to understand the factors that influence consumer sensitivity to price changes for different cheese categories. Pricing decisions are mainly based on the analysis of price elasticities and the interrelationships of these elasticities among cheese varieties. It is very important as well to identify the non-price factors that affect the demand for each differentiated cheese variety. Manufacturers and retailers make use of this information on a regular basis to develop new products and devise and/or revise marketing strategies.

Manufacturers and managers of main national brand cheese products also are concerned about the expansion of the share of private label products, and need to find ways of protecting their market. To attain this goal, factors other than consumer sensitivity to price changes could be investigated and used to expand cheese sales or, in this case, deter private label share expansion. Several studies suggested that promotions for national brands could be more effective than those for private label products (Allenby and Rossi 1991, Bronnenberg and Wathieu 1996).

Additionally, Market shares are expanded through product differentiation. Cheese products could be differentiated through innovation such as adding new health benefits to the pre-existing image of "being good for you" that all dairy products share. The increased recognition of the importance of omega-3 fatty acids in the diet, coupled with its limited availability in natural food sources, makes fortifying cheese with omega-

3 a potentially successful novel product. However fortification implies an additional cost of production that manufacturers need to take into account.

Objectives

The first two essays are retrospective analyses using available data, while the third essay is prospective, investigating potential changes in cheese product attributes.

In the first essay, we estimate censored cheese demand relationships using panel data to identify particularly the conditional and unconditional own-price and cross-price elasticities as well as income elasticities among 14 cheese varieties. We also identify the effect of different demographic and socioeconomic variables as well as the impact of dairy advertising expenditure on the household demand for these cheese products.

The second analysis deals with the investigation of the relationship between the decision to purchase private label processed cheese products and the level of retail promotion activities. It also assesses the effectiveness of national brand coupons as deterrents to private label market share expansion. We only consider American processed sliced cheese variety in this study since it had a market penetration of nearly 70% over the sample households.

In the third essay, we determine the effects of potentially fortifying processed cheese products with omega-3 fatty acids on the profits of manufacturers. This ex-ante analysis considers the market conditions (demand and supply curves) and evaluates the increase in the demand for processed cheese needed to offset the costs of fortification in order to maintain the profitability of producers.

Source of Data

The data used in this dissertation 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. Cheese purchase information was combined with a set of annual household demographic data and aggregated into different cheese categories .The household sample size consists of 38,040 households for the year 2005, and 36,923 for the year 2006.

In the first essay, the quantities purchased and expenditures were aggregated by household on a quarterly basis and we only kept households that purchased at least one cheese product during calendar year 2005 and at least another cheese product during the calendar year 2006. The final dataset consisted on a panel dataset with 235,056 observations: 29,382 households and 8 quarter time periods. Cheese purchases were aggregated into 14 cheese varieties.

The second essay focused only on transactions where American processed sliced cheese product was bought during calendar years 2005 and 2006. We use this information coupled with demographic information associated with each transaction to develop a pooled cross-sectional dataset. Therefore, the observation units in this analysis are not quantities aggregated by households and time periods as in the first essay. Each observation corresponds to a transaction where a private label or a national brand processed cheese is purchased.

In the third essay, we only consider the purchase information concerning processed cheese categories since legally a natural cheese would no longer be labeled as natural if it were fortified. Processed cheese varieties included in the dataset and considered in this study are: American sliced, remaining slices, snack, loaves, and cream cheese. We only focus on transactions where any of these cheese products had been bought during the calendar year 2005. The quantities purchased and expenditures then are aggregated by household on a monthly basis. We ended up with a panel data structure with 426,504 observations, 35,542 households and 12 monthly purchase periods.

Methodology

In the first essay, 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.

In the second essay, instead of a simple probit model of the decision to purchase private label product, we use a probit model that takes into account the endogeneity of store coupon redemption. We estimate a probit model with a binary endogenous explanatory variable.

For the third essay, we need to estimate initially the demand for processed cheese products. Then, we determine the actual producer surplus considering the case of linear demand and supply functions. Finally, we establish by how much the demand for the new product (fortified cheese) would have to shift to the right so that the producer

surplus remains the same after the fortification. Due to the presence of zero-purchase observations, we need to account for censoring in the demand estimation. A panel sample selection model with random effects is used in this analysis.

Dissertation Organization

The dissertation is arranged into five chapters with the main body of the dissertation focusing on three publishable essays each covering a separate cheese demand analysis topic.

Chapter I consists of the statement of the motivations behind the topic, the research objectives to be addressed and the methodology followed to attain each of them. Chapter II focuses on the estimation of the censored demand for 14 U.S. cheese varieties using household panel data. Chapter III examines the impact of retail promotion on the decision to purchase private label processed cheese products. Chapter IV is an ex-ante analysis of the feasibility of fortifying processed cheese with omega-3 fatty acids, and Chapter V serves as a summary of the major findings of the three essays, provides recommendations based on those findings, and offers prospects for future research.

CHAPTER II

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

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. According to the preliminary estimates of the USDA Dairy Products Annual Summary, Wisconsin and California are the leading producers of cheese in the United States, accounting respectively for 25 and 21.1 percent of all cheese production, domestically (Figure 3).

The retail cheese market is best characterized as an amalgam of leading brands: store brands account for 35% of total market share; and national brands account for the remaining 65%, but Kraft alone accounts for 45% of this total (Cropp 2001).

Cheese Categories

More than 400 varieties of cheese are available from the U.S. cheese industry. In fact, according to the US Dairy Export Council, some of the most popular cheeses like Brick, Colby, and Monterey jack originated in the United States.

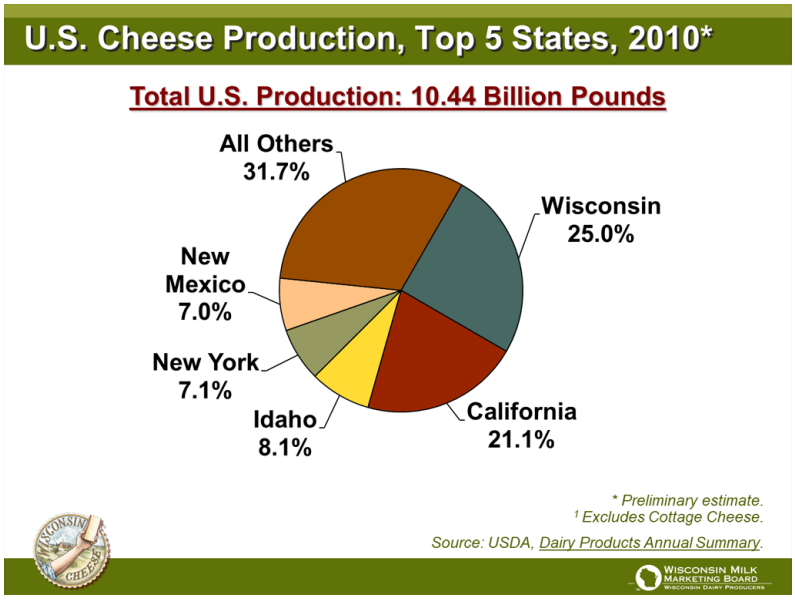

Figure 3. Top Five States in Cheese Production in the United States

The most widely accepted method to categorize cheeses is based upon their type of milk, processing method, and texture (degree of hardness). A category is a family of cheeses that share similar characteristics, while varieties or types represent individual cheeses within the families. We differentiate between natural cheese, finished, ripened cheeses which have not been further processed, and processed cheese.

Popular types of natural cheeses include unripened (fresh) like cottage cheese, soft-ripened as Brie or Camembert, semi-hard (semi-soft) like Brick or Muenster, hard

as Colby or Cheddar, cooked hard like Swiss or Parmesan, blue veined cheeses as Blue cheese and Gorgonzola, and pasta filata, which means stretched curd, as Mozzarella and Provolone. Examples of processed cheeses include American cheese and various cheese spreads, which are made by blending two or more varieties of cheese or blending portions of the same type of cheese that are at different stages of ripeness (Midwest Research Institute 1997). Depending on the desired end use, the melted mixture then is reformed and packaged into blocks, or as slices, or into tubs or jars. Processed cheeses typically cost less than natural cheeses; they have longer shelf life, and provide for a variety of products.

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 were negative and statistically significant, and when evaluated at mean consumption level, all 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. The other cheese category contained several varieties, including ricotta, Muenster, farmers, brick, and cream cheese. 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 for the respective products. 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

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

The conditional marginal effect of x_{it} is

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

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:

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

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

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 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.

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

Table 1. Continued

Variable Group	Variable Name	Type	Definition
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
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.

Cheese Varieties: Quantities and Prices

Cheese purchases were aggregated into 14 categories each one referring to a different cheese variety. The information about different categories is provided within the dataset. The 14 varieties of cheese product considered in this study are:

Natural cheese: Mozzarella, American Colby, American cheddar, Swiss, and remaining; and Processed cheese: American sliced, snack, loaves, and cream cheese. We also take into account Ricotta cheese, grated cheese, shredded cheese, specialty/imported, and cottage cheese.

Table 2. Unconditional and Conditional Means for the Quarterly Quantities Purchased of the 14 Cheese Varieties

Cheese variety	Variable	Unconditional Mean (oz)	Conditional Mean (oz)
Mozzarella	qq02	6.409	32.123
Colby	qq05	1.271	23.109
Cheddar	qq06	13.524	36.678
Swiss	qq14	2.476	20.071
Remaining Natural	qqrn	6.642	27.234
Processed Slices	qqps	19.315	40.349
Loaves	qq11	5.015	43.436
Snack	qq12	3.051	18.968
Cream Cheese	qq19	11.39	26.811
Ricotta	qq08	2.828	35.136
Grated	qq09	2.232	12.074
Specialty/Imported	qq15	3.071	16.939
Shredded	qq17	20.787	40.283
Cottage	qqcf	24.663	64.659

Table 2 presents the 14 cheese varieties considered in this analysis and shows the average quantity purchased by household on a quarterly basis for each variety. We differentiated between the unconditional and the conditional volume purchased, where the conditional mean considered only the observations in which the household actually purchased the considered cheese variety.

As shown in Table 2, overall, cottage cheese was the cheese variety with the highest quantity purchased per quarter in our sample. The unconditional (conditional) quantity purchased by household over a quarter was 24.66 ounces (64.66 ounces) on average. On the other side, Colby was the cheese variety with the lowest unconditional quantity purchased with only 1.27 ounces per quarter per household on average. The cheese variety with the lowest conditional quantity purchased was grated cheese with 12.07 ounces per quarter per household.

Within natural cheese category, cheddar showed the highest quantity purchased on average, followed by Mozzarella with unconditional (conditional) mean values of 13.52 (36.68) ounces and 6.41 (32.12) ounces respectively. Within the processed cheese category, on average, slices were purchased the most followed by cream cheese. The unconditional (conditional) mean of the quantity purchased were 19.31 (40.35) ounces for processed slices and 11.39 (26.81) ounces for cream cheese. In the third cheese category, cottage cheese was the quarterly most purchased cheese in our sample followed by shredded cheese with an unconditional (conditional) mean of 20.79 (40.28) ounces per quarter.

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. As shown in Table 3, the cheese variety with the highest average price was the specialty/imported cheese variety with 47.7 cents per ounce and the cheese variety with the lowest average price was cottage cheese with an average price per ounce of 10.5 cents. Swiss cheese was the most expensive variety within natural cheese category with an average price of 31.9 cents per ounce, and snacks were the most expensive within processed cheese varieties with an average price of 32.5 cents per ounce. The cheapest varieties were Colby among natural cheeses and loaves within processed cheeses with respective average prices of 21.7 and 15.0 cents per ounce. Considering the aggregate categories, Table 3 shows that natural cheeses are the most expensive on average. The average price of natural cheese is 25.3 cents per ounces, 5.9 cents more expensive than a processed cheese product.

Other Explanatory Variables

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.

As shown in Table 4, average household income in our sample, accounting for the calendar years 2005 and 2006, is slightly above $50,000 per year. 42% of the

households are households with 2 members and another 27% are a single member households.

Table 3. Descriptive Statistics for Price Variables before Imputation ($/oz)

Cheese Variety	Variable	Mean	Standard Error
Mozzarella	qppoz02	0.258	0.114
Colby	qppoz05	0.217	0.069
Cheddar	qppoz06	0.241	0.112
Swiss	qppoz14	0.319	0.11
Remaining Natural	qppozrn	0.256	0.095
Processed Slices	qppozps	0.184	0.074
Loaves	qppoz11	0.15	0.054
Snack	qppoz12	0.325	0.158
Cream Cheese	qppoz19	0.181	0.07
Ricotta	qppoz08	0.127	0.04
Grated	qppoz09	0.368	0.123
Specialty/Imported	qppoz15	0.477	0.217
Shredded	qppoz17	0.244	0.088
Cottage	qppozcf	0.105	0.036
Aggregate natural	qppozn	0.253	0.101
Aggregate processed	qppozp	0.194	0.085
Aggregate other	qppozo	0.218	0.125

Household heads aged between 35 and 65 years represent 70% of the sample and another 26% relates to household heads over 65 years of age. Only 5% of the sample households have a child under 5 years of age; 11% have children between 5 and 13 years old; and 12% include at least an adolescent of 13 years of age or older.

Table 4. Descriptive Statistics of Other Explanatory Variables

Variable*	Mean	Standard Error
hhincome	50573.57	27563.33
hhsize1	0.274	0.446
hhsize2	0.422	0.494
hhsize3	0.136	0.343
hhsize4	0.107	0.31
hhsize5more	0.062	0.24
child05	0.052	0.223
chil612	0.109	0.312
child1317	0.117	0.323
nochildund18	0.722	0.408
age_und25	0.002	0.04
age_2535	0.047	0.212
age_3545	0.169	0.375
age_4565	0.522	0.499
age_ovr65	0.259	0.438
edu_lesshs	0.035	0.184
edu_hs	0.276	0.447
edu_somecol	0.314	0.464
edu_colnmore	0.375	0.484
white	0.846	0.361
black	0.086	0.28
oriental	0.021	0.143
otherace	0.048	0.213
hispanic	0.058	0.234
nonhisp	0.942	0.234
east	0.162	0.368
central	0.242	0.428
south	0.381	0.486
west	0.216	0.412
Q1	0.25	0.433
Q2	0.25	0.433
Q3	0.25	0.433
Q4	0.25	0.433
Adv	25144634	6563111

*The variables are defined in Table 1.

Considering the educational attainment of household heads, 27% of our sample has a high school level education, 31% has only some college education, and 37% of household heads were college graduates. The majority of the households were Caucasians with a proportion of 84.6%. African-Americans represented 8.6%, while Oriental households only accounted for 2.1%. On the other hand, 6% of household heads described themselves as Hispanic.

Considering the location variables, we noticed that the highest proportion of households buying cheese products was located in the South, 38% of the sample, followed by the Central (Midwest) region with 24.1%, the West with 21.6%, and finally the Northeast with only 16.2% of households.

Generic dairy advertising expenditures also were introduced to control for the effect of advertising expenditure on cheese variety demands. As shown in Table 4, the average expenditure by quarter was $ 25.1 million with a standard deviation of $ 6.6 million, during 2005 and 2006 calendar years.

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 5 shows the degree of censoring for each cheese variety considered in this study.

Table 5. 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 overall cheese varieties exhibit an average censoring degree of almost 75%. As shown in Table 5, Colby is the cheese variety that displayed the highest degree of censoring, 95.5%, followed by Ricotta with almost 92%, and cheese loaves with 88.5% censoring degree. The cheese varieties with the lowest amount of censored observations were shredded cheese (48.4%), processed slices (52.1%), and cream cheese (57.5%) varieties.

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

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 Appendix A.

Once we estimated the 14 price imputation models, the coefficient estimates were used to replace the unobserved prices in our final household based data set. To achieve the imputation, household purchase behavior profiles had to be built to account for household tendency of buying private label or national brand items and also for their

typical channel or retailer choice. A dummy variable was created to establish if the household purchases mainly private label or not, and another set of dummy variables were introduced to identify the channel or retailer mostly used by the household to purchase cheese items.

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).

[†] 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.

The results of each of the 14 cheese variety demand estimations are presented in Appendix B. For each cheese variety we present three tables. The first Table shows the estimated parameters of the demand, the standard errors, and the p-values. This Table also shows the goodness of fit. The second Table exhibits the computed unconditional and conditional marginal effects, their respective standard errors and the p-values. Finally, the third Table presents the unconditional and conditional price, income and advertising elasticities calculated using the marginal effects and the average quantity purchased by household each quarter.

As a measure of the goodness of fit, we used a pseudo-R^2 that we computed using the observed quantities purchased and the unconditional predicted quantities given by our model. This statistic was estimated as:

$$(13) \qquad pseudo\ R^2 = [corr(actual\ q, unconditional\ fitted\ q)\ ]^2$$

In this study, 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. However, for illustration, in the next section, we chose one variety and analyzed its demand function in depth. The same approach could be followed in the interpretation of the demand tables related to any other cheese varieties. The analysis of the unconditional and conditional elasticities and different factors affecting the demand of cheese across the different studied varieties are presented and discussed in the other following sections

Demand for American Cheddar

According to the results of the estimation of the demand of the natural cheese Cheddar, presented in Table 6, the price of most the other natural cheese varieties, the price of the aggregate processed cheese category, and the price of shredded and cottage cheese as well, affect the demand for this product. Their coefficient estimates are all statistically significant at 5% significance level.

The unconditional (conditional) cross-price elasticities for the aggregate processed cheese and shredded cheese are positive, 0.020 (0.005) and 0.047 (0.012) respectively, meaning that they are substitutes for Cheddar. We notice how the elasticity values drop when considering conditional values, meaning that the price of these substitutes has less effect on the quantities bought of Cheddar when the household is already buying Cheddar products. Unconditional cross-price elasticity of aggregate processed cheese of 0.020 means that a 1% increase in the price of aggregate processed cheese induces an increase of 0.02% in the quantity of Cheddar cheese purchased for every household, holding all other factors constant.

Table 6. Estimation Results of the Demand for Cheddar Products

Variable*	Coefficient	Standard Error	p- value
lnP02	-1.835	0.371	0.000
lnP05	0.046	0.768	0.952
lnP06	-23.060	0.279	0.000
lnP14	-1.956	0.485	0.000
lnPrn	-1.995	0.361	0.000
lnPp	0.509	0.214	0.017
lnP08	-0.392	0.660	0.553
lnP09	-0.373	0.482	0.439
lnP15	-0.362	0.324	0.265
lnP17	1.169	0.287	0.000
lnPcf	-1.842	0.357	0.000
lnhhinc	1.757	0.292	0.000
hhsize1	-14.577	1.026	0.000
hhsize2	-6.306	0.971	0.000
hhsize3	-4.192	0.925	0.000
hhsize4	-2.840	0.855	0.001
child05	1.866	0.877	0.033
child612	-1.013	0.691	0.143
child1317	2.157	0.648	0.001
age_2535	-0.190	4.153	0.964
age_3545	-0.218	4.106	0.958
age_4565	-0.301	4.091	0.941
age_ovr65	-0.487	4.098	0.905
edu_lesshs	-4.028	0.965	0.000
edu_hs	-3.730	0.448	0.000
edu_somecol	-1.373	0.411	0.001
white	1.174	0.961	0.222
black	-3.149	1.107	0.004
oriental	-14.671	1.498	0.000
hispanic	-2.688	0.879	0.002
east	-10.144	0.583	0.000
central	-19.554	0.511	0.000
south	-10.365	0.479	0.000
Q1	-2.151	0.183	0.000
Q2	-1.823	0.171	0.000
Q3	-1.402	0.210	0.000

Table 6. Continued

Variable*	Coefficient	Standard Error	p- value
lnadv	1.695	0.328	0.000
lnl2adv	3.192	0.345	0.000
constant	-87.767	8.616	0.000
sigma_u	25.753	0.096	0.000
sigma_e	21.857	0.035	0.000
rho	0.581	0.002	
pseudo R2	0.115		

* The variables lnP are the logarithmic transformation of the other cheese variety prices. The other variables are defined in Table 1.

The unconditional (conditional) cross-price elasticities for Mozzarella, Swiss, remaining natural, and cottage cheese were found to be negative. Consequently, these varieties are complements for Cheddar. Swiss cheese, for example, had an unconditional (conditional) cross-price elasticity of -0.078 (-0.021). Therefore, a 1% increase in Swiss cheese price results in 0.08% decrease in the quantity purchased of Cheddar, holding all other factors constant.

The unconditional (conditional) own-price elasticity for Cheddar was found to be -0.918 (-0.246). The demand for Cheddar cheese then is almost unitary elastic considering the whole sample of household and very inelastic when considering only the households that purchase Cheddar. Simply put, households are not very sensitive to price once the decision to purchase was made. The unconditional (conditional) income elasticity was found to be 0.070 (0.019). Therefore, Cheddar cheese products are normal goods; an increase in household income implies an increase in the quantities purchased.

As shown in Table 6, all the coefficient estimates related to household size were found to be significant. The sign and the magnitude of these estimates imply that the quantity of Cheddar purchased is positively related to household size. Households with children under 5 years old and households with adolescents also were associated with a higher purchase of Cheddar. As exhibited in Table 7, households with at least 1 child under 5 years of age purchase quarterly one ounce more, on average, relative households with no children, holding all other factors constant.

The age of the household head was found to have no significant effect on the demand for Cheddar. All the coefficient estimates related to the four dummy variables that account for age were not statistically significant at 5% significance level. The education attainment of household head, however, had a significant effect on the Cheddar quantities purchased. According to our model, households with a household head that has at most a high-school education purchase quarterly, on average, 2 ounces less, than household in which household heads are college graduates. However, this difference decreases by a half ounce roughly when considering the conditional marginal effects, where only the households already purchasing cheddar are considered.

The quantity of Cheddar products purchased was lower for African-Americans and Asians compared to households belonging to other races. Asian households purchased nearly 8 ounces per quarter less that the other races. The estimation also showed that Hispanics purchase less Cheddar than non-Hispanic households, on average 1.4 ounce less if considering every household and 1ounce when considering only households buying Cheddar products.

The coefficient estimates for location dummy variables were statistically significant and show that households from the West region purchased more cheese that the other household, holding the other factors constant. As shown in Table 7, households located in the East and the South purchase on average more than 5 ounces less than the households from the West region, and households located in the Central region purchase on average over 10 ounces less than Western households.

Table 7. Unconditional and Conditional Marginal Effects for Cheddar

	Unconditional marginal effects			Conditional marginal effects		
Variables	dy/dx	Standard Error	p-value	dy/dx	Standard Error	p-value
lnP02	-0.988	0.200	0.000	-0.718	0.145	0.000
lnP05	0.025	0.414	0.952	0.018	0.301	0.952
lnP06	-12.420	0.155	0.000	-9.029	0.112	0.000
lnP14	-1.053	0.261	0.000	-0.766	0.190	0.000
lnPrn	-1.074	0.194	0.000	-0.781	0.141	0.000
lnPp	0.274	0.115	0.017	0.199	0.084	0.017
lnP08	-0.211	0.355	0.553	-0.153	0.258	0.553
lnP09	-0.201	0.259	0.439	-0.146	0.189	0.439
lnP15	-0.195	0.175	0.265	-0.142	0.127	0.265
lnP17	0.629	0.155	0.000	0.458	0.113	0.000
lnPcf	-0.991	0.192	0.000	-0.721	0.140	0.000
lnhhinc	0.946	0.157	0.000	0.688	0.114	0.000
hhsize1	-7.848	0.552	0.000	-5.707	0.402	0.000
hhsize2	-3.395	0.523	0.000	-2.469	0.380	0.000
hhsize3	-2.257	0.498	0.000	-1.641	0.362	0.000
hhsize4	-1.529	0.460	0.001	-1.112	0.335	0.001
child05	1.005	0.472	0.033	0.731	0.343	0.033
child612	-0.546	0.372	0.143	-0.397	0.271	0.143
child1317	1.161	0.349	0.001	0.845	0.254	0.001

Table 7. Continued

	Unconditional marginal effects			Conditional marginal effects		
Variables*	dy/dx	Standard Error	p-value	dy/dx	Standard Error	p-value
age_2535	-0.102	2.236	0.964	-0.074	1.626	0.964
age_3545	-0.118	2.211	0.958	-0.085	1.608	0.958
age_4565	-0.162	2.203	0.941	-0.118	1.602	0.941
age_ovr65	-0.262	2.206	0.905	-0.191	1.605	0.905
edu_lesshs	-2.169	0.520	0.000	-1.577	0.378	0.000
edu_hs	-2.008	0.241	0.000	-1.460	0.175	0.000
edu_somecol	-0.739	0.221	0.001	-0.538	0.161	0.001
white	0.632	0.518	0.222	0.460	0.376	0.222
black	-1.695	0.596	0.004	-1.233	0.433	0.004
oriental	-7.898	0.807	0.000	-5.744	0.587	0.000
hispanic	-1.447	0.473	0.002	-1.052	0.344	0.002
east	-5.461	0.314	0.000	-3.972	0.229	0.000
central	-10.530	0.275	0.000	-7.656	0.202	0.000
south	-5.580	0.258	0.000	-4.058	0.188	0.000
Q1	-1.158	0.099	0.000	-0.842	0.072	0.000
Q2	-0.982	0.092	0.000	-0.714	0.067	0.000
Q3	-0.755	0.113	0.000	-0.549	0.082	0.000
lnadv	0.913	0.177	0.000	0.664	0.128	0.000
lnl2adv	1.719	0.186	0.000	1.250	0.135	0.000

* The variables lnP are the logarithmic transformation of the other cheese variety prices. The other variables are defined in Table 1.

Three dummy variables were included to account for seasonality with the fourth quarter as reference quarter. There was indeed a statistically significant seasonal effect associated with cheddar product purchases. More cheddar is bought during the fourth quarter compared to the other three. On average, roughly one ounce less of Cheddar is bought by each household during the first and second quarter. The same seasonality pattern is observed even if we consider only the households that actually purchase Cheddar products.

Table 8. Unconditional and Conditional Elasticities for Cheddar

	Unconditional Elasticities	Conditional Elasticities
Mozzaella	-0.073	-0.020
Colby	0.002	0.000
Cheddar	-0.918	-0.246
Swiss	-0.078	-0.021
Rem. Natural	-0.079	-0.021
Agg. Processed	0.020	0.005
Ricotta	-0.016	-0.004
Grated	-0.015	-0.004
Spec./Imported	-0.014	-0.004
Shredded	0.047	0.012
Cottage	-0.073	-0.020
Income	0.070	0.019
adv*	0.067	0.018
l2adv*	0.127	0.034

* Variables defined in Table 1.

As shown in Table 6, the coefficient estimates of the contemporaneous and the second-lag dairy advertising expenditure variables were found to be positive and statistically significant. The implication is that generic dairy advertising impacts the quantities purchased of Cheddar not only within the same quarter but we also observe a carry-over effect two quarters later. Table 8 presents the unconditional (conditional) advertising expenditure elasticities for both the contemporaneous and the second-lag dairy advertising expenditure, respectively 0.067 (0.018) and 0.127 (0.034). We notice that advertising expenditure has more impact on the whole sample than only on households already purchasing Cheddar products. We also observe less impact in the current quarter compared to the impact after two quarters, confirming the carry-over

effect. The long-term effect would be the sum of the two, that is, 0.194 for the unconditional elasticity and 0.052 for the conditional elasticity. In the long term, a 1% increase in the quarterly generic dairy advertising expenditure increases the quantity of Cheddar purchased by household, by 0.194%.

The approach used analyzing the demand for Cheddar variety at the household level can be used to determine the characteristics of individual demands of all the other cheese varieties. We included in Appendix B three tables for each cheese varieties, exhibiting the model estimation results, the unconditional and conditional marginal effects, and the different unconditional and conditional elasticities.

Cheese Variety Interrelationships

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.

Natural Cheese Varieties

The natural cheese category includes five varieties: Mozzarella, Colby, Cheddar, Swiss, and remaining natural cheese. As exhibited in Table 9, 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. Mozzarella has only one substitute within natural cheese category that is Colby with an unconditional cross-price elasticity of 0.12, however other substitutes exist outside this category such as shredded cheese variety (0.17) and the aggregate processed cheese category (0.12). On average, when the price of shredded cheese products increase by 1%, the quantity purchased of Mozzarella increases by 0.17% holding the other factors constant. As shown in Table 9, Mozzarella products have two complements within the cheese varieties included in this study. Ricotta products and cottage cheese variety display an unconditional cross-price elasticity of -0.15 and -0.07 respectively.

Table 9. 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.

The American Colby demand estimation reveals substitute products but no complement varieties. The substitutes for Colby cheese products are, Swiss cheese within the natural cheese category with an unconditional cross-price elasticity of 0.24, Ricotta, grated, and shredded cheese varieties within other domestic cheese category with elasticities of 0.24, 0.20, 0.08 respectively, and finally the specialty/import category with an observed cross-price elasticity of 0.12. A 1% increase in the price of Swiss cheese or Ricotta induces a decrease in the quantity purchased of Colby products by 0.24%.

As shown in the previous section, Cheddar 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.

According to the Swiss cheese demand estimation, this variety does not have any complement within the other 13 cheese varieties considered in this study. Only substitution relationships were evident for this cheese. Eight varieties were shown to be substitutes for the Swiss cheese products making it the most substitutable variety in our study. All the other natural cheese varieties were found to be substitutes for Swiss cheese; Colby displayed the higher unconditional cross-price elasticity with a value of

0.4, while Mozzarella exhibited the lowest elasticity within this category with 0.06. The aggregate processed cheese category was found to be substitute for Swiss cheese products (0.08), as well as Ricotta and grated and shredded cheese varieties with unconditional cross-price elasticities of 0.09, 0.05, and 0.06 respectively.

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 10. 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%).

Table 10. 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.

As we did for natural cheese varieties, we consider now the signs and the statistical significance of the cross-price elasticities in each demand to determine which varieties are substitutes and which are complements for each processed cheese variety.

As shown in Table 10, 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.

Loaves have four substitutes, snacks within the processed cheese category and Ricotta, grated cheese and specialty/imported cheese as well. All these varieties exhibited positive statistically significant unconditional (conditional) cross-price elasticities, Specialty/imported cheese and snacks prices having the most important effect with elasticities of 0.15 (0.01) and 0.12 (0.01) respectively. The unconditional (conditional) cross-price elasticities for the aggregate natural cheese category, cream cheese and shredded cheese were found to be negative, meaning that these varieties are complements for loaves. Shredded cheese category exhibited an unconditional elasticity of -0.09, and cream cheese and aggregate natural cheese category displayed the elasticities -0.07 and -0.04 respectively.

According to the snacks demand estimation, this variety does not have any complement within the other 13 cheese varieties considered in this study. Only

substitution relationships were evident for this cheese. All the other cheese varieties belonging to the processed cheese category were found to be substitutes for snacks. Loaves presented the highest unconditional (conditional) cross-price elasticity, 0.35 (0.06) meaning that a 1% increase in the price of loaves leads to an increase of the quantity purchased of snacks by 0.35%, holding all other factors constant. Specialty/imported cheese and Grated cheese were found to be substitutes for snacks as well, with unconditional elasticities of 0.17 and 0.09.

All the processed cheese varieties were found to be substitutes for cream cheese. Within this category, the price of loaves had the highest effect on the quantity of cream cheese bought with an unconditional cross-price elasticity of 0.17, followed by snacks (0.05) and processed slices (0.03). A 1% increase in the price of loaves leads to 0.17% increase in the quantity purchased of cream cheese, holding fixed all other factors. As shown in Table 10, cream cheese has two other substitutes, shredded cheese and specialty/imported cheese.

Cream cheese was found to have three complement among the 14 investigated varieties. The aggregate natural cheese variety showed a negative unconditional cross-price elasticity of -0.04, while Ricotta and cottage cheese exhibited respectively the values of -0.05 and -0.03. A 1% increase in the price of Ricotta products leads, on average, to a decrease in the quantity of cream cheese purchased by 0.05%, holding all the other factors fixed.

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. 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.

As shown in Table 11, the demand estimation for Ricotta cheese revealed that this variety has only one complement, the aggregate natural cheese category, with an unconditional cross price elasticity of -0.14. Ricotta has several substitutes that exhibited significant positive unconditional cross-price elasticities, such as grated and shredded cheese, specialty/imported cheese, cottage cheese, and the aggregate processed cheese category. Specialty/imported cheese variety presented the strongest substitution relationship with an elasticity of 0.31, followed by grated cheese with 0.26, and shredded cheese variety with an elasticity of 0.13. 1% increase in the price of grated cheese products leads, on average, to an increase of 0.26% in the quantity purchased of Ricotta products.

Table 11. 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.

Only the shredded cheese category was not found to be a substitute for the grated cheese variety. The demand estimation of this variety showed that all the other cheese varieties considered in this study are substitutes for grated cheese as exhibited in Table 11. Ricotta cheese showed an unconditional cross-price elasticity of 0.34, while specialty/imported cheese and cottage cheese exhibited respectively elasticity values of 0.21 and 0.08. The aggregate categories for natural and processed cheese also were substitutes with the elasticities 0.07 and 0.17 respectively.

Specialty/imported cheese variety was the only cheese variety in our study for which all the other varieties were found to be substitutes. This high substitutability might be due to the very nature of this variety that could include any other cheese variety. Ricotta cheese, grated cheese and the aggregated processed cheese category exhibited the highest substitution degree with unconditional cross-price elasticities of 0.28, 0.25 and 0.24 respectively. The weakest substitute was the shredded cheese variety with an unconditional elasticity of 0.12, meaning that 1% increase in the price of shredded cheese products induces only 0.12% increase in the quantity of specialty/imported cheese products purchased on average.

As shown in Table 11, Shredded cheese was found to have two substitutes and two complements among the different cheese varieties included in this study. The substitutes are the specialty/imported variety with an unconditional cross-price elasticity of 0.06 and the aggregate natural cheese category with an elasticity of 0.02. On the other hand, the complements were found to be grated cheese variety and cottage cheese variety with unconditional cross-price elasticities of - 0.04 and - 0.09 respectively.

According to the demand estimation for cottage cheese, this variety has only one substitute and one complement. All the other varieties price coefficient estimates turned out to not be statistically significant. Cottage cheese substitute was found to be the aggregate processed cheese category with an unconditional cross-price elasticity of 0.04, and the only complement was grated cheese variety with an elasticity of -0.06. A 1% increase in the price of grated cheese products leads the quantity purchased of cottage cheese to decrease by 0.06%, holding all the other factors constant.

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 8, 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 12, 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.

Table 12. 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.

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 13 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.

Table 13. 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

As shown in Table 13, 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. Colby had the highest unconditional contemporaneous advertising expenditure elasticity among these varieties with a value of 0.57, followed by processed slices with 0.13. Thus, a 1% increase in generic dairy advertising expenditure leads to an increase of 0.57% of household Colby purchases in the current quarter. The highest conditional contemporaneous advertising expenditure elasticity was exhibited by processed slices with a value of 0.05.

Colby also was the cheese variety with the highest unconditional 2-lag advertising expenditure elasticity (0.54) followed by processed slices (0.15) and Cheddar cheese (0.13). A 1% increase in generic dairy advertising expenditure leads to an increase of 0.13% of the quantity of Cheddar products purchased by households two quarters later. The highest conditional 2-lag advertising expenditure elasticity was exhibited by processed slices with a value of 0.05, followed by Cheddar with 0.03. Among these 8 cheese varieties, the remaining natural cheese category and cottage cheese variety had the lowest unconditional long-run advertising expenditure elasticity with only 0.09 and 0.11 respectively. The highest long-run elasticity was exhibited by American Colby (1.1) followed by the processed varieties slices (0.28) and loaves (0.26).

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. Loaves presented the highest unconditional 1-lag expenditure elasticity with a value of 0.04 while Mozzarella exhibited the highest conditional 1-lag advertising expenditure elasticity with 0.006.

The varieties cream cheese, shredded cheese, and specialty/imported cheese showed only one statistically significant coefficient estimate related to the advertising expenditure variables. For both varieties cream cheese and shred cheese, only the 2-lag expenditure variable had an effect on the quantity of cheese products purchased by households. The unconditional (conditional) 2-lag advertising expenditure elasticity was 0.11 (0.03) for cream cheese and 0.04 (0.02) for shredded cheese variety. For the third category, specialty/imported cheese, only the 3-lag expenditure variable had an effect on the quantity of cheese products purchased by households. The unconditional (conditional) 3-lag advertising expenditure elasticity was 0.09 (0.01). 1% increase in the generic dairy advertising expenditure leads to 0.09% increase in the quantity of specialty/imported cheese purchased by households after 3 quarters. For the 3 varieties, cream cheese, shredded cheese and specialty/imported cheese, the values of elasticities presented represent the long-run generic dairy advertising expenditure effect as well.

In addition to specialty/imported cheese products, two other cheese varieties exhibited a statistically significant effect of the 3-lag advertising expenditure variable on the cheese quantity purchased. These varieties are the natural cheese Mozzarella and the

processed variety snacks. Specialty/imported cheese products showed the highest unconditional elasticity of 0.09, followed by Mozzarella and snacks with 0.07, while Mozzarella exhibited the highest conditional elasticity of 0.02 followed by the two other varieties with 0.01.

The estimation of demand for Mozzarella products showed that in addition to the 3-lag variable, the 1-lag and 2-lag advertising expenditure variables also had a statistically significant impact on the quantities purchased by household. According to Table 23, the unconditional 1-lag (conditional) advertising expenditure elasticity for Mozzarella is 0.02 (0.01) and the 2-lag elasticity is 0.06 (0.01). Therefore, the unconditional (conditional) long term elasticity of generic dairy advertising expenditure for Mozzarella products is 0.16 (0.03).

For snack products, the impact of advertising expenditure on the demand also was statistically significant for 1-lag variable (in addition to lag-3). The calculation of the unconditional (conditional) 1-lag elasticity revealed a value of 0.03 (0.00), meaning that, 1% increase in the generic dairy advertising expenditure leads to an increase of 0.03% of the quantity purchased of snack products after one quarter and 0.07% increase after three quarters. We notice that for the three varieties specialty/imported cheese, Mozzarella, and snack 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. These variables included household size, presence of children, age of household head, education attainment, race and ethnicity, and location. We considered seasonality as well. The presence of children and the age of household head had the least number of significant coefficient estimates across the 14 investigated cheese varieties. Overall, these factors are the least impacting demographics associated with the demand of all cheese varieties. In this section we mostly interpreted the values of unconditional marginal effects; however, 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. For these two varieties, as shown in Table 14, single households purchased respectively, on average, 0.45 and 0.61 ounces/quarter less than households with at least 5 members, holding all other factors constant.

Table 14. 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.

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. For this variety we found that household with 2 members purchased, on average, 0.15 ounces less than households with 5 members at least, while households with 3 members purchased, on average, 0.26 ounces less than households with at least 5 members.

Presence of Children

The presence of children in the household did not have any impact on the quantity of cheese products purchased for the American Colby and Ricotta cheese varieties. For both varieties, the coefficient estimates for the three variables accounting for the presence of children were not statistically significant at 5% significance level.

According to the demand estimation results showed in Table 15, the presence of children under 5 years of age implies that more quantity purchased of Mozzarella, Cheddar, and remaining cheese category cheese product. Compared with households with no children, household with children under 5 years of age purchased, on average, 1.25 ounces/quarter more Mozzarella products than household with no children. This difference increased to 1.36 ounces/quarter when considering only households that purchased Mozzarella products. For Swiss cheese, most of processed cheese varieties, grated cheese, specialty/imported cheese products, and cottage cheese variety, the presence of children under 5 years of age in the household had the opposite effect. Households with these children purchased, on average less cheese products than

households with no children. As shown in Table 15, household with children under 5 years of age purchased, respectively 0.84 ounces and 2.3 ounces/quarter less, on average, of cream cheese and cottage cheese products, compared to household with no children.

Table 15. Unconditional and Conditional Marginal Effects of the Presence of Children Variables

	Presence of Children					
	child05		child612		child1317	
Cheese Variety	uncond	cond	uncond	cond	uncond	cond
Mozzarella	**1.246**	**1.356**	**1.050**	**1.142**	0.316	0.344
Colby	-0.118	-0.091	-0.110	-0.085	0.025	0.020
Cheddar	**1.005**	**0.731**	-0.546	-0.397	**1.161**	**0.845**
Swiss	**-0.100**	**-0.149**	**-0.160**	**-0.237**	**-0.108**	**-0.161**
Remaining Natural	**1.189**	**0.855**	-0.293	-0.210	-0.065	-0.047
Processed Slices	0.045	0.034	-0.480	-0.362	**1.302**	**0.982**
Loaves	-0.437	-0.357	-0.036	-0.030	**0.433**	**0.354**
Snack	**-0.257**	**-0.267**	0.083	0.086	0.046	0.048
Cream Cheese	**-0.844**	**-0.623**	**0.689**	**0.508**	**0.640**	**0.473**
Ricotta	-0.117	-0.085	-0.168	-0.121	0.109	0.078
Grated	**-0.207**	-0.232	-0.002	-0.002	0.088	0.098
Specialty/Imported	**-0.210**	**-0.171**	**-0.315**	**-0.257**	**-0.161**	**-0.132**
Shredded	-1.402	-1.050	0.144	0.108	**3.070**	**2.300**
Cottage	**-2.313**	**-1.645**	**-2.643**	**-1.880**	**-3.260**	**-2.319**

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

The presence of children between 6 and 12 years of age had different effects on cheese purchases depending on the variety considered as well. According the demand estimation results showed in Table 15, households with children between 6 and 12 years of age purchased more Mozzarella and cream cheese products than households with no children. On average, 1.05 ounces more Mozzarella and 0.69 ounces more cream cheese products every quarter. However, these households purchased less Swiss cheese, specialty/imported cheese, and cottage cheese products, compared to households with no

children. As shown in Table 15, household with children between 6 and 12 years of age purchased, on average, 0.16 ounces, 0.31 ounces, and even 2.64 ounces/quarter less of Swiss cheese, specialty/imported cheese, and cottage cheese products respectively, than households with no children.

Households with adolescents, children between 13 and 17 years of age purchased more Cheddar, most of the processed cheese varieties, and shredded cheese than households with no children. According to our results, the presence of adolescents in the household implied, on average, 1.16 ounces more of Cheddar cheese purchased by quarter, 1.3 more ounces more of processed slices and even 3.1 ounces more of shredded cheese purchased compared to households with no children. Nonetheless, these household also purchased less Swiss cheese, specialty/imported cheese, and cottage cheese products compared to households with no children. On average, households with adolescents purchased 0.11 less ounces of Swiss cheese and 3.26 less ounces of cottage cheese products, relative to households with no children.

Age of Household Head

Overall, the demand for only five cheese varieties were found to be affected by the age of the household head. These varieties are Mozzarella, loaves, snacks, shredded cheese and cottage cheese.

As shown in Table 16, households with head with between 45 and 65 years of age purchased 2.84 ounces less, and households with heads over 65 years of age purchased on average 4.34 ounces/quarter less, compared to households with a

household head under 25 years of age. Therefore, there is a negative relationship between household head age and the quantity of Mozzarella purchased. The same pattern was observed when considering shredded cheese variety purchases.

For snack products, there was a positive relationship between age of the household head and the quantity of snacks purchased. As shown in Table 16, this relationship was only revealed for household heads over 35 years on age though. Households with heads aged between 35 and 45 years also were found to purchase, on average, 1.95 ounces more of cheese loaves per quarter than the reference category, households with the household head under 25 years of age. The only age category affecting the quantity of cottage cheese purchased was households with heads over 65 years of age. These households purchased on average 8.95 ounces/quarter more than the reference category, holding all the other factors fixed.

Table 16. Unconditional and Conditional Marginal Effects of the Age of Household Head Variables

	Age of Household Head							
	age_2535		age_3545		age_4565		age_ovr65	
Cheese Variety	uncond	cond	uncond	cond	uncond	cond	uncond	cond
Mozzarella	-1.156	-1.258	-2.057	-2.238	**-2.837**	**-3.086**	**-4.342**	**-4.724**
Colby	0.250	0.194	0.512	0.396	0.539	0.418	0.361	0.280
Cheddar	-0.102	-0.074	-0.118	-0.085	-0.162	-0.118	-0.262	-0.191
Swiss	-0.100	-0.149	0.194	0.288	0.260	0.386	0.264	0.392
Remaining Natural	0.285	0.205	0.389	0.280	0.068	0.049	-0.954	-0.686
Processed Slices	6.129	4.624	5.369	4.051	4.145	3.127	2.423	1.828
Loaves	1.717	1.404	**1.952**	**1.597**	1.447	1.184	0.478	0.391
Snack	0.446	0.464	**0.619**	**0.644**	**0.769**	**0.800**	**0.971**	**1.010**
Cream Cheese	-1.515	-1.119	-0.920	-0.679	-0.733	-0.541	0.134	0.099
Ricotta	-0.333	-0.240	-0.672	-0.485	-0.835	-0.602	-0.800	-0.577
Grated	0.063	0.071	-0.088	-0.098	-0.375	-0.420	-0.530	-0.594
Specialty/Imported	-0.276	-0.226	0.048	0.040	-0.035	-0.029	-0.015	-0.012
Shredded	-1.175	-0.880	-2.691	-2.015	**-7.550**	**-5.655**	**-14.615**	**-10.947**
Cottage	-0.652	-0.463	0.887	0.631	4.408	3.135	**8.951**	**6.367**

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

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 17 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, where the education attainment had a positive impact on the quantity purchased up to some college education. Cream cheese demand revealed that households with household heads with less than high-school education purchased, on average, 1.52 ounces/quarter less than household with household heads that are college graduates, holding any other factor constant.

Ricotta, specialty/imported cheese, and cottage cheese varieties exhibited the same education impact as did natural cheese products. For these three varieties, the quantity of cheese products purchased per quarter increased with the increase of household head education attainment as well. As shown in Table 17, households with household heads that have only a high-school education purchased, on average, 0.34 and

2.21 ounces/quarter less of Ricotta and cottage cheese, respectively, than household with household heads that are college graduates.

Table 17. 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.

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.

Table 18. 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.

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 18). 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. The difference between the quantity purchased by African-American household and other races households (reference category) was higher, on average, than the difference between the quantity purchased by Oriental household and households

within the reference category. African-American households purchased, on average, 4.86 and 1.3 ounces/quarter less Mozzarella and snack products, respectively, than the reference category households, while Oriental households purchased, on average, 2.01and 0.68 ounces/quarter less Mozzarella and snack products than the same households, holding all other variables constant.

Ethnicity of Household Head

Within natural cheese varieties, Hispanic households purchased more Mozzarella and the remaining natural cheese category than non-Hispanic households. 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.

Among the other cheese category, only specialty/imported cheese and shredded cheese varieties demands revealed a statistically significant effect of ethnicity on the quantity purchased. As shown in Table 18, Hispanic households purchased 1.07 more ounces of specialty/imported cheese products and 3.91 less ounces of shredded cheese, on average, than non-Hispanic households, holding all other factors fixed.

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 19, 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. As shown in Table 19, all the statistically significant coefficient estimates for the demand of processed slices and cream cheese exhibited positive values. Only households located in the East exhibited a negative value for the demand of loaves and snack products, relative to the West. 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.

Table 19. 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.

When considering the demand for Ricotta, specialty/imported cheese, and cottage cheese varieties we observed that, once again, the West is the region where more cheese quantities are purchased by households. All the coefficient estimates of the location dummy variables are negative. Households located in the Central region purchased, on average, 1.21 ounces less Ricotta, 0.95 ounces less specialty/imported cheese products, and 2.53 ounces less cottage cheese than households living 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 20, 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, Cheddar, Swiss, and remaining natural cheese category, 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. Households purchased, on average, 1.16 (0.05) , 0.98 (0.04), and 0.75 (0.03) ounces of Cheddar (Swiss) cheese less in the first, second, and third quarter, respectively, than the quantity purchased during the fourth quarter, holding all the other factors fixed.

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. The processed sliced variety showed it lowest purchases during the fourth quarter and the highest values during the third quarter, reproducing Mozzarella and Colby demand seasonality. As shown in Table 20, on average, households purchased respectively 4.9 and 0.70 ounces of cream cheese and snack products less in the first quarter than the quantities purchased of the same products during the fourth quarter, holding other variables constant. In the third quarter, households purchased 2.85 ounces more of processed slices but 0.70 ounces less of loaves than the quantities purchased during the fourth quarter.

Table 20. 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.

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 (Table 21). Then we obtained the correlation matrix of the residuals given that:

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

As shown in Table 22, 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.

Table 21. The Variance-Covariance Matrix of Cheese Varieties

	Mozzarella	Colby	Cheddar	Swiss	Rem. Nat.	Slices	Loaves	Snack	Cream Ch.	Ricotta	Grated	Spec/Imp	Shredded	Cottage
Mozzarella	372.25	4.03	44.24	8.72	35.24	15.24	3.00	5.09	21.60	38.74	6.08	14.28	37.84	64.67
Colby		60.84	11.09	0.83	12.86	6.98	4.12	-0.67	4.90	4.24	0.54	0.41	11.66	24.09
Cheddar			838.10	20.02	62.11	24.03	18.33	12.07	43.39	15.38	10.27	19.05	42.20	96.15
Swiss				97.42	7.88	5.14	0.52	6.70	9.08	-2.82	3.46	6.95	20.12	12.00
Rem. Nat.					348.43	21.15	7.49	2.72	27.60	18.74	4.70	14.82	59.56	99.55
Slices						1093.36	38.99	13.78	32.08	7.58	12.10	-0.84	132.31	116.99
Loaves							316.09	7.22	25.59	0.27	3.84	0.41	59.99	27.71
Snack								104.23	14.30	-1.50	1.90	6.64	14.01	6.26
Creem ch.									484.99	22.86	8.59	15.65	101.25	66.79
Ricotta										185.06	7.03	8.35	52.33	50.20
Grated											39.71	3.87	28.59	8.77
Spec./Imp.												94.87	24.82	29.27
Shredded													1229.49	168.90
Cottage														3071.61

Table 22. The Correlation Matrix of Cheese Varieties

	Mozzarella	Colby	Cheddar	Swiss	Rem. Nat.	Slices	Loaves	Snack	Cream Ch.	Ricotta	Grated	Spec/Imp	Shredded	Cottage
Mozzarella	1.00	0.03	0.08	0.05	0.10	0.02	0.01	0.03	0.05	0.15	0.05	0.08	0.06	0.06
Colby		1.00	0.05	0.01	0.09	0.03	0.03	-0.01	0.03	0.04	0.01	0.01	0.04	0.06
Cheddar			1.00	0.07	0.11	0.03	0.04	0.04	0.07	0.04	0.06	0.07	0.04	0.06
Swiss				1.00	0.04	0.02	0.00	0.07	0.04	-0.02	0.06	0.07	0.06	0.02
Rem. Nat.					1.00	0.03	0.02	0.01	0.07	0.07	0.04	0.08	0.09	0.10
Slices						1.00	0.07	0.04	0.04	0.02	0.06	0.00	0.11	0.06
Loaves							1.00	0.04	0.07	0.00	0.03	0.00	0.10	0.03
Snack								1.00	0.06	-0.01	0.03	0.07	0.04	0.01
Cream Ch.									1.00	0.08	0.06	0.07	0.13	0.05
Ricotta										1.00	0.08	0.06	0.11	0.07
Grated											1.00	0.06	0.13	0.03
Spec/Imp												1.00	0.07	0.05
Shredded													1.00	0.09
Cottage														1.00

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.

CHAPTER III

THE IMPACT OF RETAIL PROMOTION ON THE DECISION TO PURCHASE PRIVATE LABEL PRODUCTS: THE CASE OF U.S. PROCESSED CHEESE

Background

An important issue to the profitability and growth of brands indigenous to the U.S. dairy industry is the increasing influence of private label products. Over the past few years, private label products have dominated milk sales, and they have gained importance in the other dairy categories as well, particularly cheese, butter and ice cream. According to the U.S. Census Bureau (2004), cheese overtook fluid milk as the largest user of raw milk in the late 1990s and, by 2001, it accounted for $19.6 billion in sales. Americans consumed 8.8 billion pounds of cheese in 2003 with a total market value[3] of $39.9 billion, according to a study sponsored by the California Milk Advisory Board (CMAB). We focus on cheese since it is the dairy product category with the largest market value. At the retail level, private label brands (store brands) of cheese account for 35% of total market share; national brands account for the remaining 65%, where Kraft alone constitutes 45% of total market share (Cropp 2001). Although dated, these data are the most current available.

Many experts believe that this growth trend in the private label share will continue due to the recent economic downturn wherein the consumer likely will focus more attention on prices. Additionally, private label products often provide acceptable

[3] "Market value" includes foodservice and industrial sales as well as retail sales.

quality at reasonable prices. Consequently, the growth of the private label share becomes a major concern for managers of national brands who need to find ways of protecting their market.

Store brands have lower prices, generally attributed to lower manufacturing, advertising and overhead costs. As manufacturers and retailers seek to expand cheese sales, they are mainly interested in consumer sensitivity to price changes for store and national brands (Huang 2007). However it is important to investigate other factors affecting consumer choices such as promotion strategies. Several studies showed that promotions for national brands could be more effective than those for private label products (Allenby and Rossi 1991; Bronnenberg and Wathieu 1996). Other studies looked into the effect of coupon redemption on household food purchases for frozen concentrated orange juice (Lee and Brown 1985) and for cheese products (Dong and Kaiser 2005). However, neither of these studies distinguished between national brands and store brands nor between the different types of coupons used.

Objectives

In this light, the objectives are: (1) to investigate the relationship between the decision to purchase private label products of processed cheese and the level of couponing activity, and (2) to assess the effectiveness of national brand coupons as deterrents to private label market share expansion. We use data from the Nielsen Homescan Panel of U.S. households for 2005 and 2006 in this investigation. We chose

to consider only the purchase information concerning American processed sliced cheese since this product had a market penetration of nearly 70% over the sample households.

Literature Review

Sethuraman and Mittelstaedt (1992) developed a framework to explain different types of coupon usage behavior as well as a typology of coupon effects. They used aggregate scanner panel data on 480 product categories and found that both the type of the coupon (private label or national brand) and the method of coupon distribution (by manufacturer or by retailer) are important determinants of private label purchase share responses. Couponing activities related to private label products were not identified as contributing to increase private label shares, and unexpectedly, the national brand store couponing activity was positively related to the private label purchase share.

Bronnenberg and Wathieu (1996) studied the effect of brand positioning on promotion asymmetry. They analyzed consumer reactions to price discounts in a parsimonious preference model featuring loss aversion and reference-dependence along dimensions of price and quality. The study found that, given any two brands, there is an asymmetric promotion effect in favor of the higher quality/higher price brands if and only if the quality gap between the brands is sufficiently large in comparison with the price gap. Therefore, the direction of promotion asymmetry is not unconditional. If the ratio of quality and price differences is large enough, the usual asymmetry prevails (promotions of national brands are more effective than those of store brands); if such is

not the case, promotions of the lower quality/lower price brands are more effective (better consumer reaction to price discounts).

Gedenk and Nelsin (1999) estimated the role of retail promotion in determining future brand loyalty through its effect on purchase event feedback. Purchase event feedback represents the effect of current purchases on future brand preference. The extent to which purchases made during a retail promotion enhanced or detracted from the level of feedback was evaluated, compared to non-promotion purchases. In-store price promotions were found to be associated with negative purchase event feedback compared to non-promotion purchases. Non-price promotions such as features or sampling (distribution of free product samples) were found to be associated with positive purchase event feedback compared to purchases made due to promotion.

Garretson, Fisher and Burton (2002) proposed and tested a model that addressed the similarities and differences in conceptual antecedents of attitudes toward private label grocery products and national brand promotions. This study found that both price and non-price related constructs impacted attitudes of consumers toward both private label and national brand promotion, but the directionality and strength of these relationships differed. For example, value-consciousness was positively related to attitudes towards both private labels and national brand promotions, but the perception of price in terms of its relationship to product quality had the opposite effect. The relatively low price on private labels compared to national brands signaled inferior quality for consumers. In contrast, these same buyers viewed national brands on price promotion more favorably.

Dong and Kaiser (2005) estimated U.S. household cheese purchase, quality choice, and coupon redemption equations simultaneously, by endogenizing unit value and coupon redemption. The correlations among the three equations were found to be significant. The empirical findings revealed that coupon usage had a positive and significant impact on cheese purchases, and its elasticity compared favorably with previous elasticity estimates of generic cheese advertising. They also found that higher-income households selected higher-quality cheese, while larger households chose lower-quality cheese. African-American and Hispanic households redeemed less coupons, while coupon redemption of Asian households was not significantly different compared to Caucasian households.

Arnade, Gopinath, And Pick (2008) analyzed brand choices of U.S. consumers for cheese purchases by deriving a set of discrete-choice models based on a dynamic utility maximization framework. They estimated a dynamic probit model for each of the top brands for cheddar, shredded, and sliced cheese in four U.S. regions. Although households exhibited strong brand inertia (persistence in buying the same brand), they also were more likely to switch within the top brands. They also showed that brand inertia was relatively larger in cheddar and sliced cheeses, especially in the Central and South regions.

Contribution to Existing Literature

This essay reconsiders the issue addressed by Sethuraman and Mittelstaedt (1992) differentiating between type of product (private label vs. national brand) and also

the origin of coupons (store coupon vs. manufacturer coupon) but adds the demographic dimension to the analysis. Previous works failed to tackle both the type of product and the origin of coupons simultaneously. Bronnenberg and Wathieu (1996) and Garretson, Fisher and Burton (2002) differentiated between the type of product only and found that product type influences promotion effectiveness; Dong and Kaiser (2005) addressed the impact of coupons on the purchase of cheese products without pointing out any differentiation in the type of coupon. Our research also contributes to the existing literature not only by considering other types of promotion but also by examining for the first time the effects of demographics when studying the impact of promotions on purchases, taking into account the type of product.

Some of the previous studies used a conventional regression analysis (Sethuraman and Mittelstaedt 1992) or a qualitative choice (binary logit) analysis (Gedenk and Nelsin 1999) to address their research issues. Others, due to the nature of data used and the complexity of the issue tackled opted for a more elaborate econometric framework (Dong and Kaiser 2005). Dong and Kaiser (2005) estimated U.S. household cheese purchase, quality choice, and coupon redemption equations simultaneously, and took into account zero purchases to correct for selectivity bias due to the panel nature of data. In this research we consider the endogeneity of coupon use as well but within a different framework. We do not need to account for zero purchases since this analysis uses pooled cross-sectional data, wherein the observation units are actual transactions and not quantities bought by each household in each period of time as in Dong and Kaiser (2005).

Empirical Model

We examine the influence of national brand and private label coupons on the decision to purchase private label processed cheese products. To identify these effects, a probit model is estimated where the binary variable Y equals 1 if the household buys the private label cheese product and equals 0 otherwise (the household chose to buy a national brand product). The model gives the probability that Y=1 conditional on a set of explanatory variables, namely, unit value, promotion type, and selected socio-demographic variables. We are mainly interested in the signs and the marginal effects of the different types of retail promotion.

The nature of promotion affecting the purchase is studied using three variables related to the type of promotion used: store coupons, store features[4] and manufacturer coupons. Other variables corresponding to region, race and ethnicity also are included to control for potential geographic and race-related variations in cheese purchase patterns. Annual household income, household size, the age of the household head and her/his educational attainment also are used as explanatory variables. In most instances, the female household head is the household head. For households wherein no female household head is present, the male household head is the household head. We include variables to account for the presence of both the male and female household head, the presence of the female household head only, and the presence of the male household head only.

[4] Store features include major and minor displays of merchandise.

Choice of Explanatory Variables and Expected Signs

We include income as explanatory variable as typically a price gap exists between national brand and private label products. Additionally, according to Huang (2007), lower-income consumers are more price sensitive. We also expect income to have a negative impact on the choice of purchase of private label cheese products due to the findings of Dong and Kaiser (2005), where higher-income households selected higher-quality cheese products.

According to Arnade *et al.* (2008), a greater level of education positively affected the purchase of top brand cheese products. The educational attainment of the head of the household then is expected to be negatively correlated to the probability of purchasing a private label product.

Dong and Kaiser (2005) found that African-American and Hispanic households redeemed less coupons compared to Caucasian households, while no significant differences were found between Asian and Caucasian households. Since we are looking at the impact of couponing strategies, our analysis needs to account for the effect of race and ethnicity. We anticipate statistically significant differences among racial and ethnical groups when facing the same purchase choice.

We expect household size to have a positive effect on the decision of purchasing private label products. According to Arnade *et al.* (2008), the volume of purchase at the household level had a negative and significant effect on the decision of purchasing the

leading brand products[5]. Dong and Kaiser (2005) found in their study that larger households chose lower-quality cheese products.

Dong and Kaiser (2005) found that the variable on female head working outside home had a significant negative effect on the use of coupons. However, the gender effect on the purchase of private label products and the use of coupons has not been investigated in previous works. We expect households with no female household head to be less likely to purchase private label products or redeem coupons.

The decision of buying a private label product also may depend on the strength of the loyalty toward national brands. Arnade *et al.* (2008) showed that brand inertia was relatively larger for cheddar and sliced cheese products especially in the Central and South regions. We include location as an explanatory variable and expect households residing in the Central and South regions to be less likely to buy private label cheese products on average in light of previous evidence from the literature.

The age of the household head was not often examined in previous studies. We expect younger household heads to exhibit higher probabilities of purchasing private label products. On the other hand, we expect older household heads to display more loyalty toward national brands.

Probit Model

Past research (Gendek and Neslin 1999) had established that promotion affected purchase event feedback, that is, the purchase of products which offer a coupon typically

[5] Leading brands were defined as the six brands that accounted for 80% or more of purchase in each of the four U.S. regions.

induces the use of the coupon in subsequent purchases. Consequently, in our analysis an endogeneity problem occurs since the use of coupons not only affects the purchase decision but also the purchase decision affects future uses of the coupon. Dong and Kaiser (2005) also considered coupon redemption as endogenous in their estimation of U.S. household cheese demand.

To deal with this issue, we assume that the explanatory variable, *storecoupon*[6], is endogenous. This situation is illustrated by the following model specification:

(15) $y_1 = g[\boldsymbol{z_1}\delta_1 + \alpha_1 y_2 + u_1 > 0]$

(16) $y_2 = g[\boldsymbol{z}\delta_2 + v_2 > 0]$, and

(17) $(u_1, v_2|\boldsymbol{z_1}, \boldsymbol{z}) \sim N(0,0,1,1,\rho)$, where

$g(.)$ is the indicator function taking the value one if the statement in the brackets is true and zero otherwise; α_1, δ_1 and δ_2 are regression coefficients to be estimated, *N* indicates the standard bivariate normal distribution with correlation coefficient ρ, and u_1 and v_2 are the respective disturbance terms. In Table 23, we define the set of variables used to estimate this model. y_1 refers here to *privatelbl*, the purchase of a private label product, and y_2 refers to the use of store coupon. Both are binary variables. $\boldsymbol{z_1}$ is the vector of explanatory variables for equation (15), and $\boldsymbol{z}$ is the vector of explanatory variables for equation (16). $\boldsymbol{z}$ contains the instrumental variables for equation (16) in addition to the elements of $\boldsymbol{z_1}$.

[6] See Table 23 for variable definitions, * are used as the reference category when estimating the model

Table 23. Definition of the Variables Used in the Model

Variable Group	Variable Name	Type	Definition
	privatelbl	Binary	purchase of private label cheese product
	ppoz	Continuous	unit value ($/Oz)
	storecoupon	Binary	use of a store coupon during the transaction
	manufcoupon	Binary	use of manufacturer coupon during the transaction
	storefeat	Binary	use of store feature during the transaction
Household	hhinc0_25k	Binary	the income of the household head is under $25 K
Income	hhinc25_50k	Binary	the income of the household head is between $25 K and $50K
	hhinc50_100k	Binary	the income of the household head is between $50 K and $100K
	hhinc100_over	Binary*	the income of the household head is over $100 K
Household	hhsize1	Binary	the household consists of one person living alone
Size	hhsize2	Binary	the household consists of 2 members
	hhsize3	Binary	the household consists of 3 members
	hhsize4	Binary	the household consists of 4 members
	hhsize5	Binary	the household consists of 5 members
	hhsize6	Binary	the household consists of 6 members
	hhsize7	Binary	the household consists of 7 members
	hhsize8	Binary	the household consists of 8 members
	hhsize9over	Binary*	the household consists of 9 members or more
Gender	malhh	Binary	the household has no female household head
	femhh	Binary	the household only has a female household head.
	cplhh	Binary*	the household has both the female and the male household head
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	edu_lesshs	Binary	the level of education of the household head is less than high school
Attainment	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
Region	east	Binary	the household is from the Northeast region
	south	Binary	the household is from the South
	west	Binary	the household is from the West region
	central	Binary*	the household is from the Central region
	yr2006	Binary	the transaction occurs during the calendar year 2006
Instrumental	grocery	Binary	the transaction was made at a grocery store
variables	fnotwork	Binary	the female head of the household is retired or unemployed

When ρ is zero, the model for y_1 is the standard probit model but if $\rho \neq 0$ then u_1 and v_2 are correlated. When u_1 and v_2 are correlated, the estimation of the equation (15) is inconsistent for δ_1 and α_1. The instrument variables selected for equation (16) are *grocery*, a binary variable taking on the value of 1 when the transaction was made at a grocery store, and 0 otherwise, and *fnotwork,* a binary variable taking the value of 1 if the head of the household is retired or unemployed, and 0 otherwise (see Table 14). Usually, the female head is primarily responsible for food preparation, and people with more free time are more likely to spend time looking for and redeeming coupons.

Consistent and asymptotically efficient parameter estimates are obtained by maximum likelihood estimation (MLE) of the bivariate probit model, based on a likelihood function consisting of the product of the individual contributions. The likelihood function is given as:

(18) $L_i(\alpha_1, \delta_1, \delta_2 | y_1, y_2, \boldsymbol{z_1}, \boldsymbol{z}) = P(y_1, y_2 | \boldsymbol{z_1}, \boldsymbol{z}) = P(y_1 | y_2, \boldsymbol{z_1}) P(y_2 | \boldsymbol{z})$

$P(y_2|\boldsymbol{z})$ corresponds to the probability of the use of the store coupon obtained through the use of the probit model for y_2:

(19) $P(y_2|\boldsymbol{z}) = [\Phi(\boldsymbol{z}\delta_2)]^{y_2}[1 - \Phi(\boldsymbol{z}\delta_2)]^{1-y_2}$.

According to Wooldridge (2002) (p.478), the probability of the purchase of the private label product is given as:

(20) $P(y_1 = 1 | y_2 = 1, \boldsymbol{z}) = P(\alpha_1 y_2 + \boldsymbol{z_1}\delta_1 + u_1 > 0 | v_2 > -\boldsymbol{z}\delta_2)$;

equation (20) may be rewritten as:

(21) $P(y_1 = 1 | y_2 = 1, \boldsymbol{z}) = \int_{-\boldsymbol{z}\delta_2}^{\infty} \Phi\left(\frac{\alpha_1 y_2 + \boldsymbol{z_1}\delta_1 + \rho v_2}{\sqrt{1-\rho^2}}\right) \frac{\phi(v_2)}{\Phi(\boldsymbol{z}\delta_2)} d\, v_2$.

Even though precise procedures for evaluation of this expression exist, they are often time consuming in an iterative optimization context. Furthermore, when ρ approaches one, numerical calculation of the integral often becomes intractable. Both drawbacks are avoided with the following approximation using the Heckit correction:

(22) $P(\alpha_1 y_2 + \boldsymbol{z_1}\delta_1 + u_1 > 0 | v_2 > -\boldsymbol{z}\delta_2) \approx \Phi\left(\alpha_1 y_2 + \boldsymbol{z_1}\delta_1 + \rho\frac{\phi(\boldsymbol{z}\delta_2)}{\Phi(\boldsymbol{z}\delta_2)}\right)$, where the ratio ϕ/Φ corresponds to the inverse Mill's ratio. $P(y_1 = 1 | y_2 = 1, \boldsymbol{z})$ then is approximated by

(23) $1 - \Phi\left(\alpha_1 y_2 + \boldsymbol{z_1}\delta_1 + \rho\frac{\phi(\boldsymbol{z}\delta_2)}{\Phi(\boldsymbol{z}\delta_2)}\right)$.

When conditioning on $y_2 = 0$, a similar approximation holds replacing ϕ/Φ by $-\phi/(1-\Phi)$.

(24) $f(y_1, y_2 | \boldsymbol{z}) = \{\Phi(w_1)\}^{1(y_1=1, y_2=1)}\{1 - \Phi(w_1)\}^{1(y_1=0, y_2=1)}$

$\{\Phi(w_2)\}^{1(y_1=0, y_2=1)}\{1 - \Phi(w_2)\}^{1(y_1=0, y_2=0)}$,

where $w_1 = \alpha_1 y_2 + \boldsymbol{z_1}\delta_1 + \rho\frac{\phi(\boldsymbol{z}\delta_2)}{\Phi(\boldsymbol{z}\delta_2)}$ and $w_2 = \alpha_1 y_2 + \boldsymbol{z_1}\delta_1 - \rho\frac{\phi(\boldsymbol{z}\delta_2)}{1-\Phi(\boldsymbol{z}\delta_2)}$.

Combining the four possible outcomes of (y_1, y_2), along with the probit model for y_2, and using the log transformation yields the log-likelihood function:

(25) $logL_i(\alpha_1, \delta_1, \delta_2 | y_1, y_2, \boldsymbol{z}) = y_1 y_2[log\ \Phi(w_1) + log\ \Phi(\boldsymbol{z}\delta_2)]$

$+(1 - y_1)y_2\left[log\left(1 - \Phi(w_1)\right) + log\ \Phi(\boldsymbol{z}\delta_2)\right]$

$+y_1(1 - y_2)[log\ \Phi(w_2) + log(1 - \Phi(\boldsymbol{z}\delta_2))]$

$+(1 - y_1)(1 - y_2)[log(1 - \Phi(w_2)) + log(1 - \Phi(\boldsymbol{z}\delta_2))]$.

This log-likelihood function is used in the estimation of our probit model. Hence, we employ a MLE estimation technique taking into account the endogeneity of store coupon redemption.

Data

The source of the data used in this analysis is the Nielsen Homescan Panel of U.S. households. Households constituting the panel used hand-held scanners to record purchase information, including date of purchase, universal product code (UPC), total expenditure, and quantities purchased. Cheese purchases are aggregated into 19 categories each one referring to a different cheese variety, and purchase information was combined with a set of household demographic data. The sample size consists of 38,040 households for calendar year 2005 and 36,923 households for calendar year 2006.

In this study, we only focus on transactions where American processed sliced cheese had been bought. We use this information coupled with demographic information associated with each transaction to develop a pooled cross-sectional dataset. Therefore, the observation units in our analysis are not quantities aggregated by households and time periods. Each observation corresponds to a transaction where a private label or a national brand processed cheese is purchased.

Table 24. Descriptive Statistics Associated with the Explanatory Variables for Calendar Years 2005 and 2006

	Total		Privatelbl=1		Privatelbl=0	
Transactions	272,370		97,011		175,359	
	Sum	Mean	Sum	Mean	Sum	Mean
ppoz		0.176		0.151		0.190
storecoupon	5,028	0.019	1,670	0.017	3,358	0.019
manufcoupon	6,269	0.023	228	0.002	6,041	0.034
storefeat	73,614	0.270	27,594	0.284	46,020	0.262
hhinc0_25k	54,100	0.199	22,375	0.231	31,725	0.181
hhinc25_50k	100,022	0.367	37,287	0.384	62,735	0.358
hhinc50_100k	95,783	0.352	31,258	0.322	64,525	0.368
hhinc100_over	22,465	0.083	6,091	0.063	16,374	0.093
hhsize1	39,412	0.145	14,777	0.152	24,635	0.141
hhsize2	106,652	0.392	37,143	0.383	69,509	0.396
hhsize3	48,890	0.180	16,896	0.174	31,994	0.182
hhsize4	47,413	0.174	17,127	0.177	30,286	0.173
hhsize5	19,471	0.072	7,005	0.072	12,466	0.071
hhsize6	6,851	0.025	2,718	0.028	4,133	0.024
hhsize7	2,111	0.008	746	0.008	1,365	0.008
hhsize8	1,032	0.004	372	0.004	660	0.004
hhsize9over	538	0.002	227	0.002	311	0.002
malhh	18,696	0.069	7,987	0.082	10,709	0.061
femhh	49,392	0.181	17,108	0.176	32,284	0.184
cplhh	204,282	0.750	71,916	0.741	132,366	0.755
age_under25	517	0.002	191	0.002	326	0.002
age_2535	19,466	0.072	6,731	0.069	12,735	0.073
age_3545	61,451	0.226	21,308	0.220	40,143	0.229
age_4555	77,493	0.285	27,036	0.279	50,457	0.288
age_5565	61,283	0.225	21,857	0.225	39,426	0.225
age_over65	52,160	0.192	19,888	0.205	32,272	0.184
edu_lesshs	13,175	0.048	5,081	0.052	8,094	0.046
edu_hs	86,799	0.319	30,455	0.314	56,344	0.321
edu_somecol	86,921	0.319	31,454	0.324	55,467	0.316
edu_colnmore	85,475	0.314	30,021	0.310	55,454	0.316
black	24,329	0.089	7,997	0.082	16,332	0.093
white	230,368	0.846	83,271	0.858	147,097	0.839
oriental	3,259	0.012	1,014	0.011	2,245	0.013
otherace	14,414	0.053	4,729	0.049	9,685	0.055
hisp	17,782	0.065	5,776	0.060	12,006	0.069
east	39,634	0.146	15,281	0.158	24,353	0.139
central	71,983	0.264	26,273	0.271	45,710	0.261
south	124,101	0.456	41,244	0.425	82,857	0.473
west	36,652	0.135	14,213	0.147	22,439	0.128

As shown in Table 24, private label products represent 35.6% of all the sliced American cheese bought during calendar years 2005 and 2006. When store coupons were used to complete the transactions, households bought private label products in 33.2% of the cases. However, when manufacturer coupons were used, they were mostly redeemed to acquire national brand cheese products (96.4%). Promotional store features were more frequently used than the use of either store coupons or the use of manufacturer coupons. Over calendar years 2005 and 2006, 73,614 transactions involved a store feature, whereas only 5,028 transactions and 6,269 transactions involved the use of store coupons and the use of manufacturer coupons respectively.

The majority of the households have incomes less than $100,000. Only 8.2% of the household heads had incomes over $100,000. The largest proportion of private label product is bought by households belonging to the two lowest income categories (under $50,000).

Households are mostly distributed within the first four household size categories (1 to 4 members). Households with two members buy the highest proportion of the cheese products, 38.3% of the private label products and 39.6% of the national brand products.

Household heads aged between 35 and 65 years include more than 70% of the sample. The distribution of age is almost the same across the use of private label and national brand products. No difference in the distribution also is observed when considering the educational attainment of household heads in both categories of cheese purchases.

As shown in Table 24, Caucasians are represented in higher proportion when private label products are bought, 85.8% compared to 83.9% for the national brand transactions. The opposite occurs when observing Hispanics and African-Americans.

Considering the location variables, we notice that a higher proportion of households buying private label products is located in the Northeast and the West region compared to households located in the South or Central regions.

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

When a private label transaction is made, the average price per ounce is 0.1512 cents; when a transaction occurs for a national brand, the average price per ounce is 0.1901 cents. Consequently, as expected, prices are higher for national brand transactions compared to private label transaction. This differential is about 0.04 cents per ounce.

Estimation and Empirical Results

The estimation of the probit model with a binary endogenous explanatory variable was performed using the software package *Stata* (version 10.1). An advantage of the MLE approach is that it makes use of the information in $f(y_1|y_2, \boldsymbol{z})$ and $f(y_2|\boldsymbol{z})$ simultaneously[7] and yields consistent parameter estimates and the correct standard errors, unlike two-step procedures. The *Stata* program used in the estimation of the

[7] $f(y_1|y_2, \boldsymbol{z})$ and $f(y_2|\boldsymbol{z})$ correspond to the density of y_1 given $y_2$and $\boldsymbol{z}$, and the density of y_2 given $\boldsymbol{z}$, respectively.

respective models is available from the author upon request. Table 25 shows the estimated parameters of the model, standard errors, the p-values, and the corresponding marginal effects. In Table 26, we provide joint tests of hypotheses associated with selected demographic variables.

Marginal Effects

The coefficients from the probit model allow the identification of statistically significant drivers associated with the probability of purchasing private label products. To obtain how the probability of purchasing private label products changes due to changes in the explanatory variables, we calculate the marginal effects ME_{ji} of explanatory variable *j* at observation *i* defined as:

$$(26) \qquad ME_{ji} = \frac{\partial P(y_i=1)}{\partial x_{ji}} = f(s_i)\hat{B}_j,$$

where $f(s_i)$ is the value of the probability density function at s_i. s_i is the linear combination of the product of the estimated coefficients and the corresponding values of the explanatory variables at observation i. In our analysis, we compute the marginal effects for all the covariates at their sample means.

Table 25. Estimation Results for the Probit Model of Purchase of Private Label Cheese Products for Calendar Years 2005 and 2006

	Equation 1				Equation 2		
	Privatelbl				Storecoupon		
	Estimated Coefficient	Standard Error	p-value	Marginal Effect	Estimated Coefficient	Standard Error	p-value
ppoz	-7.392	0.054	0.000	-2.675	-13.633	0.164	0.000
storecoupon	-0.664	0.049	0.000	-0.240			
manufcoupon	-1.901	0.032	0.000	-0.688	-6.387	248.443	0.979
storefeat	-0.085	0.006	0.000	-0.031	-5.329	71.046	0.940
hhinc0_25k	0.295	0.012	0.000	0.107	-0.483	0.034	0.000
hhinc25_50k	0.202	0.011	0.000	0.073	-0.328	0.030	0.000
hhinc50_100k	0.102	0.011	0.000	0.037	-0.210	0.029	0.000
hhsize1	-0.119	0.057	0.037	-0.043	0.306	0.205	0.136
hhsize2	-0.123	0.056	0.028	-0.045	0.222	0.203	0.274
hhsize3	-0.124	0.056	0.028	-0.045	0.110	0.203	0.587
hhsize4	-0.055	0.056	0.326	-0.020	0.171	0.203	0.399
hhsize5	-0.084	0.057	0.136	-0.031	0.179	0.205	0.382
hhsize6	0.006	0.058	0.921	0.002	0.042	0.209	0.841
hhsize7	-0.156	0.063	0.013	-0.056	0.037	0.223	0.867
hhsize8	-0.096	0.069	0.168	-0.035	-0.270	0.263	0.304
malhh	0.143	0.013	0.000	0.052	-0.046	0.037	0.223
femhh	-0.068	0.009	0.000	-0.025	0.023	0.028	0.405
age_und25	-0.022	0.059	0.707	-0.008	-0.072	0.219	0.742
age_2535	-0.091	0.012	0.000	-0.033	-0.054	0.038	0.156
age_3545	-0.082	0.009	0.000	-0.030	-0.080	0.029	0.005
age_4555	-0.062	0.008	0.000	-0.022	0.025	0.025	0.309
age_5565	-0.026	0.008	0.002	-0.009	0.032	0.024	0.175
edu_lesshs	-0.143	0.013	0.000	-0.052	-0.350	0.040	0.000
edu_hs	-0.148	0.007	0.000	-0.054	-0.007	0.020	0.721
edu_somecol	-0.054	0.007	0.000	-0.019	-0.119	0.020	0.000
black	-0.027	0.017	0.111	-0.010	0.163	0.056	0.004
white	0.085	0.015	0.000	0.031	0.319	0.049	0.000
oriental	-0.060	0.028	0.034	-0.022	0.462	0.074	0.000
hisp	-0.049	0.013	0.000	-0.018	-0.074	0.041	0.073
east	0.234	0.009	0.000	0.085	0.348	0.024	0.000
south	-0.066	0.006	0.000	-0.024	-0.009	0.020	0.634
west	0.285	0.009	0.000	0.103	0.671	0.024	0.000
yr2006	-0.048	0.005	0.000	-0.017	0.118	0.015	0.000
grocery					1.199	0.028	0.000
fnotwok					0.049	0.018	0.007
constant	0.914	0.060	0.000		-1.352	0.213	0.000
ρ^*	-0.076	0.028	0.008				
McFadden's R^2	0.140						

* The correlation coefficient of the error terms in equation (15) and equation (16)

Table 26. Chi-Squared Test Statistics for Selected Demographic Variables

Variable Groups	Degrees of Freedom	x^2 Test Stat	p-value
hhinc	3	805.50	0.000
hhsize	8	129.62	0.000
gender	2	328.91	0.000
age	5	105.28	0.000
education	3	487.98	0.000
race	3	195.13	0.000
region	3	2566.04	0.000

Goodness of Fit

As a goodness of fit measure, we use the likelihood ratio index also referred to as McFadden's R^2 . This statistic may be estimated as:

$$(27) \qquad R_L^2 = 1 - \frac{\log(L_1)}{\log(L_0)},$$

where $\log(L_0)$ is defined as the log likelihood at iteration 0, and $\log(L_1)$ is defined as the log likelihood at final iteration. According to our estimation results in Table 25, we obtain a McFadden's R^2 of .1389, typical for the use of probit analysis.

Interpretation of Results

Promotion using store coupons is found to have a significant negative effect on private label purchases. The presence of these coupons results, on average, in a reduction by 24 basis points in the probability of purchasing private label products. This result suggests that store level couponing does not help to increase the purchase of private label products. In fact the opposite effect occurs. This result is due to the fact that not all store level coupons are used to promote the purchase of private label products. Actually

only 39.4% and 28.7% of store coupons redeemed respectively in 2005 and 2006 were used to purchase private label products, while the remaining store coupons were used to purchase national brand products. This result does not contradict the literature since Sethuraman and Mittelstaedt (1992) previously found that couponing activities related to private label products did not help to increase private label market share.

As expected, couponing activities by national brand manufacturers are negatively related to private label purchases. The availability of manufacturer coupons reduces the probability of purchase of the private label product by 69 basis points. The price of cheese products also has a significant negative impact on the private label purchase decision. Since private label products often are characterized by lower prices, consumers are more willing to purchase national brand products when prices of cheese products increase, *ceteris paribus*. Promotional store features also had a negative impact on private label cheese purchases. This result is likely due to the fact that store features typically are used to boost national brand sales; only 36.9% of store feature activities concerned private label products in calendar year 2005, while 38% of store feature activities concerned private label products in calendar year 2006.

The coefficient estimates for income dummy variables are jointly significant (Table 26) and show that the higher the income of the household head, the lower the probability for the household to purchase private label cheese products. This result confirms our assumption about the effect of household income based on previous studies.

Not all the coefficient estimates related to household size were found to be significant. Nonetheless, we reject the null hypothesis that they are jointly equal to zero (Table 26). As anticipated, we observe that the probability of purchase of private label products was positively related to the household size.

We expected female household heads to be more willing to buy private label products. The opposite was revealed in this analysis. Households with no female household head were more likely to purchase private label processed cheese products compared to households with the presence of female household head. The absence of a female household head increased the probability of purchase of the private label product by 5 basis points compared to households where male and female heads are both present. The probability of purchasing private label products also was lower for households where only the female head was present compared to households with both male and female heads.

The probability of purchasing private label cheese products increases with the age of the household head. This result contradicts our initial hypothesis that younger households would be more likely to buy private label products and that older households were more loyal to national brands.

The educational attainment of the head of the household was expected to be negatively correlated to the probability of purchase of private label product, since previous studies (Arnade *et al*. 2008) found that greater levels of education positively affected the choice of the purchase of top brand cheese products. The opposite was revealed in our analysis. That is, the greater the education level of the household heads,

the more likely the purchase of private label products. Compared to household heads who are college graduates, household heads with some college had a lower probability of purchasing private label cheese products by roughly 2 basis points; for household heads with at most a high-school education, the probability was lower by 5 basis points. This result is perhaps due to the fact that educated individuals are more pragmatic in their purchase choices, more aware of the tradeoff between quality and price, and/or less sensitive to national brand promotional campaigns.

As we expected, the probability of purchasing private label products was lower for African-Americans and Asians compared to Caucasian households. We also found that Hispanics are less likely to purchase private label cheese products than non-Hispanics. On average, being of Hispanic origin reduces the probability of purchase of private label products by nearly 2 basis points.

The coefficient estimates for location dummy variables are jointly significant and show that households from the Northeast and West regions had higher probabilities to purchase private label cheese products than households located in the Central or South regions. We anticipated this result based on the previous study by Arnade *et al.* (2008) showing that brand inertia was relatively larger in sliced cheese especially in the Central and South regions.

The coefficient estimate for the binary variable *yr2006*, taking on the value of 1 when the transaction occurs during the calendar year 2006, is negative and statistically significant. The probability of purchasing a private label product decreased on average by nearly 2 basis points in the calendar year 2006 compared with 2005, holding all other

variables constant. A decrease in the probability of purchase does not mean a decrease in quantities purchased; it just shows that controlling for all the variables in our model, the probability of purchasing private label processed cheese in 2005 and 2006 were statistically different.

Prediction Success

As shown in Table 27, the overall rate of correct prediction by our model is 59.25%. However, this rate varies depending on the purchase decision outcome. The prediction success rate reaches 76% when predicting the purchase of private label processed cheese products, and drops to 50% when predicting the non-purchase of private label processed cheese products. The decision rule used to calculate these rates corresponded to the proportion of transactions corresponding to private label product purchases during the calendar years 2005 and 2006 instead of the 0.5 criterion often used (Park and Capps 1997; Briggeman 2002). As shown in Table 25, private label products represented 35.6% of all the sliced American cheese bought during 2005 and 2006. Therefore, the optimal value to use as the decision rule was 0.356.

Table 27. Prediction Success Table*

	Predicted		
Actual	0	1	Total
0	**87,670**	87,689	175,359
1	23,291	**73,720**	97,011
Total	110,961	161,409	272,370

*Cutoff is 0.356 (see Park and Capps (1997) and Briggeman (2002) for the justification of this cutoff value.)
Bold values indicate correct predictions.

Model Validation

We need to substantiate the appropriateness of the probit model with a binary endogenous explanatory variable to estimate the impact of retail promotion on the decision to purchase private label products. Simply put, we need to show that the binary variable *storecoupon* indeed was endogenous. The null hypothesis to be considered is $H_0: \rho = 0$, where ρ is the correlation coefficient between the error terms in equation (15) and equation (16). From Table 25, we observe that even though its value is small (-0.076), ρ is still statistically significant with a p-value equal to 0.008. Consequently, we reject H_0 at a 1% significance level. We conclude therefore that the variable *storecoupon* is endogenous. The estimation results also confirm that the instrumental variables used in the second equation to correct for the endogeneity issue are correlated to *storecoupon.* Both *grocery* and *fnotwork* have significant positive coefficient estimates, with respective p-values of 0.000 and 0.007.

Conclusions

Retail promotion using store coupons was found to have a significant negative effect on the private label purchase decision for processed cheese products. Consequently, store level couponing does not help to increase the purchase of private label products. This result was consistent with findings of Blattberg and Wisniewski (1989) and Sethuraman and Mittelstaedt (1992) although different methodologies and products were used. We conclude then that the consumers of national brands are

unwilling to "trade down" to private label products even when they are promoted with store coupons.

Although increasing store couponing has no impact on increasing private label purchases, we find a strong negative relationship between national brand manufacturer couponing activity and the decision to purchase private label processed cheese products. This finding is at odd with Sethuraman and Mittelstaedt (1992) who found unexpectedly that national brand couponing activity was positively related to private label share. Our study shows that the opposite is true and that national brand couponing appears to be the most effective strategy for manufacturers to deter private label growth in the processed cheese market. Promotional store features can be used as well since it had a negative (but relatively small) impact on the decision to purchase private label processed cheese products.

This research is the first to investigate promotion impacts on the purchase of private label products taking into consideration demographics. We show that the decision to purchase private label processed cheese products is influenced by a number of socio-demographic characteristics of the households. This valuable information could be used subsequently to prepare consumer profiles, identify better target markets, and to modify promotional strategies. Results show that income had a negative effect on the probability of making private label product purchases. Household size, age and education had positive effects on the likelihood of purchasing private label cheese products. Moreover, race and ethnicity influenced the decision to purchase private label products. We find that Hispanics, African-Americans and Asians are less likely to

purchase private label products compared to non-Hispanics and Caucasians respectively. This study also discussed the effect of household with female and male heads present, only female heads present, and only male heads present on the decision to purchase private label products. Households with only male heads present are more likely to buy private label cheese products compared to households with both male and female heads present. The opposite is observed concerning households with only female heads present.

The next step for future research is to consider factors affecting the volume of processed cheese for private label and national brand products. This work serves as a logical extension not only to our analysis but also to the analysis of Dong and Kaiser (2005). The important distinction is the differentiation of private label and national brand products as well as the type of promotion activity, especially use of store coupons, manufacturer coupons, and store features. This work will benefit stakeholders engaged in the processed cheese industry.

CHAPTER IV

EX-ANTE ANALYSIS OF THE FEASIBILITY OF FORTIFYING PROCESSED CHEESE WITH OMEGA-3 FATTY ACIDS

Background

Omega-3 fatty acids are essential fatty acids that must be supplied in the diet. Recently, there has been a dramatic surge in interest among public and health professionals alike, of the health effects associated with omega-3 fatty acids derived from fish consisting of Docosahexaenoic acid (DHA) and Eicosapentanoic acid (EPA). DHA is required in high levels in the brain and retina as a physiologically-essential nutrient to provide for optimal neuronal functioning (learning ability, mental development) and visual acuity, in young and old alike. According to Dr. Bruce Holub from the DHA/EPA Omega-3 Institute, DHA and EPA are considered to have beneficial effects in the prevention and management of cardiovascular disease, associated risk factors as well as other chronic disorders (http://www.dhaomega3.org).

Types of Omega-3s

The Omega-3 Centre Inc. reports two main types of omega-3s, shorter chain and long chain omega-3s. The long chain omega-3 fatty acids are very important to the development of the brain and eyes, for heart health, and for managing good health.

- Eicosapentanoic acid (EPA) is a long chain omega-3 fatty acid mainly found in oily fish. It is beneficial for reducing inflammation and helps managing and reducing the risk of heart disease.
- Docosahexaenoic acid (DHA) is considered the most beneficial long chain omega-3. It is mainly found in oily fish and algal oil, and is especially important for brain growth and visual development of unborn babies. DHA also helps to manage and reduce the risk of heart disease.
- Docosapentaenoic acid (DPA) is the main long chain omega-3 fatty acid found in lean red meat. DPA has been less well studied. However, the evidence available suggests that it has the same heart health benefits as EPA and DHA.
- Alpha-linolenic acid (ALA) is a shorter chain omega-3, which is important for health, but poorly converted by our body into the more beneficial long chain omega-3s. This omega-3 fatty acid mainly is found in canola and linseed/flaxseed oils, green vegetables and soybeans.

Benefits of Omega-3 Fatty Acids

According to the Omega-3 Learning Consortium, based at the University of Connecticut, omega-3 fatty acids are not only critical at the early stage of life but also very important through the whole life cycle (pregnancy, infancy, childhood, adulthood and aging) due to their benefits associated with growth and development, coronary heart disease, high blood triglycerides, and chronic disease.

Growth and Development

Omega-3 fatty acids are structural components of cells of the central nervous system. Therefore, they are essential nutrients for brain development. DHA is the principal omega-3 fatty acid essential for brain and neural development. Also, these fatty acids are important for retinal development of the eye for infants.

Coronary Heart Disease (CHD)

Long chain omega-3 fatty acids, DHA and EPA, decrease the risk of coronary heart disease (CHD) and ischemic heart disease (Yokoyama *et al.* 2007). They also have been shown to act as anti-arrhythmic agents (Lombardi and Terranova 2007). Several epidemiological studies examined dietary and other lifestyle factors that influence health outcomes. The Physician's Health Study found that consumption of one or more servings of fish per week was associated with a 52% lower risk of sudden cardiac disease compared to less than one fish meal per week. The Nurses' Health Study in America reported that consumption of five or more servings of fish per week was associated with 45% fewer cardiac deaths compared to consumption of one fish meal per month.

High Blood Triglycerides

The level of triglycerides in blood is positively associated with an increase in the risk of CHD. Both DHA and EPA appear to support cardiovascular health and lower blood triglyceride levels. The American Heart Association (AHA) carried out comprehensive reviews of fish and fish oil consumption and cardiovascular disease and

recommended that individuals with elevated blood triglyceride levels consume fish or take a fish oil supplement (Kris-Etherton *et al.* 2002). AHA recommends that individuals with CHD consume 1 gram of EPA and DHA per day. Those without CHD should consume two servings of fish per week. For patients who need to lower triglyceride levels, the AHA recommends 2-4 grams of EPA and DHA per day in supplemental form.

Chronic Disease

Omega-3 fatty acids are being investigated to determine whether they can effectively improve a wide range of disease states such as heart disease, diabetes, inflammation, depression, Alzheimer's and attention deficit disorder.

Epidemiological studies on DHA and EPA suggest that there exists an inverse relationship of dietary intake with cognitive impairment and decline. Emerging evidence suggests that supplementation of the diet with DHA and EPA improves mental health in schizophrenic subjects and may improve cognitive function in patients with dementia. These studies support a role for omega-3s throughout the life cycle. Epidemiological studies also report that Omega-3 consumption may improve disease conditions associated with chronic inflammation and may help control inflammatory processes that contribute to disease (Goldberg and Katz 2007). Studies also show that populations consuming omega-3 fatty acids may experience a lower incidence of cancers (Mclean *et al.* 2006).

Dairy Food and Omega-3s

While it has been shown that dietary omega-3 polyunsaturated fatty acids are important for health and development, it is difficult for most people to get enough through the diet alone since the most widely available source is cold water oily fish such as salmon which are not always consumed on a regular basis. Despite regular recommendations from various governmental and other health agencies for the public to increase their intakes of fish as a source of DHA and EPA, North Americans consume approximately only one fish serving every 7-10 days. The increased recognition of the importance of DHA in the diet, coupled with its limited availability in natural food sources, makes fortifying foods with DHA a noteworthy solution in closing the nutrition gap for better cardio-health and disease prevention/management.

Recent reports have targeted dairy foods as having a high opportunity or potential for growth in the omega-3 fortification business. First, most dairy foods provide the minimal fat basis needed to more easily incorporate the omega-3 oils. Additionally, all dairy products share the image of "being good-for-you" given that they deliver essential nutrients to consumers. This choice also is justified by the existence in the market of several dairy products already carrying added health benefits (probiotics in yogurt) since this exposure is very important when looking for new opportunities to proliferate healthy functional food ingredients such as omega-3s.

Objectives

The chief objective is to determine the effects of potentially fortifying processed cheese with omega-3 fatty acids on the profits of manufacturers. Fortification implies an additional cost of production for cheese processors. This ex-ante analysis takes into account the market conditions (demand and supply curves) and evaluates the increase in the demand for processed cheese needed to offset these costs of fortification in order to maintain the profitability of producers.

To attain this goal, we need to estimate initially the demand for processed cheese products. Then, we determine the actual producer surplus considering the case of linear demand and supply functions. Finally, we establish by how much the demand for the new product (fortified cheese) would have to shift to the right so that the producer surplus remains the same after the fortification. That is, we determine the minimum demand increase required so that manufacturers would at least cover the marginal costs in producing omega-3 fortified cheese.

Literature Review

Several works have determined demand elasticities associated with cheese products. Some have investigated at-home cheese purchase behavior using cross-sectional data (Gould 1992; Gould and Lin 1994), while others have used panel household data (Gould, Cornick and Cox 1994; Schmit *et al*. 2002; Schmit *et al*. 2003).

Gould (1992) used a Tobit approach to estimate a purchase-infrequency model for cheese using the 1987 BLS Consumer Expenditure Survey. As explanatory variables,

this analysis employed annual household income, race, location, and family size and composition through the construction of a dairy adult equivalent scale variable for cheese. Gould found that income and location were not a significant driver of cheese consumption, and that African-American households consumed less cheese. The number of dairy adult equivalents present in the household positively affected the probability of purchase but at a decreasing rate.

Gould, Cornick and Cox (1994) used a generalized Tobit system estimator to address the censored nature of cheese expenditures and to identify consumers of reduced-fat cheese consumers. They used household expenditure data to estimate Engel curves for reduced and full-fat varieties of three cheese types and quantify differences in the demand structure. This study used an additional set of variables, compared to Gould (1992), to explain the variation in cheese consumption: single households, education attainment, ethnicity, and region of residence (8 regions). Three cheese varieties were considered, natural American, processed American, and cottage. The coefficient of the variable Hispanic was found to be statistically significant and negative for all full-fat cheese varieties. Two thirds of the full-fat cheese regional coefficients were statistically significant, compared with less than 42% for the reduced-fat varieties. According to this study, households located in the Pacific region consumed significantly less full-fat natural and processed American cheese than most of the other regions. The authors also found a negative relationship between single households and cheese consumption for five of the six cheese varieties considered. Income significantly impacted expenditures on all cheese categories.

Gould and Lin (1994) used a Heckman sample selection model to obtain at-home demand function parameter estimates for several cheese varieties. They examined factors affecting the demand for cheese in the United States using an adult equivalent scale variable for cheese to quantify the relationship between age/gender distribution of household members and cheese consumption. Their model differed from the previously mentioned studies by employing new explanatory variables: cheese prices, age of meal planners, the extent of market work by the meal planner, and the lack of children under 18. In this study, they analyzed four cheese categories, natural American cheese, other natural cheese, American and other processed cheese, and processed snack. Imputations were made for missing prices. No differences were found among cheese consumption across the regions, and relatively lower cheese consumption within African-American and Asian households was explained by the great incidence of lactose intolerance among these populations. Evaluated at mean values of the dependent and explanatory variables, the own-price elasticity was estimated to be -0.57 for aggregate cheese demand. Except for American and other processed cheese category, all coefficients implied elastic price responses. The own-price elasticity for processed cheese was estimated to be -0.70.

To identify the effects of generic advertising on the household demand for cheese, Schmit *et al.* (2002) applied a two-step model with sample selection to panel data of U.S. households. According to the authors, this model had accounted for sample-selection bias, unobserved household heterogeneity, and temporal correlation. Their approach extended the traditional two-step approach to panel data by providing consistent estimates of the dichotomous purchase decision and avoiding the evaluation

of multi-dimensional integrals. The procedure was similar to the two-step censored demand system approach of Shonkwiler and Yen (1999), where the first stage is represented by single equation probit models followed by a second stage system estimation procedure accounting for cross-equation correlation for fluid milk (whole, low fat, and skim) and cheese (American, Mozzarella, processed, and other). The unconditional price elasticities were inelastic for both aggregate milk and aggregate cheese, -0.24 and -0.65 respectively, but elastic for all cheese subcategories.

Schmit *et al.* (2003) insisted that the method used above was unique in that it not only allowed for the use of simulated probability techniques to solve high-order integrals but also partitioned the data into smaller components to reduce the order of integration. This approach allowed for analysis of longer time periods, increased accuracy and reduced computing time. To evaluate differences in response to advertising, cheese purchases were disaggregated into two subcategories: natural and processed cheese. This analysis accounted for double income households and also for seasonality by including dummy variables. The unconditional elasticities for both cheese subcategories were found to be inelastic, with natural cheese exhibiting higher price sensitivity, -0.53, compared to -0.36 for processed cheese.

Kim *et al.* (2008) used the mixed logit model to estimate demand in the U.S. processed cheese market and determine pass-through rates of cost changes under different behavioral regimes. According to the authors, this model provided greater flexibility in substitution patterns. In the logit model, the curvature of demand system (the second derivatives) is determined by functional form assumptions, whereas in the

mixed logit model, the curvature depends on the empirical distribution of consumers. Kim *et al.* affirmed that this property is important for obtaining accurate estimates of cost pass-through rates. Own and cross-price elasticities were estimated for the 10 leading processed cheese brands in the United States. The elasticities based on the estimates of the mixed logit model varied between -3.67 and -7.35 depending on the brand. These elasticity values are very high compared to previous works on cheese demand. This result is due to the use of specific brands in this analysis instead of aggregated cheese categories. When considering brands, consumers have at all times the opportunity to switch to competing brands, which explains the very elastic demand revealed in this study.

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 for the respective products. In this study the uncompensated own price elasticity for processed cheese products was estimated to be -0.99.

This review of previous work related to cheese demand showed that there is no a unique value for the own-price elasticity for processed cheese demand. The elasticity for aggregated processed cheese ranged between -0.36 and -0.99. The variation in the estimated elasticities is attributed to the difference in the nature of data used and also in the economic model estimated.

Description of the Economic Model

Given the nature of household data used, zero-purchase observations are expected, requiring the use of econometric approaches accounting for censoring. One-step decision models, such as the tobit, imply simultaneity of the decision to consume as well as consumption amounts. Schmit *et al.* (2002) and previous works argued that food consumption decisions should be modeled as a two-stage decision process where not only are the decisions separate, but also the determinants of each decision may differ. The general two-step process is typically represented by a first-stage dichotomous choice model focusing on the purchase decision. Then a second-stage consumption model using only purchase observations is augmented with an additional variable such as the inverse Mill's ratio (IMR) to control for selection bias.

As shown by Wooldridge (2002), under assumptions that allow for an unobserved effect in the underlying selection equation, adding the IMR to the equation and using fixed effects estimation does not produce consistent estimators; that is, we cannot use the standard Heckman selectivity correction when analyzing household panel data. Instead, Wooldridge (2005) suggests to estimate first a probit model for each time period and save the corresponding IMRs, and next, to run a pooled OLS regression using the selected sample and including the IMRs coupled with time dummies as interaction terms. When using this model, Wooldridge stated that the asymptotic variance of the coefficient estimates needs to be corrected for general heteroskedasticity and serial correlation.

The panel sample selection model with random effects used in our analysis is discussed by Greene (2002). It was developed following the same approach using the Heckman selectivity correction (1979) as presented by Verbeek (1990), Zabel (1992) and Verbeek and Nijman (1992). Since this model is not fit by a two-step least squares procedure but instead using a simulated maximum likelihood procedure, there is no IMR variable created or used during the estimation.

This method of maximum likelihood consists in simulating rather than computing high dimensional integrals in the likelihood function. According to Arias and Cox (1999), using probability simulation methods allows model estimation without relying on the use of quite strong simplifying assumptions pertaining to either the structure of the model (aggregation to avoid censoring issue) or the disturbance terms of the model. The idea behind probability simulation methods is that since the integrals of interests are probabilities of a certain event in a random process, we can simulate that random process and use the empirical probability of the event as an approximation to the value of the integral of interest. The structural equations are:

Censoring mechanism (Decision to purchase)

$$\begin{cases} (28) & z_{it}* = \boldsymbol{\alpha}'\boldsymbol{w_{it}} + u_{it} + d_i \\ (29) & z_{it} = 1(z_{it}* > 0), u_{it} \sim N[0,1] \end{cases}$$

Corrected Regression (Amount to purchase)

$$(30) \qquad y_{it} = \boldsymbol{\beta}'\boldsymbol{x_{it}} + \varepsilon_{it} + c_i, \quad \varepsilon_{it} \sim N[0, \sigma^2]$$

y_{it} refers to the quantity of American processed cheese purchased by household i during month t, and z_{it} is a binary variable referring to the purchase of American processed

cheese by household i in month t. $\boldsymbol{w_{it}}$ and $\boldsymbol{x_{it}}$ are the vectors of explanatory variables for equation (28) and (30) respectively.

The random effects, (c_i, d_i) are assumed to follow a bivariate normal distribution with zero means, standard deviations σ_c and σ_d, and with correlation θ. The selectivity comes through the correlation of the unique components, ε_{it} and u_{it}, and also the correlation of the group specific components, c_i and d_i.

Zabel (1992) suggests that with this random effects approach, the group effects are likely to be correlated with the included variables, and proposed to include the group means of the variables in the models to circumvent this potential problem. The modified specification then is given by

(31) $$z_{it} * = \boldsymbol{\alpha'} \boldsymbol{w_{it}} + \boldsymbol{\gamma'} \boldsymbol{\bar{w}_i} + u_{it} + d_i$$

(32) $$y_{it} = \boldsymbol{\beta'}\, \boldsymbol{x_{it}} + \boldsymbol{\delta'} \boldsymbol{\bar{x}_i} + \varepsilon_{it} + c_i\,,\ \varepsilon_{it} \sim N[0, \sigma^2]$$

Profitability of Fortification with Omega-3s

After estimating the demand for American processed cheese, we need to calculate the producer surplus for the industry and to determine by how much the demand for this cheese would have to increase so that manufacturers would at least cover their marginal costs in producing omega-3 fortified cheese.

In the calculations, we assume both the demand and the supply functions are linear and that the shift in supply due to the change in fixed and marginal costs is a parallel shift. We also assume that the shift in demand is not only parallel but also to the right due the health benefits associated with omega-3 fatty acids.

$Q_d = -\alpha P + c$: Demand

$Q_s = \beta P + d$: Supply

$Q_d = Q_s$: Equilibrium condition

In Figure 4, we graphically portray this situation.

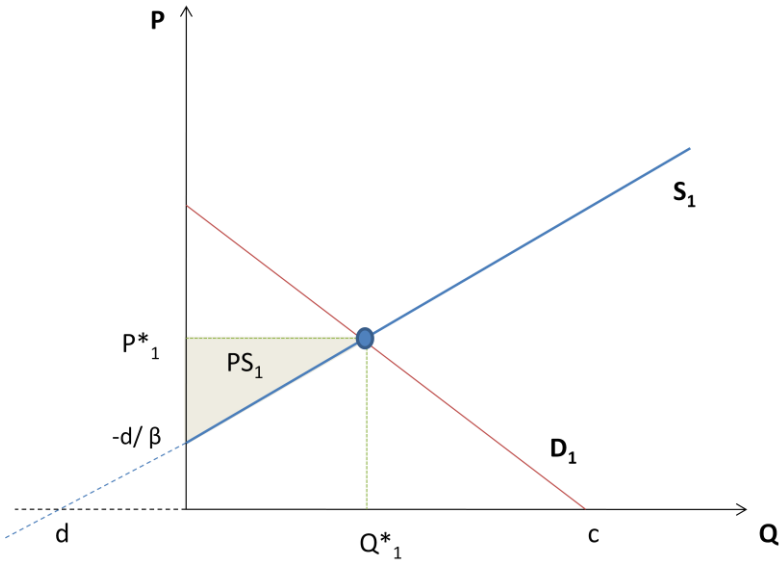

Figure 4. Demand and Supply Relationship before Fortification

After fortification, as illustrated in Figure 5, we have

$Q_d{}' = -\alpha P + c'$: Demand

$Q_s{}' = \beta P + d'$: Supply

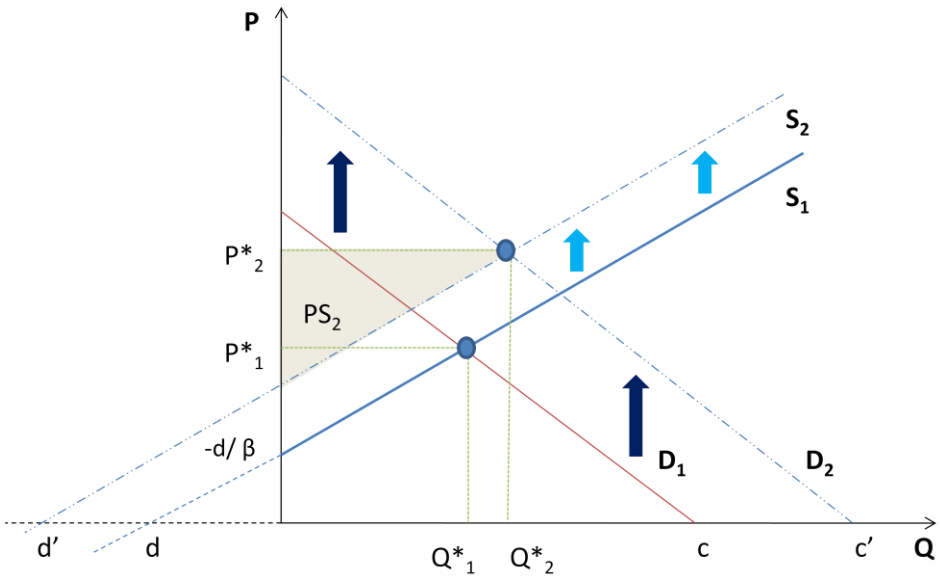

Figure 5. Demand and Supply Relationship after Fortification

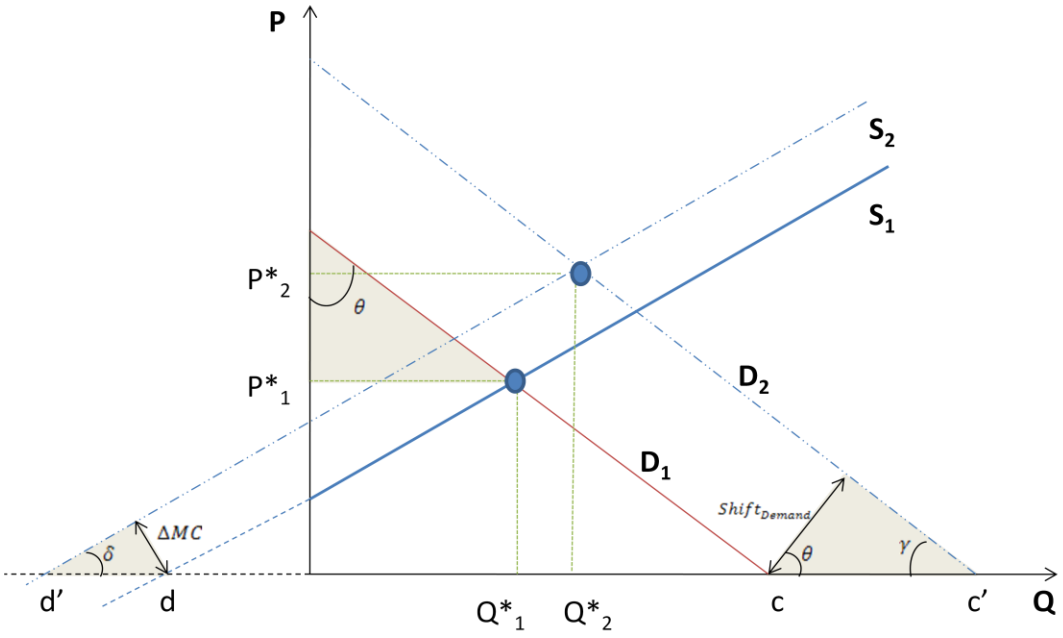

Figure 6. Demand and Supply Relationship after Fortification, Detailed

Let us determine the producer surplus before and after the fortification, respectively PS1 and PS2

At the equilibrium we have $PS_1 = \frac{1}{2}\left(P_1^* + {}^{d}/_{\beta}\right) * {Q_1}^*$ and $Q_d = Q_s$

Then $-\alpha P^* + c = \beta P^* + d$ and $P_1^* = \frac{c-d}{\alpha+\beta}$, $Q_1^* = -\alpha * \left(\frac{c-d}{\alpha+\beta}\right) + c$

Thus $PS_1 = \frac{1}{2}\left(\frac{c-d}{\alpha+\beta} + \frac{d}{\beta}\right) * \left(-\alpha * \left(\frac{c-d}{\alpha+\beta}\right) + c\right)$

(33) $$PS_1 = \frac{-\alpha}{2} * \left(\frac{c-d}{\alpha+\beta}\right)^2 + \frac{c(c-d)}{2(\alpha+\beta)} - \frac{d\alpha}{2\beta}\left(\frac{c-d}{\alpha+\beta}\right) + \frac{dc}{2\beta}$$

Following the same procedure we have

(34) $$PS_2 = \frac{-\alpha}{2} * \left(\frac{c\prime-d\prime}{\alpha+\beta}\right)^2 + \frac{c\prime(c\prime-d\prime)}{2(\alpha+\beta)} - \frac{d\prime\alpha}{2\beta}\left(\frac{c\prime-d\prime}{\alpha+\beta}\right) + \frac{d\prime c\prime}{2\beta}$$

To determine by how much the demand for the American processed cheese would have to increase so that the manufacturers would at least cover their marginal costs in producing omega-3 fortified cheese, we set ΔPS equal to 0 and we solve for c':

The change in producer surplus is given by

$$\Delta PS = \frac{\beta}{(\alpha+\beta)^2}c'^2 + \frac{\alpha d\prime}{(\alpha+\beta)^2}c' + \left[\frac{-\alpha(d'^2-(c-d)^2)}{2(\alpha+\beta)^2} - \frac{c(c-d)}{2(\alpha+\beta)} + \frac{\alpha(d'^2+d(c-d))}{2\beta(\alpha+\beta)} - \frac{dc}{2\beta}\right]$$

Solving the second degree equation

$$\frac{\beta}{(\alpha+\beta)^2}c'^2 + \frac{\alpha d\prime}{(\alpha+\beta)^2}c' + \left[\frac{-\alpha(d'^2-(c-d)^2)}{2(\alpha+\beta)^2} - \frac{c(c-d)}{2(\alpha+\beta)} + \frac{\alpha(d'^2+d(c-d))}{2\beta(\alpha+\beta)} - \frac{dc}{2\beta}\right] = 0$$

Or $A * c'^2 + B * c' + C = 0$

where $A = \frac{\beta}{(\alpha+\beta)^2}$, $B = \frac{\alpha d\prime}{(\alpha+\beta)^2}$, and $C = \frac{-\alpha(d'^2-(c-d)^2)}{2(\alpha+\beta)^2} - \frac{c(c-d)}{2(\alpha+\beta)} + \frac{\alpha(d'^2+d(c-d))}{2\beta(\alpha+\beta)} - \frac{dc}{2\beta}$

gives us $c' = \frac{-B\pm(B^2-4AC)^{\frac{1}{2}}}{2A}$

or

(35) $$c' = \frac{\frac{-\alpha d\prime}{(\alpha+\beta)^2}\pm\left[\left(\frac{\alpha d\prime}{(\alpha+\beta)^2}\right)^2 - \frac{4\beta}{(\alpha+\beta)^2}*\left(\frac{-\alpha(d'^2-(c-d)^2)}{2(\alpha+\beta)^2} - \frac{c(c-d)}{2(\alpha+\beta)} + \frac{\alpha(d'^2+d(c-d))}{2\beta(\alpha+\beta)} - \frac{dc}{2\beta}\right)\right]^{\frac{1}{2}}}{\frac{2\beta}{(\alpha+\beta)^2}}$$

$$c' = f(\alpha, c, \beta, d, d')$$

All these parameters are known. α and c are the demand equation parameters, slope and intercept respectively, β and d are the supply function parameters, respectively the slope and the intercept, and d' is related to the shift in the supply function due to the increase in the marginal cost.

According to Figure 6, we determine d' as $d - d' = \frac{\Delta MC}{\sin \delta}$ where $\tan \delta = \beta$ and ΔMC is the change in the marginal cost of production due to the fortification.

Then

(36) $$d' = d - \frac{\Delta MC}{\sin(\operatorname{atan} \beta)}$$

Graphically we can see that the shift in demand could be determined as

$Shift_{Demand} = (c' - c) * \sin \gamma$ where $\gamma = \frac{\pi}{2} - \theta$ and $\tan \theta = -\alpha$

Then $Shift_{Demand} = (c' - c) * \cos(\operatorname{atan}(-\alpha))$

Therefore, the percentage shift in demand necessary to at least offset the marginal costs of producing omega-3 fortified cheese is

(37) $$\% \, Shift_{Demand} = \frac{(c' - c)\cos[\operatorname{atan}(-\alpha)]}{c} \times 100$$

Data

The source of the data used in this analysis is 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. Cheese purchase information was combined with a set of household demographic data. The sample size consists of 38,040 households for calendar year 2005, the most recent dataset available at the time of this study.

Cheese purchases are aggregated into 19 categories each one referring to a different cheese variety. In this study, we chose to consider the purchase information concerning processed cheese categories since legally a natural cheese would no longer

be labeled as natural if it was fortified. Processed cheese varieties included in the dataset and considered in this study are: American sliced, remaining slices, snack, loaves, and cream cheese. Therefore we only focus on transactions where any of these cheese products had been bought. The quantities purchased and expenditures are then aggregated by household on a monthly basis. We ended up with a panel data structure with 426,504 observations, 35,542 households and 12 monthly purchase periods.

In the extent literature, demographic factors affect the demand for cheese products. In our analysis, we use demographic factors such as annual household income, age of female household head, educational attainment and employment status as explanatory variables. Household income was found to have a significant positive effect on the purchase of cheese product (Gould and Lin 1994; Schmit *et al*. 2003) but a significant negative effect when considering only processed cheese (Gould *et al.* 1994). The impact of the educational attainment of the household head was found significant as well (Gould *et al.* 1994; Davis *et al*. 2010). Gould and Lin (1994) included several variables related to the female head employment status in the cheese demand model. Meal planners working over 35 hours per week had a significant negative effect on the amount of cheese purchased per household, compared to those not working for pay.

We also consider household composition variables, such as household size, and the distribution of the age/presence of children. These same variables or their variation were used in estimating the demand for cheese products in several studies (Gould and Lin 1994; Schmit *et al*. 2003; Davis *et al.* 2010). Dichotomous regional, race/ethnicity

and monthly variables are included to control for geographic, race-related and seasonal variations in cheese purchase patterns. (See Table 28)

Table 28. Definition of Variables Used in the Model

Variable Group	Variable Name	Type	Definition
	PPOZinit	Cont.	unit value ($/Oz) observed before imputation
	PPOZ2	Cont	unit value ($/Oz) after imputation for all observations
	storecoupon	Binary	use of a store coupon during the transaction
	manufcoupon	Binary	use of manufacturer coupon during the transaction
	storefeat	Binary	use of store feature during the transaction
	otherdeal	Binary	use of other promotion deal
Household	hhinc0_25k	Binary	income of the household head is under $25 K
Income	hhinc25_50k	Binary	income of the household head is between $25 K and $50K
	hhinc50_100k	Binary	income of the household head is between $50 K and $100K
	hhinc100_over	Binary*	income of the household head is over $100 K
Household	hhsize1	Binary	household consists of one person living alone
Size	hhsize2	Binary	household consists of 2 members
	hhsize3	Binary	household consists of 3 members
	hhsize4	Binary	household consists of 4 members
	hhsize5	Binary	household consists of 5 members
	hhsize6	Binary	household consists of 6 members
	hhsize7	Binary	household consists of 7 members
	hhsize8	Binary	household consists of 8 members
	hhsize9over	Binary*	household consists of 9 members or more
Age	age_und25	Binary	age of the household head is under 25 years
	age_2535	Binary	age of the household head is between 25 and 35 years
	age_3545	Binary	age of the household head is between 35 and 45 years
	age_4555	Binary	age of the household head is between 45 and 55 years
	age_5565	Binary	age of the household head is between 55 and 65 years
	age_ovr65	Binary*	age of the household head is over 65 years
Educational	edu_lesshs	Binary	level of education of household head is less than high school
Attainment	edu_hs	Binary	household head has graduated from high school
	edu_somecol	Binary	household head attended some college courses
	edu_colnmore	Binary*	household head has graduated from college

Table 28. Continued

Variable Group	Variable Name	Type	Definition
Race	Black	Binary	household head is African-American
	White	Binary	household head is Caucasian
	oriental	Binary	household head is Asian
	otherace	Binary*	the household head belong to other race
Ethnicity	Hisp	Binary	household head is Hispanic
Region	East	Binary	household is from the Northeast region
	South	Binary	household is from the South
	West	Binary*	household is from the West region
	central	Binary	household is from the Central region
	kid_und6_1317	Binary	households has children belonging to both age categories "under 6 yo" and "between 13 and 17 yo"
	kid_612_1317	Binary	households has children belonging to both age categories "between 6 and 12 yo" and "between 13 and 17 yo"
	kidund6_612_1317	Binary*	households has children belonging to the 3 age categories under 6 yo, "between 6 and 12 yo" and "between 13 and 17 yo"
	kid_no_und18	Binary	household has no children under 18 years old
Seasonality	M01	Binary	transaction has occurred in January
	M02	Binary	transaction has occurred in February
	M03	Binary	transaction has occurred in March
	M04	Binary	transaction has occurred in April
	M05	Binary	transaction has occurred in May
	M06	Binary	transaction has occurred in June
	M07*	Binary	transaction has occurred in July
	M08	Binary	transaction has occurred in August
	M09	Binary	transaction has occurred in September
	M10	Binary	transaction has occurred in October
	M11	Binary	transaction has occurred in November
	M12	Binary	transaction has occurred in December

Price Imputation

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

by quantity purchased. A number of alternative approaches are considered in the literature to obtain estimates of unobserved cheese prices during non-purchase periods. In this analysis, we impute prices for non-purchase observations for each household using a regression model of the logarithm of price on regional dummy variables, monthly dummy variables, household income category variables, and promotion variables (the dollar value of the coupon and the store feature discount).

Table 29. Price Imputation Equation for Processed Cheese Products

Variables**	Estimated Coefficient	Standard Error	p-value
east	-0.104	0.002	0.000
central	-0.201	0.002	0.000
south	-0.213	0.002	0.000
m1	0.016	0.003	0.000
m3	-0.023	0.003	0.000
m4	0.006	0.003	0.071
m5	0.008	0.003	0.014
m6	-0.019	0.003	0.000
m7	-0.008	0.003	0.011
m8	-0.001	0.003	0.790
m9	-0.005	0.003	0.098
m10	-0.004	0.003	0.226
m11	-0.054	0.003	0.000
m12	-0.042	0.003	0.000
hhinc0_25k	-0.160	0.003	0.000
hhinc25_50k	-0.133	0.002	0.000
hhinc50_100k	-0.087	0.002	0.000
storecpn	-0.023	0.003	0.000
manucpn	0.087	0.003	0.000
storefeat	-0.154	0.002	0.000
otherdeal	-0.086	0.007	0.000
constant	-1.365	0.003	0.000
Adjusted R2	0.075		

** The dependent variable is lnPPOZ, the natural logarithm of the variable PPOZinit. In this regression the promotion variables (last category) are not dummy variable as in the other models estimated in this study.

The estimation of the regression model used to impute prices employed transactions where processed cheese products were purchased as observation units (367,516 observations). The adjusted R^2 value was 0.075 and all variable categories were jointly significant at the 1% significance level. According to the price imputation results presented in Table 29, processed cheese products are more expensive in the West than any other region; in the South region, processed cheese products are the cheapest. We notice also the existence of a seasonality effect since some of the coefficient estimates related to monthly dummies are significant at the 1% significance level, with February as reference category. The income variables, included to account for quality, are jointly significant at the 1% significance level. The higher the household income the more expensive the purchased cheese products are. According to our results, households with an annual income below $25,000 purchase processed cheese products that are 16 ¢/oz cheaper, on average, than those bought by households with incomes exceeding $100,000. All promotion types included in the estimation except for manufacturer coupons have a significant negative effect on the price of processed cheese product. A $1 store coupon decreases the price of processed cheese products by 2.3¢/oz on average.

Estimation and Empirical Results

Estimating the Demand for Processed Cheese Products

The estimation of our model of censored demand with random effects was performed using the software package *Limdep* (version 8.0). As mentioned previously,

we adopted the simulated maximum likelihood (SML) approach that provides a practical alternative to numerical evaluation of the probability integrals.

In Table 30 the estimated parameters, standard errors and the p-values of the first equation of our model are exhibited. Equation (28) provides information on variables influencing the decision to purchase processed cheese products. Equation (30) allows the identification of statistically significant drivers associated with how much of processed cheese to buy. The estimated parameters, standard errors and p-values of the explanatory variables associated with equation (30) are given below as well.

Decision to Purchase Processed Cheese

According to Table 30, the coefficient estimates for location dummy variables are jointly significant and show that households from the South and West regions have higher probabilities to purchase processed cheese products than households located in the Central or East regions. Households from the South have the highest probability to purchase processed cheese products and households from the East show the lowest probability to purchase.

The coefficient estimates for income dummy variables are jointly significant and show that all income categories have a higher probability to purchase processed cheese products than the reference category, households with annual incomes of the household head exceeding $100,000.

Table 30. Estimated Parameters, Standard Errors and p-Values for the Decision to Purchase

Variable	Coefficient	Standard Error	p-value
PPOZ2	-1.413	0.055	0.000
East	-1.135	0.017	0.000
Central	-0.376	0.017	0.000
South	0.216	0.016	0.000
HHinc0_25k	0.747	0.021	0.000
HHinc25_50k	0.197	0.015	0.000
HHinc50_100k	1.335	0.020	0.000
HHsize1	0.030	0.402	0.940
HHsize2	-1.435	0.400	0.000
HHsize3	-0.860	0.400	0.032
HHsize4	-1.063	0.399	0.008
HHsize5	-0.938	0.400	0.019
HHsize6	-0.585	0.400	0.144
HHsize7	-1.209	0.401	0.003
HHsize8	-0.271	-0.271	0.507
Kid_und6	0.357	0.062	0.000
Kid_612	-0.206	0.053	0.000
Kid_1317	0.313	0.054	0.000
Kid_und6_612	0.079	0.055	0.152
Kid_und6_1317	-0.583	0.068	0.000
Kid_612_1317	-0.138	0.051	0.007
Kid_no_und18	0.239	0.054	0.000
Emp_und35	0.069	0.014	0.000
Emp_ovr35	0.365	0.012	0.000
Edu_lesshs	-0.196	0.022	0.000
Edu_hs	0.236	0.014	0.000
Edu_somecol	0.149	0.013	0.000
White	1.844	0.022	0.000
Black	1.504	0.030	0.000
Oriental	0.292	0.028	0.000
Hispanic	-0.150	0.019	0.000
M01	-0.122	0.029	0.000
M02	0.073	0.035	0.038
M03	-0.001	0.031	0.962
M04	-0.036	0.030	0.227
M05	0.163	0.035	0.000
M06	-0.197	0.027	0.000
M08	-0.032	0.034	0.357
M09	-0.132	0.029	0.000
M10	-0.273	0.027	0.000
M11	-0.277	0.026	0.000
M12	0.124	0.029	0.000
constant	1.132	0.009	0.000

Not all the coefficient estimates related to household size were found to be significant. However, we observe that the probability of purchase of processed cheese products is positively related to household size in most of the cases.

Female heads employed for under 35 hours and over 35 hours per week have a higher probability, 7% and 36% respectively, to purchase a processed cheese product compared to households where the female head is not employed for pay. Both coefficients are significant at the 1% significance level.

The probability of the purchase of processed cheese products is significantly affected by the educational attainment of the household head at the 1% significance level. For household heads without a high-school diploma, the probability of purchasing processed cheese products is the lowest compared to the other categories. For other households, we found that the greater the education level of the household head, the less likely the purchase of processed cheese products.

African-American and Caucasian households were found to be more likely to buy processed cheese products than Oriental households and households of other races. Caucasian households have the highest probability to purchase processed cheese products compared to the reference category, non-Caucasian, non-African-American and non-oriental households.

The probability of purchasing processed cheese products is significantly affected by seasonality. Depending on the month, households would be more or less likely to buy processed cheese compared the purchasing in the reference month July. December and May showed the highest probability to purchase processed cheese products, while

October and November were months with the lowest probabilities to purchase processed cheese products.

Demand for Processed Cheese Products

According to the results of the estimation of the demand of processed cheese presented in Table 31, the price of cheese has a significant negative coefficient estimate of -46.69 meaning that an increase of the price of processed cheese of 10¢ leads to a decrease in the quantity purchased of 4.67 ounces per month on average. Knowing that the average monthly quantity purchased by households for calendar year 2005 was 13.6 ounces and that the average unit value was 20 ¢/oz, then the own-price elasticity for the processed cheese was computed to be -0.68. This value is very close to previous studies mentioned above. The extant literature elasticities for aggregated processed cheese ranged between -0.36 and -0.99.

All the types of promotion included in our model have statistically significant positive effect on the quantity purchased of processed cheese. The presence of manufacturer coupons increases the quantity purchased on average by 9.12 oz, store coupons by 8.66 oz on average, and store features (including major and minor displays) by 7.19 oz on average.

Table 31. Estimated Parameters, Standard Errors and p-Values for the Processed Cheese Demand Equation

Variable	Coefficient	Standard Error	p-value
PPOZinit	-46.692	0.514	0.000
Storecpn	8.666	0.233	0.000
Manucpn	9.123	0.159	0.000
Storefeat	7.191	0.079	0.000
Otherdeal	8.893	0.352	0.000
East	-0.530	0.137	0.000
Central	1.282	0.125	0.000
South	1.707	0.116	0.000
HHinc0_25k	-0.347	0.168	0.039
HHinc25_50k	0.102	0.140	0.466
HHinc50_100k	-0.844	0.134	0.000
HHsize1	-18.863	0.908	0.000
HHsize2	-13.746	0.901	0.000
HHsize3	-9.873	0.900	0.000
HHsize4	-6.178	0.897	0.000
HHsize5	-1.142	0.895	0.202
HHsize6	0.882	0.903	0.329
HHsize7	6.074	0.962	0.000
HHsize8	4.390	1.116	0.000
Age_2535	-4.863	0.799	0.000
Age_3545	-5.615	0.795	0.000
Age_4565	-4.792	0.793	0.000
Age_ovr65	-7.827	0.797	0.000
Kid_und6	-3.654	0.453	0.000
Kid_612	-0.720	0.386	0.062
Kid_1317	-1.766	0.390	0.000
Kid_und6_612	-5.477	0.426	0.000
Kid_und6_1317	-1.228	0.605	0.042
Kid_612_1317	-0.054	0.382	0.887
Kid_no_und18	1.385	0.393	0.000
Emp_und35	-1.744	0.123	0.000
Emp_ovr35	-0.016	0.093	0.866
Edu_lesshs	2.054	0.196	0.000
Edu_hs	0.704	0.104	0.000
Edu_somecol	1.187	0.095	0.000
White	-0.271	0.228	0.234
Black	-5.294	0.272	0.000
Oriental	-2.628	0.379	0.000
Hispanic	-2.970	0.211	0.000

Table 31. Continued

Variable	Coefficient	Standard Error	p-value
M01	0.241	0.244	0.324
M02	-1.212	0.248	0.000
M03	-0.337	0.244	0.168
M04	0.169	0.255	0.508
M05	0.188	0.249	0.450
M06	0.072	0.245	0.769
M08	-0.843	0.252	0.001
M09	-0.671	0.247	0.007
M10	-0.609	0.247	0.014
M11	1.434	0.226	0.000
M12	4.498	0.216	0.000
constant	14.159	0.028	0.000

The coefficient estimates for location dummy variables are jointly significant and show that households from the East region purchase less processed cheese than households from the West region (0.5 oz/month less), and households located in the Central or South regions purchase 1.3 and 1.7 oz more processed cheese per month than households from the West region.

Only the coefficient estimate associated with an annual income between 50,000 and $100,000 was statistically significant at the 1% level. On average, households belonging to this category purchase 0.8 oz/month less processed cheese products than households with incomes exceeding $100,000.

Most of the coefficient estimates related to household size were found to be significant. We observe that the quantity purchased of processed cheese is positively related to household size.

Compared to the reference category, households with a female head under 25 years old, all the other age categories purchase significantly less processed cheese. Households with a female head over 65 years old purchase the smallest amount of processed cheese, 7.8 oz per month less than households with female heads under the age of 25.

Age and presence of children are significant determinants of the purchase of processed cheese. Households with chidren under 6 years old and households only with children aged between 13 and 17 purchase less processed cheese than the reference category; the reference category is a household with at least one child under 6 years old, at least one child between 6 and 12 years old, and at least one child between 13 and 17 years old. According to the results in Table 31, households with no children under 18 years old purchase more processed cheese products relative to the reference category. On average, households without children under the age of 18 purchase 1.4 oz/month more processed cheese than reference households.

Households with a female head working under 35 hours a week purchase on average 1.7 oz per month less than households where the female head is not employed for pay. The coefficient estimate for households with female head working over 35 hours a week is not statistically significant, meaning that these households purchase statistically the same amount of processed cheese as households with female head not employed for pay.

The quantity of processed cheese purchased is significantly affected by the educational attainment of the head of the household. Household heads with some

college, high school diploma or less than high school education purchase more processed cheese compared to household heads who are college graduates. Household heads with less than high school education level is the category with the highest coefficient, purchasing on average 2 oz per month more than household heads that are college graduates. This result confirms Gould *et al.* (1994) and Davis *et al.* findings where college variable had a significant negative effect on processed cheese demand.

The quantity of processed cheese product purchased was lower for African-Americans and Asians compared to households belonging to other races. We also found that Hispanics purchase less processed cheese products than non-Hispanics, roughly 3 oz/month less on average. This finding might be explained by eating habits and the prevalent consumption of natural cheeses within this population.

To account for seasonality we included dummy variables for each month with July as the reference month. There is indeed a statistically significant seasonal effect associated with processed cheese product purchases. More processed cheese products are purchased during November and December compared to other months. On average, each household purchased at least 4 oz more in December than the quantity of processed cheese purchased during almost any other month (the only exception being November). This finding could be explained by the fact that this period corresponds to the Thanksgiving and Christmas holidays.

Comparison of Explanatory Variables Effects

The elements affecting the decision of buying (or not buying) a processed cheese product are slightly different from the variables affecting the quantity of processed cheese products purchased.

Looking at both equations, we noticed that both coefficient estimates for the East and the South regions have the same sign whether in equation 28 or in equation 30. However, households belonging to the Central region behave differently. While equation 28 indicates that Central region households have, on average, a higher probability to buy a processed cheese product than households from the West region, the monthly quantities purchased by a household are on average higher in the West region than in the Central region.

In the selection equation (equation 28), all coefficient estimates for income variables were statistically significant at the 1% significance level but only households with income between $50,000 and $100,000 had a statistically significant coefficient estimate in equation 30. According to the estimation of equation 28, these households are more likely to purchase processed cheese products than households with an annual income exceeding $100,000, however, the quantities purchased would be smaller (opposite sign in equation 30).

While household size matters in deciding the quantity of processed cheese products purchased, according to the demand equation 30, the opposite result occurred when investigating the probabilities of purchase. Most of the dummy variables related to household size turned out to be not statistically significant at 1% significance level.

The probability of the purchase of processed cheese is significantly affected by the educational attainment of the head of the household at the 1% significance level. Compared to the results from equation 30, we notice that household heads with some college education exhibit the same behavior in both equations, a higher probability to purchase processed cheese products and higher purchased quantities on average compared to household heads that are college graduates. The other two categories exhibit a different behavior since in the case of household heads with less than a high school diploma, the coefficient estimates have opposite signs in the two equations and in the other case the magnitudes are different compared to households with some college education.

According to equation 28, Hispanic households are less likely to purchase processed cheese products than non-Hispanics. This result is consistent with the demand equation results where we found that Hispanic households purchase fewer quantities of processed cheese products.

Seasonality patterns are different when deciding to purchase processed cheese compared to when deciding how much to purchase. Most coefficient estimates for the dummy variables standing for different months of the year showed different signs and statistical significance comparing equation 28 and 30 estimates. However, for one month, December, households showed the exact same behavior whether at the moment of deciding to buy or not to buy processed cheese products or when deciding the quantity amounts to purchase. In December, the probability of purchasing processed cheese products is among the highest, and households are willing to purchase more quantity too.

Random Effects

The random effects in our model (c_i, d_i) are assumed to be bivariate normally distributed with zero means. Results showed that both standard deviations σ_c and σ_d are statistically significant at the 1% significance level. Their values are 14.16 and 1.13 respectively. Indeed there is a group effect due to each household specificity. In this study selectivity comes through the correlation of u_{it} in equation 1 and ε_{it} in equation 30. The two disturbance terms were highly correlated with $\rho = corr(\varepsilon_{it}, u_{it}) = 0.99$.

Evaluation of the Fortification with Omega-3s

The objective of this section is to determine by how much the demand for processed cheese products would have to increase so that the manufacturers would at least cover their marginal costs in producing omega-3 fortified cheese.

According to equation (37) the required percentage shift in demand is given by:

$$\%\, Shift_{Demand} = \frac{(c' - c)\cos\,[\text{atan}(-\alpha)]}{c} \times 100,$$

where $c' = f(\alpha, c, \beta, d, d')$

To solve for this percentage we need to know the values of the parameters α, c, β, d, d'. α and c are the demand equation parameters, slope and intercept respectively, β and d are the supply function parameters, respectively the slope and the intercept, and d' is related to the shift in the supply function due to the increase in the marginal cost.

Demand Parameters

In the previous section we estimate the demand equation for processed cheese products. The slope α is the coefficient estimate of the variable PPOZ (unit value). According to our estimation this coefficient estimate is -46.69. Then $\alpha = -46.69$.

To determine the intercept c we use the mean value of the quantity variable and the mean value of the price value. We have $\bar{P} = 0.20\ \$/oz$, $\bar{Q} = 13.64\ oz$, and $\bar{Q} = -46.69\ \bar{P} + c$

Then $c = \bar{Q} + 46.69\ \bar{P}$ or $c = 22.98$.

Supply Parameters

To our knowledge, no current information on the supply function of processed cheese products is available in the extant literature. In this study we use different supply parameters β and d, standing for different values of the own price elasticity of supply ϵ_s. The values we chose for ϵ_s range from 0.001 (extremely inelastic) to 10 (very elastic), accounting for the short run and the long-run impacts of the change in marginal cost of production.

To estimate the potential shift in demand we need to feed our program the values of β and d. However, since we consider in our study an elasticity approach, only the parameter β can be derived from ϵ_s and we need to impose values for the parameter d.

To investigate the impact of imposing the intercept d, we performed a sensitivity test using different values of d and measuring the effects on the final outcome. As Table 32 shows, if we keep the change in marginal cost ΔMC and the elasticity of supply ϵ_s

constant, imposing any value of d did not produce any change in the percentage change in demand needed, meaning that imposing d does not impact our final results.

Table 32. Testing for Changes in Demand Shift Related to Change in Supply Intercept d

ΔMC	Es	β	d	% Change in Demand
0.03	0.003	0.2	5	3.3279
0.03	0.003	0.2	10	3.3279
0.03	0.003	0.2	15	3.3279
0.03	0.003	0.2	20	3.3279
0.03	0.1	6	20	0.0221
0.03	0.1	6	15	0.0221
0.03	0.1	6	10	0.0221
0.03	0.1	6	5	0.0221
0.03	0.5	34.5	5	0.0038
0.03	0.5	34.5	10	0.0038
0.03	0.5	34.5	15	0.0038
0.03	0.5	34.5	20	0.0038
0.03	3	204.6	-5	0.0006
0.03	3	204.6	-10	0.0006
0.03	3	204.6	-20	0.0006
0.03	3	204.6	-30	0.0006
0.2	0.003	0.2	5	22.1858
0.2	0.003	0.2	20	22.1858
0.2	0.5	34.5	5	0.0252
0.2	0.5	34.5	20	0.0252
0.2	3	204.6	-5	0.0043
0.2	3	204.6	-30	0.0043

Change in Cost of Production Parameters

According to Adam Ismail, Executive Director of the Global Organization for EPA and DHA Omega-3 (GOED), a not-for-profit trade association focused on growing the markets for EPA and DHA products, the fixed costs for implementing a fortification production process are negligible and the only marginal cost that need to be accounted

for is Omega-3 purchase since no further equipment is needed. Ismail also mentioned that usually manufacturers have a rule of thumb when considering fortifying their products. The marginal cost should not exceed 2 cents per serving.

Considering a processed cheese product, American sliced cheese, we determined the quantity of cheese considered as serving. For the chosen product, each slice of cheese is considered as one serving. The pack has 8 slices for 6 oz, which mean that a serving of cheese is 0.75 oz. Then the reasonable change in marginal cost of production would be 2 cents per 0.75 oz or approximately 3 cents per ounce. $\Delta MC = 0.03\ \$/\text{oz}$.
In our application we choose different values of ΔMC and evaluate the impact of changing ΔMC on the profitability of fortifying process cheese products with omega-3.
Since $d' = d - \frac{\Delta MC}{\sin(\text{atan}\,\beta)}$ and $d, \Delta MC,$ and β are known by now, we can determine the value of d', compute the percentage shift in demand necessary to offset the extra costs of production and then decide if the fortification project is profitable.

In this study the values of ΔMC ranged from 1¢ to 20¢/oz, the last value being the average price of processed cheese product per oz in our dataset. It is the extreme case when the fortification results in a 100% increase in the price of the product.

Change in Demand Offsetting Fortification Costs

According to the results in Table 33, in most cases the shift in demand needed to offset the extra cost due to the fortification is negligible. Apart from cases of very inelastic supply or very high change in the marginal cost, the fortification of processed cheese with Omega-3 turned to be a viable diversification strategy for the American

processed cheese industry. In the results Table PS1 stands for the value of producer surplus before fortification, PS2' refers to what would have been the producer surplus if no shift in demand takes place, and ΔPS represents the loss in producer surplus incurred with no potential shift in demand.

Table 33. Change in the Shift in Demand Due to Change in Marginal Cost and Elasticity of Supply

ΔMC	Es	β	% Change Demand	PS1	PS2'	ΔPS***
0.01	0.001	0.07	9.3762	735.9160	714.5150	-21.4010
	0.005	0.34	0.3953	149.4000	148.4909	-0.9091
	0.01	0.68	0.1132	76.0790	75.8179	-0.2611
	0.05	3.41	0.0133	17.3676	17.3366	-0.0310
	0.1	6.82	0.0064	9.9573	9.9422	-0.0151
	0.2	13.64	0.0032	6.1325	6.1251	-0.0074
	0.3	20.46	0.0021	4.7586	4.7539	-0.0048
	0.4	27.28	0.0016	4.0072	4.0038	-0.0034
	0.5	34.10	0.0013	3.5126	3.5100	-0.0026
	0.6	40.92	0.0011	3.1522	3.1501	-0.0021
	0.7	47.74	0.0009	2.8726	2.8708	-0.0017
	0.8	54.56	0.0008	2.6464	2.6450	-0.0014
	0.9	61.38	0.0007	2.4581	2.4569	-0.0012
	1	68.20	0.0006	1.3640	1.3632	-0.0008
	3	204.60	0.0002	0.4216	0.4215	-0.0001
	5	341.00	0.0001	0.4039	0.4039	-0.0001
	10	682.00	0.0001	0.2812	0.2812	0.0000
0.03	0.001	0.07	28.1286	735.9160	672.6604	-63.2556
	0.005	0.34	1.1860	149.4000	146.6810	-2.7191
	0.01	0.68	0.3397	76.0790	75.2971	-0.7818
	0.05	3.41	0.0399	17.3676	17.2747	-0.0929
	0.1	6.82	0.0193	9.9573	9.9121	-0.0452
	0.2	13.64	0.0096	6.1325	6.1104	-0.0221
	0.3	20.46	0.0064	4.7586	4.7444	-0.0142
	0.4	27.28	0.0048	4.0072	3.9969	-0.0103
	0.5	34.10	0.0038	3.5126	3.5048	-0.0079
	0.6	40.92	0.0032	3.1522	3.1459	-0.0063

Table 33. Continued

ΔMC	Es	β	% Change Demand	PS1	PS2'	ΔPS***
0.03	0.7	47.74	0.0027	2.8726	2.8674	-0.0051
	0.8	54.56	0.0024	2.6464	2.6421	-0.0043
	0.9	61.38	0.0021	2.4581	2.4544	-0.0037
	1	68.20	0.0019	1.3640	1.3616	-0.0024
	3	204.60	0.0006	0.4216	0.4212	-0.0004
	5	341.00	0.0004	0.4039	0.4038	-0.0002
	10	682.00	0.0002	0.2812	0.2811	-0.0001
0.05	0.001	0.07	46.8810	735.9160	632.0689	-103.8470
	0.005	0.34	1.9767	149.4000	144.8821	-4.5179
	0.01	0.68	0.5661	76.0790	74.7782	-1.3008
	0.05	3.41	0.0665	17.3676	17.2130	-0.1546
	0.1	6.82	0.0322	9.9573	9.8821	-0.0752
	0.2	13.64	0.0160	6.1325	6.0957	-0.0367
	0.3	20.46	0.0106	4.7586	4.7349	-0.0237
	0.4	27.28	0.0080	4.0072	3.9901	-0.0171
	0.5	34.10	0.0064	3.5126	3.4995	-0.0131
	0.6	40.92	0.0053	3.1522	3.1417	-0.0105
	0.7	47.74	0.0046	2.8726	2.8640	-0.0086
	0.8	54.56	0.0040	2.6464	2.6392	-0.0072
	0.9	61.38	0.0035	2.4581	2.4520	-0.0061
	1	68.20	0.0032	1.3640	1.3599	-0.0041
	3	204.60	0.0011	0.4216	0.4210	-0.0006
	5	341.00	0.0006	0.4039	0.4036	-0.0003
	10	682.00	0.0003	0.2812	0.2811	-0.0001
0.07	0.001	0.07	65.6334	735.9160	592.7406	-143.1750
	0.005	0.34	2.7674	149.4000	143.0944	-6.3056
	0.01	0.68	0.7926	76.0790	74.2610	-1.8180
	0.05	3.41	0.0931	17.3676	17.1513	-0.2163
	0.1	6.82	0.0451	9.9573	9.8521	-0.1052
	0.2	13.64	0.0224	6.1325	6.0811	-0.0514
	0.3	20.46	0.0149	4.7586	4.7254	-0.0332
	0.4	27.28	0.0112	4.0072	3.9833	-0.0239
	0.5	34.10	0.0089	3.5126	3.4943	-0.0184
	0.6	40.92	0.0074	3.1522	3.1376	-0.0146
	0.7	47.74	0.0064	2.8726	2.8606	-0.0120
	0.8	54.56	0.0056	2.6464	2.6364	-0.0101
	0.9	61.38	0.0050	2.4581	2.4495	-0.0086

Table 33. Continued

ΔMC	Es	β	% Change Demand	PS1	PS2'	ΔPS***
0.07	1	68.20	0.0045	1.3640	1.3583	-0.0057
	3	204.60	0.0015	0.4216	0.4208	-0.0008
	5	341.00	0.0009	0.4039	0.4035	-0.0004
	10	682.00	0.0004	0.2812	0.2810	-0.0001
0.1	0.001	0.07	93.7621	735.9160	536.1165	-199.8000
	0.005	0.34	3.9534	149.4000	140.4336	-8.9664
	0.01	0.68	1.1323	76.0790	73.4886	-2.5904
	0.05	3.41	0.1330	17.3676	17.0590	-0.3086
	0.1	6.82	0.0645	9.9573	9.8072	-0.1501
	0.2	13.64	0.0320	6.1325	6.0591	-0.0734
	0.3	20.46	0.0213	4.7586	4.7112	-0.0474
	0.4	27.28	0.0160	4.0072	3.9731	-0.0342
	0.5	34.10	0.0128	3.5126	3.4864	-0.0262
	0.6	40.92	0.0106	3.1522	3.1313	-0.0209
	0.7	47.74	0.0091	2.8726	2.8554	-0.0171
	0.8	54.56	0.0080	2.6464	2.6321	-0.0144
	0.9	61.38	0.0071	2.4581	2.4459	-0.0122
	1	68.20	0.0064	1.3640	1.3559	-0.0081
	3	204.60	0.0021	0.4216	0.4204	-0.0012
	5	341.00	0.0013	0.4039	0.4034	-0.0006
	10	682.00	0.0006	0.2812	0.2810	-0.0002
0.15	0.001	0.07	140.6431	735.9160	448.0588	-287.8570
	0.005	0.34	5.9300	149.4000	136.0545	-13.3455
	0.01	0.68	1.6984	76.0790	72.2102	-3.8688
	0.05	3.41	0.1995	17.3676	16.9058	-0.4618
	0.1	6.82	0.0967	9.9573	9.7325	-0.2248
	0.2	13.64	0.0480	6.1325	6.0226	-0.1099
	0.3	20.46	0.0319	4.7586	4.6876	-0.0710
	0.4	27.28	0.0239	4.0072	3.9560	-0.0512
	0.5	34.10	0.0191	3.5126	3.4734	-0.0393
	0.6	40.92	0.0160	3.1522	3.1209	-0.0313
	0.7	47.74	0.0137	2.8726	2.8469	-0.0257
	0.8	54.56	0.0120	2.6464	2.6249	-0.0215
	0.9	61.38	0.0106	2.4581	2.4398	-0.0183
	1	68.20	0.0096	1.3640	1.3518	-0.0122
	3	204.60	0.0032	0.4216	0.4198	-0.0018
	5	341.00	0.0019	0.4039	0.4031	-0.0009

Table 33. Continued

ΔMC	Es	β	% Change Demand	PS1	PS2'	ΔPS***
0.15	10	682.00	0.0010	0.2812	0.2809	-0.0003
0.2	0.001	0.07	187.5241	735.9160	367.8957	-368.0200
	0.005	0.34	7.9067	149.4000	131.7447	-17.6553
	0.01	0.68	2.2646	76.0790	70.9431	-5.1359
	0.05	3.41	0.2659	17.3676	16.7532	-0.6144
	0.1	6.82	0.1290	9.9573	9.6582	-0.2991
	0.2	13.64	0.0640	6.1325	5.9862	-0.1463
	0.3	20.46	0.0426	4.7586	4.6641	-0.0945
	0.4	27.28	0.0319	4.0072	3.9390	-0.0682
	0.5	34.10	0.0255	3.5126	3.4603	-0.0523
	0.6	40.92	0.0213	3.1522	3.1105	-0.0417
	0.7	47.74	0.0182	2.8726	2.8383	-0.0342
	0.8	54.56	0.0160	2.6464	2.6177	-0.0287
	0.9	61.38	0.0142	2.4581	2.4337	-0.0244
	1	68.20	0.0128	1.3640	1.3478	-0.0162
	3	204.60	0.0043	0.4216	0.4192	-0.0024
	5	341.00	0.0026	0.4039	0.4028	-0.0012
	10	682.00	0.0013	0.2812	0.2808	-0.0004

******* PS1 stands for the value of producer surplus before fortification, PS2' refers to what would have been the producer surplus if no shift in demand takes place, and ΔPS represents the loss in producer surplus incurred with no potential shift in demand.

For ΔMC= 0.01$/oz, in the very short run, when the supply is very inelastic (Es=0.001), the shift needed in demand is 9.37%. In our opinion, this value is too high to meet even knowing all the benefits that the fortification with Omega-3 would bring to consumers. However, the moment we move toward more reasonable values of the elasticity of supply, the shift in demand needed diminishes making the fortification process feasible from the standpoint of maintaining producer profits. When Es=0.1, this value drops to 0.006% and for Es=0.6 the shift in demand needed barely exceeds 0.001%. According to our findings, the more elastic the supply, the less the demand for

processed cheese products needs to shift to the right in order to cancel out the fortification costs. The fortification is not likely a viable option only in extreme cases when the supply is very inelastic.

Increasing the change in marginal cost due to fortification leads to an increase of the percentage shift in demand needed to make the fortification strategy viable for producers. We observe that when ΔMC= 0.03$/oz instead of the initial value of 0.01, all demand shift values corresponding to different supply elasticity sittings increased considerably. However the shift value are still very small, 0.34% for Es=0.01, 0.005% for Es=0.4, and 0.002% for Es=1, making the fortification very profitable for the manufacturers in the short and the long run. As before, we notice that the shift in demand needed decreases with the increase of the elasticity of supply value, making the fortification process more attractive at the long run. The same results are obtained when choosing very high changes in marginal cost due to fortification. When ΔMC= 0.2$/oz, which is the average price of processed cheese, meaning that the fortification induces on average 100% increase in the price of processed cheese, we are still observing the same pattern. Even with this considerably high cost, we can still say that the fortification could be beneficial to both consumers and producers since at reasonable values of elasticity of supply, the demand shift needed is still manageable.

Change in Demand Parameters

To push our analysis further, we decided to investigate the impact of fortification with omega-3 on the producer surplus and product profitability for demand elasticity

values other than the one estimated for processed cheese products in this study. We allow the demand elasticity to vary and we compute the shift in demand needed to offset the increase in marginal cost for different values of supply elasticity and marginal cost.

In Table 34 we show results concerning own-price elasticity of demand values that we might come across when estimating demand for processed cheese products we chose the values of -0.4, -0.68 (outcome of our estimation), -0.8, and -1.2. We investigate the impact of the change of the demand elasticity on the demand shift needed to offset change in the marginal cost, using ΔMC of 0.03 and 0.1 and an elasticity of supply ranging from 0.005 to 1.

Results indicate that whatever the change in marginal cost and the elasticity of supply are, the increase in the elasticity of demand value produces a decrease in the percentage change in demand needed to offset the change in marginal cost of production due to fortification. When the ΔMC= 0.03 and Es= 0.005 for example, the shift in demand needed is 1.82% for an own-price elasticity of demand of -0.4, however the shift needed drops to 0.68% when the elasticity of demand is -0.8 and drops to 0.45% when the demand is inelastic with Ed= -1.2.

For the range of own-price elasticities of demand investigated, the shift in demand needed to offset the extra marginal cost due to fortification never exceeded 2%. This finding makes fortification of processed cheese a feasible and attractive option for manufacturers to diversify their product line and maintain profitability attributed to the image of healthier food product.

Table 34. Change in the Shift of Demand Due to the Change in the Elasticity of Demand

ΔMC	Es	β	d	Ed	α	c	% Change Demand
0.03	0.005	0.341	10	-0.4	-27.28	15	1.816
				-0.6846	-46.69	22.978	1.186
				-0.8	-54.56	40	0.6813
				-1.2	-81.84	60	0.4543
	0.1	6.82	10	-0.4	-27.28	15	0.0296
				-0.6846	-46.69	22.978	0.0193
				-0.8	-54.56	40	0.0111
				-1.2	-81.84	60	0.0074
	0.3	20.46	10	-0.4	-27.28	15	0.0098
				-0.6846	-46.69	22.978	0.0064
				-0.8	-54.56	40	0.0037
				-1.2	-81.84	60	0.0024
	0.6	40.92	10	-0.4	-27.28	15	0.0049
				-0.6846	-46.69	22.978	0.0032
				-0.8	-54.56	40	0.0018
				-1.2	-81.84	60	0.0012
	1	68.2	0	-0.4	-27.28	15	0.0029
				-0.6846	-46.69	22.978	0.0019
				-0.8	-54.56	40	0.0011
				-1.2	-81.84	60	0.0007
0.1	0.3	20.46	10	-0.4	-27.28	15	0.0326
				-0.6846	-46.69	22.978	0.0213
				-0.8	-54.56	40	0.0122
				-1.2	-81.84	60	0.0082

Conclusions

In this study, we investigated the feasibility of fortifying processed cheese with omega-3. We first estimated the demand for processed cheese products and then used this estimation to determine the profitability of manufacturing such product. Estimating the censored demand for processed cheese products using panel data allowed us to determine which socio- demographic factors influence not only the decision of purchasing a processed cheese but also which factors affect the quantity of product to

purchase. Our model allowed us to distinguish between these two behaviors differentiating our analysis from those using a tobit model for example.

The analysis of the impacts of fortification on producer profits showed that, in most of the cases, the fortification of processed cheese products with omega-3 is profitable to manufacturers. Within reasonable market conditions, realistic values of elasticity of demand and supply, and likely marginal costs due to the fortification process, the values by how much the demand for the new fortified product would have to shift so that the change in producer surplus equal the incremental costs of fortification are relatively very small. Therefore, fortification of processed cheese products with omega-3 fatty acids can occur without any loss in producer profits, subject to minimal shifts in the demand for processed cheese.

CHAPTER V

SUMMARY, RECOMMENDATIONS AND FUTURE RESEARCH

Summary and Recommendations

Cheese consumption in the United States has steadily grown over the last decade and is expected to continue growing over the years. This growth has brought a high differentiation into the cheese market and the creation of market segments where knowledge of the way economic and demographic factors influence household demands became extremely important.

In this dissertation, we first estimated the household demand for 14 disaggregated cheese varieties. These varieties were categorized as natural cheeses (Mozzarella, Colbi, Cheddar, Swiss, and remaining natural), processed cheeses (slices, loaves, snacks, and cream cheese), or belonging to other cheese category (Ricotta, grated, specialty/imported, shredded, and cottage cheese). Results showed that some cheese varieties share the same characteristics within their respective categories but in the same time each variety demand is very differentiable depending on the economic or socio-demographic factor considered.

We found that demands for most natural cheese varieties generally are elastic while most processed cheese varieties revealed inelastic demands. Hence to increase total revenue, manufacturers and retailers need to adopt different pricing strategies depending on the cheese variety. For a variety such as cream cheese, to increase total revenue, the prices need to be raised, however, for products such as Mozzarella, the

opposite needs to be done. The cross-price elasticities for different cheese varieties also were determined. This information is crucial when making pricing decisions and forecasting market dynamics. The magnitude and sign of these elasticities determine the way the demand for a certain cheese product is affected by the price of another cheese variety. Products such as Swiss cheese, Colby or specialty/imported cheese products showed a high number of substitutes, meaning that their managers have to pay close attention to these substitute prices since any decrease would mean less sales for their own products and any increase in their prices would imply an opportunity to sell more. Products such as processed slices, in which demand analysis did not reveal any significant substitute, and cottage cheese, in which demand estimation revealed only one substitute and one complement, suggest different marketing approaches. For these products, other cheese variety prices does not have a notable impact on the demand; therefore, manufacturers and retailers should focus more on the intrinsic product attributes and other non-price factors such as socio-demographic characteristics and how they influence consumer preferences.

Household income had a positive effect on most of the cheese varieties considered. All cheese varieties are normal goods except processed slices. Income affected cheese varieties differently. Changes in household income affected more the purchase of natural cheese and specialty/imported cheese products, while changes in household income did not impact at all the demand for cheese loaves. Other demographic factors also had a positive effect on almost all cheese varieties such as household size, education attainment of household head and race. Ethnicity (Hispanic)

affected negatively the demand for all processed cheese varieties and some natural cheeses also such as Cheddar and Swiss cheese; however, being Hispanic had a positive impact on quantities purchased of Mozzarella, the remaining natural cheese, and specialty/imported varieties. Most of the 14 cheese varieties revealed higher purchases during the fourth quarter; however, this same quarter showed the lowest quantities purchased by household when considering Mozzarella products and processed slices. This information, coupled with advertising lagged effects is very valuable to producers and marketers when deciding on any sales or promotion strategies. Generic dairy advertising expenditures impacted cheese variety demands differently, but had significant impact on cheese demand mostly in the contemporaneous and the 2-lag quarters. Results showed the generic advertising had the greatest effect on the demand of Colby and processed slices and no significant effect on the demand of Ricotta products. Demand for cheese varieties differed by regions as well. Natural cheese varieties were purchased more in the West region whereas the processed varieties showed high purchased volumes in the South. Grated cheese showed almost no variation through the four regions considered.

We succeeded in characterizing the demand for all cheese varieties and we demonstrated that these 14 cheese varieties are very differentiable. Results from this study should be used by cheese manufacturers and marketers while implementing new or revising currently marketing strategies or considering the development of new products targeted to specific households.

In the second essay, we investigate promotion impacts on the purchase of private label products taking into consideration demographics. Although increasing store couponing has no impact on increasing private label cheese purchases, this study revealed a strong negative relationship between national brand manufacturer couponing activity and the decision to purchase private label processed cheese products. Therefore, national brand couponing appears to be the most effective strategy for manufacturers to deter private label growth in the processed cheese market.

The decision to purchase private label processed cheese products was influenced several household socio-demographic characteristics. Household income had a negative effect on the probability of making private label product purchases, while household size, age and education of household head had a positive effect. Hispanics, African-Americans and Oriental households were less likely to purchase private label products compared to non-Hispanics and Caucasians households. National brand and private label cheese product managers and marketers could use these findings to prepare consumer profiles, identify better target markets, and to modify promotional strategies accordingly.

In the third essay, we examined the feasibility of fortifying processed cheese with omega-3 fatty acids. To determine the profitability of manufacturing such product, the censored demand for processed cheese products using panel data had to be estimated first. The analysis of the impacts of fortification on producer profits showed that the fortification of processed cheese products with omega-3 is profitable to manufacturers. Within reasonable market conditions and fortification marginal costs, the values by how much the new fortified product demand would have to shift so that the change in

producer surplus equals the incremental costs of fortification were found to be very small. Consequently, the fortification of processed cheese is a feasible and attractive option for manufacturers to diversify their product line and maintain profitability attributed to the image of healthier food product.

Prospects for Future Research

The next step for further research related the first essay would be to estimate a demand system instead of single equations accounting for the panel nature of data and the censoring issue. This step would be a logical extension to our analysis where advantage could be taken from the system's parameter restrictions. Another extension would be the use of more recent data and investigate the potential changes in demand over the past five years. For future efforts, it may be worthwhile to use more specific cheese advertising expenditures instead of the generic dairy advertising expenditures used in this study. Further research also could consider the price of complements outside the cheese industry, such as wine, when considering the demand for natural cheese products, and pasta when investigating the demand for Italian cheese varieties.

For the second essay, a logical extension would be to consider not only the factors affecting the decision to purchase private label products but the volume of processed cheese purchased as well. Further research could also consider different cheese variety instead of processed sliced cheese products and compare the impact of promotion activity, especially use of store coupons, manufacturer coupons, and store

features on the demand or the decision to purchase private label products belonging to different cheese varieties.

The third essay considered the fortification from the producer perspective. Future research could investigate the impact of fortification with omega-3 fatty acid on the demand from the consumer perspective. This objective could be achieved by employing a wiliness-to-pay study, possibly through the use of an experimental auctions approach.

REFERENCES

Arendt, J. N. and A. Holm. 2006. "Probit models with binary endogenous regressors." Discussion Papers on Business and Economics No. 4. University of Copenhagen. Copenhagen, Danemark.

Arias, C. and T.L. Cox. 1999. "Maximum Simulated Likelihood: A Brief Introduction for Practitioners." Staff Paper No. 421. University of Wisconsin-Madison. Madison, WI.

Arnade, C., M. Gopinath, and D. Pick. 2008. "Brand Inertia in U.S. Household Cheese Consumption." *American Journal of Agricultural Economics* 90(3): 813–826.

--------. 2007. "Measuring the Degree of Retail Competition in U.S. Cheese Markets." *Journal of Agricultural & Food Industrial Organization* 5: 1-18

Blattberg, R.C. and K.J. Wisniewski. 1989. "Price Induced Patterns of Competition." *Marketing Science*, 8: 291-309.

Briggeman, B.C. 2002. "Consumers of Fresh and Processed Pork in the At-Home and Away-From-Home Markets." M.S. Thesis. Texas A&M University. College Station, TX.

Bronnenberg, B.J. and L. Wathieu. 1996. "Asymmetric Promotion Effects and Brand Positioning." *Marketing Science*, 15: 379-394.

Bruno, G. 2004. "Limited Dependent Panel Data Models: A Comparative Analysis of Classical and Bayesian Inference among Econometric Packages." *Computing in Economics and Finance 2004*. Society for Computational Economics.

Butler, J. and R. Moffit. 1982. "A Computationally Efficient Quadrature Procedure for the One Factor Multinomial Probit Model." *Econometrica*, 50:761–764

California Milk Advisory Board. 2004. "U.S. Cheese Consumption Trends, 1994-2003." California Milk Advisory Board. Modesto, CA.

Capps, O., J. Park. 2002."Impact of Advertising, Attitudes, Lifestyles, and Health on the Demand for U.S. Pork: A Micro-Level Analysis." *Journal of Agricultural and Applied Economics* 34 (1): 1-15.

Clarke, D.G. 1976."Econometric Measurment of the Duration of Advertising Effect on Sales." *Journal of Marketing Research* 13: 345-357.

Cropp, R. 2001. "Retail Distribution of Dairy Products." Department of Agricultural and Applied Economics, University of Wisconsin-Madison. Madison, WI.

Davis, C.G., D. Dong, D.P. Blayney, and A. Owens. 2010. "An Analysis of U.S. Household Dairy Demand." Technical Bulletin Number 1928. USDA Economic Research Service. Washington, DC.

Davis, C.G., D.P. Blayney, D. Dong, S.T. Yen,and R. Johnson. 2011. "Will Changing Demographics Affect U.S. Cheese Demand?" *Journal of Agricultural and Applied Economics* 43 (2): 259-273.

Dong, D., & Kaiser, H.M. 2005. "Coupon Redemption and its Effect on Household Cheese Purchases." *American Journal of Agricultural Economics*, 87: 689–702.

Dong, D., B.W. Gould, and H.M. 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(4): 1094–1107.

Dunn, R.A., J.R. Sharkey, Lotade-Manje, J., Y. Bouhlal, and R.M. Nayga. 2011. "Socio-Economic Status, Racial Composition and Affordability of Fresh Fruits and Vegetables in Neighborhoods of Large Rural Region in Texas." *Nutrition Journal* 10(6).

Food and Agricultural Policy Research Institute. 2010. "FAPRI 2010 U.S. and World Agricultural Outlook." FAPRI Staff Report 10-FSR 1.

Fousekis, P., and B.J. Revell. 2005. "Retail Fish Demand in Great Britain and its Fisheries Management Implications." *Marine Resource Economics* 19: 495–510.

Garretson, J.A., D. Fisher, D. and S. Burton. 2002. "Antecedents of private label attitude and national brand promotion attitude: Similarities and differences." *Journal of Retailing*, 78: 91–99.

Gedenk, K., & Neslin, S. A. 1999. "The role of retail promotion in determining future brand loyalty: its effect on purchase event feedback." *Journal of Retailing* 75: 433–459.

Geisler, Malinda. 2011. "Cheese Industry Profil." Agricultural marketing Resource center. Internet site: http://www.agmrc.org. (Accessed October 20, 2011).

Goldberg, R.J. and J. Katz. 2007. "A meta-analysis of the analgesic effects of omega-3 polyunsaturated fatty acid supplementation for inflammatory joint pain." *Pain* 129:210-223.

Gould, B. W. and H. C. Lin. 1994. "The Demand for Cheese in the United States: The Role of Household Composition." *Agribusiness* 10 (1): 43–57.

Gould, B. W., J. Cornick, and T. Cox. 1994. "Consumer Demand for New Reduced-Fat Foods: An Analysis of Cheese Expenditures." *Canadian Journal of Agricultural Economics* 42 (2): 367–80.

Gould, B.W. 1992. "At-Home Consumption of Cheese: A Purchase-Infrequency Model." *American Journal of Agricultural Economics* 74 (2): 453–59.

Greene, W. H. 2002. "*LIMDEP Version 8.0, Econometric Modeling Guide*." Econometric Software, Inc. Plainview, NY.

Holub, B. 2011. "DHA and DPA for Life Stages." DHA/EPA Omega-3 Institute. Internet site: http://www.dhaomega3.org. (Accessed April 10, 2011).

Huang, M-H, E. Jones, and D.E. Hahn. 2007. "Determinants of Price Elasticities for Private Labels and National Brands of Cheese." *Applied Economics* 39(5): 553-563.

International Omega-3 Learning and Education Consortium for Health and Medicine.2011. "Omega-3 Fatty Acid Benefits." Internet site: http://www.omega3learning.uconn.edu. (Accessed April 10, 2011)

Ismail, Adam. 2010. Executive Director of the Global Organization for EPA and DHA Omega-3 (GOED). *Phone interview*.

Kim, D.H. and R.W. Cotterill. 2008. "Cost Pass-through in Differentiated Product Markets: the Case of U.S. Processed Cheese." *The Journal of Industrial Economics*, 55(1): 32-48.

Kris-Etherton, P.M., W. S. Harris and L. J. Appel. 2002. "AHA Scientific Statement, Fish Consumption, Fish Oil, Omega-3 Fatty Acids, and Cardiovascular Disease." Circulation 106:2747. American Heart Association, Inc.

Lombardi, F. and P. Terranova. 2007. "Anti-Arrhythmic Properties of N-3 Poly-Unsaturated Fatty Acids (n-3 PUFA)." *Current Medicinal Chemistry,* 14:2070-2080.

MacLean C.H., S.J. Newberry, W.A. Mojica, P. Khanna, A.M. Issa, M.J. Suttorp, Y.W. Lim, S.B. Traina, L. Hilton, R. Garland, S.C. Morton. 2006. "Effects of omega-3 fatty acids on cancer risk: a systematic review." *The Journal of the American Medical Association*, 295:403-415.

McDonald, J.F., and R.A. Moffit. 1980. "The Uses of Tobit Analysis." *Review of Economic and Statistics,* 62:318-321.

Midwest Research Institute. 1997. U. S. Environmental Protection Agency, "Section 9.6.1, Natural and Processed Cheese." Final Report. *Emission Factor Documentation for AP-42*.

Omega-3 Centre Inc.2011. "Long Chain Omega-3s." Internet site: http://www.omega-3centre.com (Accessed April 10, 2011)

Park, J.L., and O. Capps, Jr. 1997. "The Demand for Processed Meals by U.S. Households." *American Journal of Agricultural Economics*, 79: 814-824.

Schmit, T.M., B.W. Gould, D. Dong, H.M. Kaiser, and C. Chung. 2003. "The Impact of Generic Advertising on U.S. Household Cheese Purchases: A Censored Autocorrelated Regression Approach." *Canadian Journal of Agricultural Economics* 51: 15–37.

Schmit, T.M., D. Dong, C. Chung, H.M. Kaiser, and B.W. Gould. 2002. "Identifying the Effects of Generic Advertising on the Household Demand for Fluid Milk and Cheese: A Two-Step Panel Data Approach." *Journal of Agricultural and Resource Economics* 27(1): 165-186.

Sethuraman, R. and J. Mittelstaedt. 1992. "Coupons and private labels: A cross-category analysis of grocery products." *Psychology & Marketing* 9: 487–500.

Shonkwiler, J.S. and S.T. Yen. 1999. "Two-Step Estimation of a Censored System Equations." *American Journal of Agricultural Economics* 81: 972–82.

U.S. Census Bureau. 2004. "*Statistical Abstract of the United States."* Washington, DC: U.S. Government Printing Office.

U.S. Census Bureau. 2007. "*Statistical Abstract of the United States."* Washington, DC: US Government Printing Office.

U.S. Dairy Export Council. 2011. "Cheese Categories." Last accessed October 20, 2011, from http://www.usdec.org.

US Department of Agriculture (USDA), Economic Research Service. 2010. "Per Capita Consumption of Selected Cheese Varieties." Livestock, Dairy, and Poultry Outlook. Last accessed October 15, 2011, from http://www.ers.usda.gov/publications/1dp/LDPTables.htm

US Department of Agriculture (USDA), National Agricultural Statistics Service. 2011. "Dairy Products 2010 Summary." United States Department of Agriculture. Washington, DC.

Verbeek, M.1990. "On the Estimation of a Fixed Effects Model with Selectivity Bias." *Economics Letters* 34: 267-270.

Verbeek, M. and T. Nijman. 1992. "Testing for Selectivity Bias in Panel Data Models." *International Economic Review*, 33: 681-703.

Wales, T.J., and A.D. Woodland. 1983. "Estimation of Consumer Demand Systems with Binding Non-negativity Constraints." *Journal of Econometrics* 21:263–85.

Wooldridge, J. M. 2002. "*Econometric Analysis of Cross Section and Panel Data*." Cambridge MA: MIT Press.

Yokoyama M, H. Origasa, M. Matsuzaki, Y.Matsuzawa, Y. Saito,Y. Ishikawa, S. Oikawa, J. Sasaki , H. Hishida, H. Itakura, T. Kita, A. Kitabatake, N. Nakaya, T. Sakata, K. Shimada, K. Shirato. 2007. "Effects of eicosapentaenoic acid on major coronary events in hypercholesterolaemic patients (JELIS): a randomised open-label, blinded endpoint analysis." *The Lancet* 369:1090-1098.

Zabel J.E. 1992. "Estimating Fixed and Random Effects Models with Selectivity." *Economics Letters* 40: 269-272.

APPENDIX A

In the first essay, 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). Details of the regression results associated with prices of the 14 cheese varieties, and the 3 aggregate cheese categories are presented below:

$$\ln(P_i) = f\left(\begin{array}{c} east, central, south, Yr2006, Q1, Q2, Q3, \\ grocery, drug, massmerch, supercenter, club, convinience, \\ privatelbl, hhincome \end{array}\right)$$

1. Mozzarella

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.185298	.0036918	-50.19	0.000	-.192534	-.178062
central	-.070563	.0034652	-20.36	0.000	-.0773547	-.0637713
south	-.0320724	.0032814	-9.77	0.000	-.0385039	-.0256408
yr2006	-.011901	.0024128	-4.93	0.000	-.0166301	-.0071719
Q1	.0393911	.003428	11.49	0.000	.0326723	.04611
Q2	.0308029	.0034222	9.00	0.000	.0240954	.0375104
Q3	.0492118	.0034067	14.45	0.000	.0425346	.055889
grocery	.2563658	.0075475	33.97	0.000	.2415728	.2711589
drug	.37705	.0176609	21.35	0.000	.3424347	.4116653
massmerch	.1229071	.012251	10.03	0.000	.0988952	.1469189
supercenter	.0904534	.008003	11.30	0.000	.0747676	.1061391
club	-.3336063	.0086561	-38.54	0.000	-.3505722	-.3166403
convenience	.7956553	.0292888	27.17	0.000	.7382495	.8530611
privatelbl	-.198116	.0026657	-74.32	0.000	-.2033408	-.1928912
hhincome	8.90e-07	4.44e-08	20.04	0.000	8.03e-07	9.77e-07
_cons	-1.542532	.0083423	-184.90	0.000	-1.558883	-1.526181

R-squared = 0.1798

2. Colby

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	.0325918	.0107092	3.04	0.002	.011601	.0535826
central	-.0417622	.007019	-5.95	0.000	-.05552	-.0280043
south	.0537707	.0072169	7.45	0.000	.039625	.0679164
yr2006	-.052003	.0041161	-12.63	0.000	-.060071	-.0439351
Q1	.018833	.005748	3.28	0.001	.0075664	.0300996
Q2	.0088935	.0057164	1.56	0.120	-.002311	.0200981
Q3	.0068088	.0057136	1.19	0.233	-.0043903	.018008
grocery	.2664508	.0128293	20.77	0.000	.2413043	.2915972
drug	.1799982	.0642958	2.80	0.005	.0539733	.3060231
massmerch	.1563241	.026697	5.86	0.000	.1039959	.2086524
supercenter	.2013717	.013528	14.89	0.000	.1748557	.2278876
club	.020265	.0203214	1.00	0.319	-.0195665	.0600964
convenience	.4360019	.0673203	6.48	0.000	.3040489	.5679549
privatelbl	-.192452	.0044846	-42.91	0.000	-.2012422	-.1836619
hhincome	9.41e-07	7.98e-08	11.79	0.000	7.85e-07	1.10e-06
_cons	-1.716326	.014483	-118.51	0.000	-1.744713	-1.687938

R-squared = 0.1127

3. Cheddar

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0206011	.0025156	-8.19	0.000	-.0255316	-.0156707
central	-.0613484	.0025658	-23.91	0.000	-.0663773	-.0563195
south	.0241642	.002111	11.45	0.000	.0200266	.0283018
yr2006	-.0336959	.0016036	-21.01	0.000	-.036839	-.0305528
Q1	.024098	.0022291	10.81	0.000	.019729	.028467
Q2	.0122578	.0022268	5.50	0.000	.0078933	.0166224
Q3	.0172351	.0022373	7.70	0.000	.0128501	.0216202
grocery	.2799489	.005093	54.97	0.000	.2699667	.2899311
drug	.1840719	.020947	8.79	0.000	.1430164	.2251275
massmerch	.1864602	.0093306	19.98	0.000	.1681725	.204748
supercenter	.177702	.0054438	32.64	0.000	.1670324	.1883717
club	-.0703434	.0057725	-12.19	0.000	-.0816574	-.0590294
convenience	.6148356	.0199643	30.80	0.000	.5757061	.6539651
privatelbl	-.2380366	.0016888	-140.95	0.000	-.2413466	-.2347266
hhincome	1.14e-06	2.94e-08	38.85	0.000	1.08e-06	1.20e-06
_cons	-1.664997	.0055778	-298.51	0.000	-1.67593	-1.654065

R-squared = 0.1478

4. Swiss

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.1115209	.004717	-23.64	0.000	-.1207663	-.1022754
central	-.1366928	.0041101	-33.26	0.000	-.1447486	-.1286369
south	-.040497	.0037122	-10.91	0.000	-.047773	-.033221
yr2006	-.0454289	.0027179	-16.71	0.000	-.0507561	-.0401018
Q1	.0292498	.0038502	7.60	0.000	.0217033	.0367962
Q2	.0019158	.0038098	0.50	0.615	-.0055514	.009383
Q3	.0015442	.0037588	0.41	0.681	-.005823	.0089115
grocery	.3985822	.0088724	44.92	0.000	.3811922	.4159721
drug	.2349427	.037278	6.30	0.000	.1618774	.3080079
massmerch	.2010463	.0191687	10.49	0.000	.1634754	.2386172
supercenter	.2229072	.009403	23.71	0.000	.2044772	.2413372
club	-.0517694	.0100998	-5.13	0.000	-.0715652	-.0319736
convenience	.5223791	.065561	7.97	0.000	.3938788	.6508794
privatelbl	-.2897084	.0029263	-99.00	0.000	-.295444	-.2839728
hhincome	9.36e-07	4.95e-08	18.89	0.000	8.39e-07	1.03e-06
_cons	-1.385515	.0096985	-142.86	0.000	-1.404525	-1.366506

R-squared = 0.2557

5. Remaining natural

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0454467	.0035749	-12.71	0.000	-.0524535	-.0384399
central	-.0729383	.0029136	-25.03	0.000	-.078649	-.0672276
south	.0322421	.0028144	11.46	0.000	.0267259	.0377583
yr2006	-.0435393	.0020649	-21.09	0.000	-.0475865	-.0394922
Q1	.0238019	.0029066	8.19	0.000	.0181051	.0294987
Q2	.0076287	.0028599	2.67	0.008	.0020233	.0132341
Q3	.0100328	.0028608	3.51	0.000	.0044257	.0156399
grocery	.2839302	.006805	41.72	0.000	.2705924	.2972679
drug	.1474171	.0282332	5.22	0.000	.0920805	.2027537
massmerch	.1801514	.0124911	14.42	0.000	.155669	.2046337
supercenter	.1548932	.0071906	21.54	0.000	.1407997	.1689867
club	-.1565975	.0077064	-20.32	0.000	-.1717019	-.1414932
convenience	.6324873	.0337504	18.74	0.000	.566337	.6986376
privatelbl	-.2529314	.0021863	-115.69	0.000	-.2572165	-.2486464
hhincome	1.24e-06	3.81e-08	32.47	0.000	1.16e-06	1.31e-06
_cons	-1.589291	.0074412	-213.58	0.000	-1.603876	-1.574707

R-squared = 0.1826

6. Processed slices

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0381762	.0028486	-13.40	0.000	-.0437594	-.032593
central	-.1790555	.0025077	-71.40	0.000	-.1839706	-.1741404
south	-.1394484	.0023414	-59.56	0.000	-.1440374	-.1348594
yr2006	-.034595	.0015407	-22.45	0.000	-.0376147	-.0315753
Q1	.0123895	.002208	5.61	0.000	.0080618	.0167172
Q2	-.0265542	.002186	-12.15	0.000	-.0308388	-.0222696
Q3	-.0193176	.0021954	-8.80	0.000	-.0236206	-.0150146
grocery	.2636292	.0048183	54.71	0.000	.2541855	.2730729
drug	.1922654	.0186962	10.28	0.000	.1556213	.2289095
massmerch	.1679196	.0087583	19.17	0.000	.1507536	.1850855
supercenter	.2120491	.0051085	41.51	0.000	.2020366	.2220616
club	-.1476076	.0062832	-23.49	0.000	-.1599225	-.1352926
convenience	.4801851	.0230569	20.83	0.000	.4349942	.5253759
privatelbl	-.2798842	.0016344	-171.25	0.000	-.2830876	-.2766809
hhincome	1.42e-06	2.92e-08	48.72	0.000	1.37e-06	1.48e-06
_cons	-1.825163	.0054152	-337.05	0.000	-1.835776	-1.814549

R-squared = 0.1566

7. Loaves

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0332138	.0065677	-5.06	0.000	-.0460867	-.0203409
central	-.2544373	.0048416	-52.55	0.000	-.2639269	-.2449476
south	-.1743673	.0045762	-38.10	0.000	-.1833367	-.1653979
yr2006	-.0210475	.002819	-7.47	0.000	-.0265727	-.0155223
Q1	-.0066487	.0036867	-1.80	0.071	-.0138748	.0005773
Q2	.0009584	.0039849	0.24	0.810	-.0068521	.0087689
Q3	-.0039208	.0039691	-0.99	0.323	-.0117004	.0038588
grocery	.1290524	.0102142	12.63	0.000	.1090324	.1490724
drug	.0691316	.0337331	2.05	0.040	.0030139	.1352493
massmerch	-.1085646	.012922	-8.40	0.000	-.1338921	-.0832371
supercenter	-.0162015	.0104734	-1.55	0.122	-.0367298	.0043267
club	-.1734732	.012622	-13.74	0.000	-.1982126	-.1487339
convenience	.4171677	.0717076	5.82	0.000	.276619	.5577164
privatelbl	-.3607857	.004099	-88.02	0.000	-.3688199	-.3527516
hhincome	4.16e-07	5.36e-08	7.77	0.000	3.11e-07	5.21e-07
_cons	-1.818187	.011237	-161.80	0.000	-1.840212	-1.796162

R-squared = 0.2593

8. Snacks

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.1847766	.0062232	-29.69	0.000	-.1969741	-.1725792
central	-.2077423	.0055035	-37.75	0.000	-.2185292	-.1969554
south	-.2771461	.0049764	-55.69	0.000	-.2868999	-.2673923
yr2006	.0053718	.0035263	1.52	0.128	-.0015398	.0122835
Q1	.0265397	.0047533	5.58	0.000	.0172233	.0358561
Q2	.0028028	.0048239	0.58	0.561	-.0066521	.0122577
Q3	.0235744	.0048897	4.82	0.000	.0139905	.0331583
grocery	.6561977	.007485	87.67	0.000	.6415272	.6708682
drug	.2677272	.0293907	9.11	0.000	.2101214	.3253331
massmerch	.4639366	.0140646	32.99	0.000	.4363701	.4915032
supercenter	.3949395	.0085884	45.99	0.000	.3781062	.4117728
club	.5270272	.0108133	48.74	0.000	.505833	.5482213
convenience	.5706657	.0583831	9.77	0.000	.4562346	.6850967
privatelbl	-.5409954	.0055034	-98.30	0.000	-.551782	-.5302087
hhincome	1.94e-06	6.43e-08	30.11	0.000	1.81e-06	2.06e-06
_cons	-1.64942	.0089167	-184.98	0.000	-1.666897	-1.631944

R-squared = 0.2777

9. Cream cheese

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.1590082	.0025855	-61.50	0.000	-.1640757	-.1539408
central	-.1969853	.0023879	-82.49	0.000	-.2016654	-.1923052
south	-.1697421	.0022492	-75.47	0.000	-.1741504	-.1653338
yr2006	-.0307205	.0015768	-19.48	0.000	-.0338109	-.02763
Q1	.1341437	.002153	62.30	0.000	.1299238	.1383637
Q2	.1360631	.0021469	63.38	0.000	.1318552	.140271
Q3	.1606729	.0021701	74.04	0.000	.1564195	.1649263
grocery	.2316681	.0054471	42.53	0.000	.2209919	.2423444
drug	.134361	.0151053	8.89	0.000	.104755	.1639671
massmerch	.0854464	.0089766	9.52	0.000	.0678525	.1030403
supercenter	.1286446	.0057519	22.37	0.000	.117371	.1399181
club	-.1069233	.0081728	-13.08	0.000	-.1229419	-.0909048
convenience	.4824511	.0308434	15.64	0.000	.4219989	.5429034
privatelbl	-.260889	.0016413	-158.95	0.000	-.264106	-.257672
hhincome	7.07e-07	2.88e-08	24.50	0.000	6.50e-07	7.63e-07
_cons	-1.844627	.005909	-312.17	0.000	-1.856209	-1.833046

R-squared = 0.1778

10. Ricotta

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.3312055	.0059794	-55.39	0.000	-.3429255	-.3194855
central	-.1394994	.0068367	-20.40	0.000	-.1528997	-.126099
south	-.2238322	.0060357	-37.08	0.000	-.2356626	-.2120018
yr2006	.0126423	.00394	3.21	0.001	.0049198	.0203648
Q1	.0337448	.0051905	6.50	0.000	.0235711	.0439186
Q2	.0288344	.0055771	5.17	0.000	.017903	.0397658
Q3	.0817662	.0057042	14.33	0.000	.0705855	.0929468
grocery	.204305	.0142636	14.32	0.000	.1763474	.2322625
drug	.0416355	.0720512	0.58	0.563	-.0995889	.1828598
massmerch	.0819923	.0313282	2.62	0.009	.0205873	.1433973
supercenter	.0176635	.0151785	1.16	0.245	-.0120873	.0474142
club	-.1799751	.0206182	-8.73	0.000	-.220388	-.1395623
convenience	.5048438	.1200921	4.20	0.000	.2694564	.7402311
privatelbl	-.0686634	.0041207	-16.66	0.000	-.0767402	-.0605867
hhincome	5.86e-07	7.14e-08	8.20	0.000	4.46e-07	7.26e-07
_cons	-2.125945	.0154917	-137.23	0.000	-2.15631	-2.095581

R-squared = 0.1809

11. Grated cheese

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.1686731	.0036521	-46.19	0.000	-.1758312	-.161515
central	-.2035635	.0035386	-57.53	0.000	-.2104992	-.1966277
south	-.1368955	.0033811	-40.49	0.000	-.1435224	-.1302686
yr2006	-.0106865	.0022204	-4.81	0.000	-.0150385	-.0063345
Q1	-.0002164	.0030411	-0.07	0.943	-.006177	.0057441
Q2	-.0114692	.0031531	-3.64	0.000	-.0176493	-.005289
Q3	.0006454	.0031432	0.21	0.837	-.0055153	.0068061
grocery	.3688636	.0060772	60.70	0.000	.3569522	.380775
drug	.2760395	.0218688	12.62	0.000	.2331765	.3189025
massmerch	.2263527	.0094658	23.91	0.000	.2077998	.2449057
supercenter	.2922622	.0066759	43.78	0.000	.2791773	.3053471
club	-.014637	.0071543	-2.05	0.041	-.0286595	-.0006146
convenience	.6012091	.0490186	12.26	0.000	.5051324	.6972858
privatelbl	-.2632797	.0023596	-111.58	0.000	-.2679044	-.2586549
hhincome	4.46e-07	4.11e-08	10.87	0.000	3.66e-07	5.27e-07
_cons	-1.133252	.0069591	-162.84	0.000	-1.146892	-1.119612

R-squared = 0.2750

12. Specialty/imported cheese

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.1013718	.0047249	-21.45	0.000	-.1106325	-.092111
central	-.1253594	.0043524	-28.80	0.000	-.1338901	-.1168286
south	-.1113311	.0036811	-30.24	0.000	-.1185461	-.1041162
yr2006	-.0262778	.0028786	-9.13	0.000	-.0319197	-.0206358
Q1	-.0038178	.0041068	-0.93	0.353	-.0118671	.0042316
Q2	-.0323123	.0040149	-8.05	0.000	-.0401814	-.0244432
Q3	-.0497805	.0039967	-12.46	0.000	-.0576141	-.041947
grocery	.3027895	.0082788	36.57	0.000	.286563	.3190159
drug	-.0799364	.0381597	-2.09	0.036	-.1547291	-.0051436
massmerch	.0061616	.022203	0.28	0.781	-.0373562	.0496794
supercenter	.037863	.0092636	4.09	0.000	.0197065	.0560195
club	-.3424867	.0092762	-36.92	0.000	-.360668	-.3243054
convenience	.1084178	.077496	1.40	0.162	-.0434739	.2603094
privatelbl	-.3963462	.0039331	-100.77	0.000	-.404055	-.3886374
hhincome	1.08e-06	5.17e-08	20.88	0.000	9.79e-07	1.18e-06
_cons	-.8941569	.0093563	-95.57	0.000	-.9124952	-.8758186

R-squared = 0.260

13. Shredded cheese

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0528719	.0022854	-23.13	0.000	-.0573513	-.0483925
central	-.1567109	.0018404	-85.15	0.000	-.160318	-.1531037
south	-.0749138	.0017867	-41.93	0.000	-.0784156	-.071412
yr2006	-.0570286	.0011993	-47.55	0.000	-.0593792	-.054678
Q1	.0222275	.0016536	13.44	0.000	.0189865	.0254685
Q2	-.0021259	.0016881	-1.26	0.208	-.0054345	.0011827
Q3	.0041289	.0016915	2.44	0.015	.0008136	.0074443
grocery	.1811664	.0044151	41.03	0.000	.172513	.1898199
drug	-.028056	.0127136	-2.21	0.027	-.0529743	-.0031377
massmerch	.1114454	.0078227	14.25	0.000	.0961131	.1267777
supercenter	.1278563	.0046408	27.55	0.000	.1187605	.1369521
club	-.242743	.00549	-44.22	0.000	-.2535031	-.2319829
convenience	.4024755	.0253354	15.89	0.000	.3528188	.4521323
privatelbl	(omitted)					
hhincome	1.39e-06	2.21e-08	62.64	0.000	1.34e-06	1.43e-06
_cons	-1.595437	.0048257	-330.61	0.000	-1.604895	-1.585978

R-squared = 0.0761

14. Cottage cheese

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0480973	.0020157	-23.86	0.000	-.052048	-.0441466
central	-.1666764	.0016454	-101.30	0.000	-.1699013	-.1634515
south	-.0725236	.001628	-44.55	0.000	-.0757144	-.0693329
yr2006	.015433	.0012035	12.82	0.000	.0130741	.0177919
Q1	-.0107422	.0017361	-6.19	0.000	-.0141449	-.0073396
Q2	-.0129074	.0017281	-7.47	0.000	-.0162945	-.0095203
Q3	-.0085888	.0017277	-4.97	0.000	-.0119751	-.0052025
grocery	.2646765	.0043021	61.52	0.000	.2562445	.2731084
drug	.2321009	.014708	15.78	0.000	.2032736	.2609283
massmerch	.2167185	.0080975	26.76	0.000	.2008476	.2325894
supercenter	.207626	.004603	45.11	0.000	.1986043	.2166477
club	-.0715424	.0057919	-12.35	0.000	-.0828944	-.0601904
convenience	.3574676	.0209447	17.07	0.000	.3164166	.3985186
privatelbl	-.3494823	.0012489	-279.84	0.000	-.3519301	-.3470345
hhincome	9.03e-07	2.22e-08	40.59	0.000	8.59e-07	9.46e-07
_cons	-2.319774	.0046149	-502.67	0.000	-2.328819	-2.310729

R-squared = 0.1870

15. Aggregate natural cheese

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0737271	.0017068	-43.20	0.000	-.0770723	-.0703818
central	-.0692957	.0015504	-44.69	0.000	-.0723345	-.0662569
south	.0121458	.0014109	8.61	0.000	.0093804	.0149111
yr2006	-.0342667	.0010466	-32.74	0.000	-.036318	-.0322153
Q1	.02829	.0014686	19.26	0.000	.0254116	.0311683
Q2	.0157477	.0014599	10.79	0.000	.0128864	.018609
Q3	.0233022	.0014591	15.97	0.000	.0204424	.0261621
grocery	.2922594	.0033488	87.27	0.000	.2856959	.2988228
drug	.306509	.0114393	26.79	0.000	.2840884	.3289297
massmerch	.1712272	.006061	28.25	0.000	.1593477	.1831066
supercenter	.1642637	.0035589	46.16	0.000	.1572884	.1712389
club	-.1394442	.003822	-36.48	0.000	-.1469352	-.1319532
convenience	.6463261	.0144141	44.84	0.000	.6180749	.6745774
privatelbl	-.2459187	.0011077	-222.01	0.000	-.2480897	-.2437477
hhincome	1.18e-06	1.92e-08	61.31	0.000	1.14e-06	1.21e-06
_cons	-1.602814	.0036743	-436.22	0.000	-1.610015	-1.595612

R-squared = 0.1612

16. Aggregate processed cheese

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.1098386	.001973	-55.67	0.000	-.1137056	-.1059715
central	-.2137265	.0017533	-121.90	0.000	-.2171629	-.2102902
south	-.1796667	.0016342	-109.94	0.000	-.1828697	-.1764638
yr2006	-.0259091	.0011142	-23.25	0.000	-.0280928	-.0237254
Q1	.0515163	.0015365	33.53	0.000	.0485047	.0545278
Q2	.0334026	.0015366	21.74	0.000	.0303909	.0364143
Q3	.0469627	.0015474	30.35	0.000	.0439299	.0499955
grocery	.2740105	.0033938	80.74	0.000	.2673587	.2806623
drug	.1778536	.0115651	15.38	0.000	.1551864	.2005209
massmerch	.140887	.0057957	24.31	0.000	.1295276	.1522463
supercenter	.1662662	.0036142	46.00	0.000	.1591826	.1733499
club	-.0299289	.0046527	-6.43	0.000	-.0390479	-.0208098
convenience	.483383	.0188221	25.68	0.000	.4464923	.5202736
privatelbl	-.3252849	.0012057	-269.80	0.000	-.3276479	-.3229218
hhincome	1.26e-06	2.07e-08	60.90	0.000	1.22e-06	1.30e-06
_cons	-1.783759	.0037823	-471.61	0.000	-1.791172	-1.776345

R-squared = 0.1591

17. Other cheese category

lnppoz	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
east	-.0376342	.0021895	-17.19	0.000	-.0419256	-.0333429
central	-.146393	.0018538	-78.97	0.000	-.1500264	-.1427596
south	-.0050704	.0017783	-2.85	0.004	-.0085558	-.001585
yr2006	-.0094099	.0012675	-7.42	0.000	-.0118943	-.0069256
Q1	-.0161721	.0017739	-9.12	0.000	-.0196489	-.0126952
Q2	-.0316114	.0017926	-17.63	0.000	-.0351248	-.0280979
Q3	-.022344	.001794	-12.46	0.000	-.0258601	-.0188279
grocery	.2185497	.0043459	50.29	0.000	.2100319	.2270676
drug	.0531706	.0143227	3.71	0.000	.0250986	.0812425
massmerch	.2062361	.0080185	25.72	0.000	.1905201	.2219522
supercenter	.1470521	.0046351	31.73	0.000	.1379674	.1561368
club	-.0416625	.0053441	-7.80	0.000	-.0521367	-.0311883
convenience	.2491191	.0256386	9.72	0.000	.1988683	.2993698
privatelbl	-.6625388	.00154	-430.21	0.000	-.6655572	-.6595204
hhincome	2.15e-06	2.32e-08	92.59	0.000	2.11e-06	2.20e-06
_cons	-1.744259	.0047534	-366.95	0.000	-1.753576	-1.734943

R-squared = 0.2172

APPENDIX B

Estimation results of the panel Tobit model for all cheese varieties, the unconditional and conditional marginal effects for the explanatory variables, and the own-price, cross-price, income, and advertising elasticities.

1- Colby

Variable	Coefficient	Standard Error	p- value
lnP02	-34.739	0.552	0.000
lnP05	3.910	1.554	0.012
lnP06	0.191	0.654	0.771
lnP14	-0.554	0.979	0.572
lnPrn	0.131	0.713	0.854
lnPp	3.917	0.444	0.000
lnP08	-4.919	1.127	0.000
lnP09	2.634	0.947	0.005
lnP15	0.185	0.627	0.768
lnP17	5.392	0.586	0.000
lnPcf	-2.300	0.711	0.001
lnhhinc	6.963	0.536	0.000
hhsize1	-24.399	1.794	0.000
hhsize2	-13.512	1.683	0.000
hhsize3	-7.824	1.596	0.000
hhsize4	-3.391	1.456	0.020
child05	6.237	1.493	0.000
child612	5.253	1.188	0.000
child1317	1.583	1.126	0.160
age_2535	-5.786	7.156	0.419
age_3545	-10.296	7.083	0.146
age_4565	-14.197	7.057	0.044
age_ovr65	-21.730	7.072	0.002
edu_lesshs	-11.895	1.810	0.000
edu_hs	-8.105	0.807	0.000

edu_somecol	-3.173	0.736	0.000
white	4.359	1.685	0.010
black	-24.327	2.020	0.000
oriental	-10.041	2.588	0.000
hispanic	8.105	1.525	0.000
east	-7.792	1.032	0.000
central	-9.974	0.905	0.000
south	-16.782	0.861	0.000
Q1	0.554	0.655	0.398
Q2	0.629	0.585	0.282
Q3	2.884	0.400	0.000
lnl1adv	0.815	0.629	0.195
lnl2adv	1.967	0.727	0.007
lnl3adv	2.390	1.224	0.051
_cons	-177.564	23.228	0.000
sigma_u	42.096	0.307	0.000
sigma_e	36.000	0.136	0.000
rho	0.578	0.004	
pseudo R2	0.091		

	Unconditional marginal effects			**Conditional marginal effects**		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP02	-6.941	0.120	0.000	-7.552	0.122	0.000
lnP05	0.781	0.310	0.012	0.850	0.338	0.012
lnP06	0.038	0.131	0.771	0.041	0.142	0.771
lnP14	-0.111	0.196	0.572	-0.120	0.213	0.572
lnPrn	0.026	0.143	0.854	0.029	0.155	0.854
lnPp	0.783	0.089	0.000	0.851	0.097	0.000
lnP08	-0.983	0.225	0.000	-1.069	0.245	0.000
lnP09	0.526	0.189	0.005	0.573	0.206	0.005
lnP15	0.037	0.125	0.768	0.040	0.136	0.768
lnP17	1.077	0.117	0.000	1.172	0.127	0.000

lnPcf	-0.460	0.142	0.001	-0.500	0.155	0.001
lnhhinc	1.391	0.108	0.000	1.514	0.117	0.000
hhsize1	-4.875	0.361	0.000	-5.304	0.391	0.000
hhsize2	-2.700	0.337	0.000	-2.937	0.366	0.000
hhsize3	-1.563	0.319	0.000	-1.701	0.347	0.000
hhsize4	-0.678	0.291	0.020	-0.737	0.317	0.020
child05	1.246	0.299	0.000	1.356	0.325	0.000
child612	1.050	0.238	0.000	1.142	0.258	0.000
child1317	0.316	0.225	0.160	0.344	0.245	0.160
age_2535	-1.156	1.430	0.419	-1.258	1.556	0.419
age_3545	-2.057	1.415	0.146	-2.238	1.540	0.146
age_4565	-2.837	1.410	0.044	-3.086	1.534	0.044
age_ovr65	-4.342	1.414	0.002	-4.724	1.538	0.002
edu_lesshs	-2.377	0.362	0.000	-2.586	0.394	0.000
edu_hs	-1.619	0.162	0.000	-1.762	0.176	0.000
edu_somecol	-0.634	0.147	0.000	-0.690	0.160	0.000
white	0.871	0.337	0.010	0.948	0.366	0.010
black	-4.861	0.406	0.000	-5.289	0.440	0.000
oriental	-2.006	0.518	0.000	-2.183	0.563	0.000
hispanic	1.619	0.305	0.000	1.762	0.332	0.000
east	-1.557	0.207	0.000	-1.694	0.224	0.000
central	-1.993	0.182	0.000	-2.168	0.197	0.000
south	-3.353	0.175	0.000	-3.648	0.188	0.000
Q1	0.111	0.131	0.398	0.120	0.142	0.398
Q2	0.126	0.117	0.282	0.137	0.127	0.282
Q3	0.576	0.080	0.000	0.627	0.087	0.000
lnl1adv	0.163	0.126	0.195	0.177	0.137	0.195
lnl2adv	0.393	0.145	0.007	0.428	0.158	0.007
lnl3adv	0.478	0.245	0.051	0.520	0.266	0.051

Variables	Unconditional Elasticities	Conditional Elasticities
P02	-1.083	-0.235
P05	0.122	0.026
P06	0.006	0.001
P14	-0.017	-0.004
Prn	0.004	0.001
Pp	0.122	0.027
P08	-0.153	-0.033
P09	0.082	0.018
P15	0.006	0.001
P17	0.168	0.036
Pcf	-0.072	-0.016
hhinc	0.217	0.047
l1adv	0.025	0.006
l2adv	0.061	0.013
l3adv	0.075	0.016

2- Mozzarella

Variable	Coefficient	Standard Error	p- value
lnP02	0.105	0.132	0.427
lnP05	-15.324	0.185	0.000
lnP06	-0.067	0.114	0.552
lnP14	0.743	0.169	0.000
lnPrn	0.034	0.126	0.789
lnPp	0.057	0.074	0.443
lnP08	0.730	0.244	0.003
lnP09	0.622	0.166	0.000
lnP15	0.380	0.115	0.001
lnP17	0.240	0.100	0.016
lnPcf	-0.138	0.118	0.242
lnhhinc	0.362	0.067	0.000
hhsize1	-1.818	0.233	0.000
hhsize2	-0.989	0.221	0.000
hhsize3	-0.708	0.210	0.001
hhsize4	-0.332	0.194	0.087
child05	-0.283	0.200	0.158
child612	-0.264	0.157	0.093
child1317	0.061	0.147	0.680
age_2535	0.600	0.959	0.531
age_3545	1.230	0.948	0.195
age_4565	1.297	0.945	0.170
age_ovr65	0.867	0.946	0.359
edu_lesshs	-0.025	0.217	0.910
edu_hs	0.409	0.102	0.000
edu_somecol	0.350	0.094	0.000
white	0.173	0.221	0.433
black	-0.639	0.254	0.012
oriental	-0.936	0.344	0.007
hispanic	-0.226	0.202	0.263
east	0.693	0.148	0.000
central	2.174	0.118	0.000
south	1.714	0.120	0.000
Q1	0.182	0.064	0.004

Q2	0.277	0.060	0.000
Q3	0.625	0.074	0.000
lnadv	1.752	0.113	0.000
lnl2adv	1.643	0.121	0.000
_cons	-60.765	2.556	0.000
sigma_u	5.132	0.021	0.000
sigma_e	5.640	0.007	0.000
rho	0.453	0.002	
pseudo R2	0.056		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP02	0.044	0.055	0.427	0.034	0.043	0.427
lnP05	-6.375	0.085	0.000	-4.940	0.063	0.000
lnP06	-0.028	0.047	0.552	-0.022	0.037	0.552
lnP14	0.309	0.070	0.000	0.240	0.055	0.000
lnPrn	0.014	0.053	0.789	0.011	0.041	0.789
lnPp	0.024	0.031	0.443	0.018	0.024	0.443
lnP08	0.304	0.101	0.003	0.235	0.079	0.003
lnP09	0.259	0.069	0.000	0.200	0.053	0.000
lnP15	0.158	0.048	0.001	0.123	0.037	0.001
lnP17	0.100	0.041	0.016	0.077	0.032	0.016
lnPcf	-0.057	0.049	0.242	-0.044	0.038	0.242
lnhhinc	0.151	0.028	0.000	0.117	0.021	0.000
hhsize1	-0.756	0.097	0.000	-0.586	0.075	0.000
hhsize2	-0.411	0.092	0.000	-0.319	0.071	0.000
hhsize3	-0.295	0.088	0.001	-0.228	0.068	0.001
hhsize4	-0.138	0.081	0.087	-0.107	0.062	0.087
child05	-0.118	0.083	0.158	-0.091	0.065	0.158
child612	-0.110	0.065	0.093	-0.085	0.051	0.093
child1317	0.025	0.061	0.680	0.020	0.047	0.680
age_2535	0.250	0.399	0.531	0.194	0.309	0.531
age_3545	0.512	0.394	0.195	0.396	0.306	0.195
age_4565	0.539	0.393	0.170	0.418	0.305	0.170

age_ovr65	0.361	0.394	0.359	0.280	0.305	0.359
edu_lesshs	-0.010	0.090	0.910	-0.008	0.070	0.910
edu_hs	0.170	0.042	0.000	0.132	0.033	0.000
edu_somecol	0.145	0.039	0.000	0.113	0.030	0.000
white	0.072	0.092	0.433	0.056	0.071	0.433
black	-0.266	0.106	0.012	-0.206	0.082	0.012
oriental	-0.389	0.143	0.007	-0.302	0.111	0.007
hispanic	-0.094	0.084	0.263	-0.073	0.065	0.263
east	0.288	0.061	0.000	0.223	0.048	0.000
central	0.904	0.049	0.000	0.701	0.038	0.000
south	0.713	0.050	0.000	0.553	0.039	0.000
Q1	0.076	0.027	0.004	0.059	0.021	0.004
Q2	0.115	0.025	0.000	0.089	0.019	0.000
Q3	0.260	0.031	0.000	0.202	0.024	0.000
lnadv	0.729	0.047	0.000	0.565	0.037	0.000
lnl2adv	0.683	0.051	0.000	0.530	0.039	0.000

Variables	Unconditional Elasticities	Conditional Elasticities
P02	0.034	0.001
P05	-5.015	-0.214
P06	-0.022	-0.001
P14	0.243	0.010
Prn	0.011	0.000
Pp	0.019	0.001
P08	0.239	0.010
P09	0.203	0.009
P15	0.124	0.005
P17	0.079	0.003
Pcf	-0.045	-0.002
hhinc	0.119	0.005
adv	0.573	0.024
l2adv	0.538	0.023

3- Cheddar

Variable	Coefficient	Standard Error	p- value
lnP02	-1.835	0.371	0.000
lnP05	0.046	0.768	0.952
lnP06	-23.060	0.279	0.000
lnP14	-1.956	0.485	0.000
lnPrn	-1.995	0.361	0.000
lnPp	0.509	0.214	0.017
lnP08	-0.392	0.660	0.553
lnP09	-0.373	0.482	0.439
lnP15	-0.362	0.324	0.265
lnP17	1.169	0.287	0.000
lnPcf	-1.842	0.357	0.000
lnhhinc	1.757	0.292	0.000
hhsize1	-14.577	1.026	0.000
hhsize2	-6.306	0.971	0.000
hhsize3	-4.192	0.925	0.000
hhsize4	-2.840	0.855	0.001
child05	1.866	0.877	0.033
child612	-1.013	0.691	0.143
child1317	2.157	0.648	0.001
age_2535	-0.190	4.153	0.964
age_3545	-0.218	4.106	0.958
age_4565	-0.301	4.091	0.941
age_ovr65	-0.487	4.098	0.905
edu_lesshs	-4.028	0.965	0.000
edu_hs	-3.730	0.448	0.000
edu_somecol	-1.373	0.411	0.001
white	1.174	0.961	0.222
black	-3.149	1.107	0.004
oriental	-14.671	1.498	0.000
hispanic	-2.688	0.879	0.002
east	-10.144	0.583	0.000
central	-19.554	0.511	0.000
south	-10.365	0.479	0.000
Q1	-2.151	0.183	0.000
Q2	-1.823	0.171	0.000

Q3	-1.402	0.210	0.000
lnadv	1.695	0.328	0.000
lnl2adv	3.192	0.345	0.000
_cons	-87.767	8.616	0.000
sigma_u	25.753	0.096	0.000
sigma_e	21.857	0.035	0.000
rho	0.581	0.002	
pseudo R2	0.115		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP02	-0.988	0.200	0.000	-0.718	0.145	0.000
lnP05	0.025	0.414	0.952	0.018	0.301	0.952
lnP06	-12.415	0.155	0.000	-9.029	0.112	0.000
lnP14	-1.053	0.261	0.000	-0.766	0.190	0.000
lnPrn	-1.074	0.194	0.000	-0.781	0.141	0.000
lnPp	0.274	0.115	0.017	0.199	0.084	0.017
lnP08	-0.211	0.355	0.553	-0.153	0.258	0.553
lnP09	-0.201	0.259	0.439	-0.146	0.189	0.439
lnP15	-0.195	0.175	0.265	-0.142	0.127	0.265
lnP17	0.629	0.155	0.000	0.458	0.113	0.000
lnPcf	-0.991	0.192	0.000	-0.721	0.140	0.000
lnhhinc	0.946	0.157	0.000	0.688	0.114	0.000
hhsize1	-7.848	0.552	0.000	-5.707	0.402	0.000
hhsize2	-3.395	0.523	0.000	-2.469	0.380	0.000
hhsize3	-2.257	0.498	0.000	-1.641	0.362	0.000
hhsize4	-1.529	0.460	0.001	-1.112	0.335	0.001
child05	1.005	0.472	0.033	0.731	0.343	0.033
child612	-0.546	0.372	0.143	-0.397	0.271	0.143
child1317	1.161	0.349	0.001	0.845	0.254	0.001
age_2535	-0.102	2.236	0.964	-0.074	1.626	0.964
age_3545	-0.118	2.211	0.958	-0.085	1.608	0.958
age_4565	-0.162	2.203	0.941	-0.118	1.602	0.941

age_ovr65	-0.262	2.206	0.905	-0.191	1.605	0.905
edu_lesshs	-2.169	0.520	0.000	-1.577	0.378	0.000
edu_hs	-2.008	0.241	0.000	-1.460	0.175	0.000
edu_somecol	-0.739	0.221	0.001	-0.538	0.161	0.001
white	0.632	0.518	0.222	0.460	0.376	0.222
black	-1.695	0.596	0.004	-1.233	0.433	0.004
oriental	-7.898	0.807	0.000	-5.744	0.587	0.000
hispanic	-1.447	0.473	0.002	-1.052	0.344	0.002
east	-5.461	0.314	0.000	-3.972	0.229	0.000
central	-10.527	0.275	0.000	-7.656	0.202	0.000
south	-5.580	0.258	0.000	-4.058	0.188	0.000
Q1	-1.158	0.099	0.000	-0.842	0.072	0.000
Q2	-0.982	0.092	0.000	-0.714	0.067	0.000
Q3	-0.755	0.113	0.000	-0.549	0.082	0.000
lnadv	0.913	0.177	0.000	0.664	0.128	0.000
lnl2adv	1.719	0.186	0.000	1.250	0.135	0.000

Variables	**Unconditional Elasticities**	**Conditional Elasticities**
P02	-0.073	-0.020
P05	0.002	0.000
P06	-0.918	-0.246
P14	-0.078	-0.021
Prn	-0.079	-0.021
Pp	0.020	0.005
P08	-0.016	-0.004
P09	-0.015	-0.004
P15	-0.014	-0.004
P17	0.047	0.012
Pcf	-0.073	-0.020
hhinc	0.070	0.019
adv	0.067	0.018
l2adv	0.127	0.034

4- Swiss

Variable	Coefficient	Standard Error	p-value
lnP02	1.352	0.261	0.000
lnP05	8.410	0.549	0.000
lnP06	1.705	0.230	0.000
lnP14	-24.195	0.241	0.000
lnPrn	2.447	0.256	0.000
lnPp	1.690	0.151	0.000
lnP08	1.851	0.467	0.000
lnP09	0.976	0.332	0.003
lnP15	-0.073	0.212	0.730
lnP17	1.184	0.200	0.000
lnPcf	0.147	0.242	0.545
lnhhinc	2.090	0.126	0.000
hhsize1	-3.798	0.429	0.000
hhsize2	-0.725	0.404	0.073
hhsize3	-0.235	0.386	0.543
hhsize4	0.029	0.358	0.935
child05	-0.843	0.371	0.023
child612	-1.343	0.290	0.000
child1317	-0.909	0.270	0.001
age_2535	-0.844	1.814	0.642
age_3545	1.628	1.794	0.364
age_4565	2.183	1.788	0.222
age_ovr65	2.218	1.790	0.215
edu_lesshs	-3.190	0.422	0.000
edu_hs	-1.643	0.185	0.000
edu_somecol	-0.561	0.169	0.001
white	2.823	0.412	0.000
black	-5.878	0.501	0.000
oriental	-2.597	0.650	0.000
hispanic	-1.779	0.371	0.000
east	-2.699	0.271	0.000
central	-1.853	0.216	0.000
south	-0.825	0.221	0.000
Q1	-0.449	0.137	0.001
Q2	-0.311	0.128	0.015

Q3	0.275	0.156	0.078
lnadv	1.257	0.243	0.000
lnl2adv	1.709	0.259	0.000
_cons	-67.561	5.365	0.000
sigma_u	7.953	0.032	0.000
sigma_e	11.765	0.026	0.000
rho	0.314	0.002	
pseudo R2	0.075		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP02	0.161	0.031	0.000	0.239	0.046	0.000
lnP05	1.001	0.066	0.000	1.487	0.097	0.000
lnP06	0.203	0.027	0.000	0.302	0.041	0.000
lnP14	-2.880	0.037	0.000	-4.278	0.044	0.000
lnPrn	0.291	0.031	0.000	0.433	0.045	0.000
lnPp	0.201	0.018	0.000	0.299	0.027	0.000
lnP08	0.220	0.056	0.000	0.327	0.083	0.000
lnP09	0.116	0.039	0.003	0.172	0.059	0.003
lnP15	-0.009	0.025	0.730	-0.013	0.037	0.730
lnP17	0.141	0.024	0.000	0.209	0.035	0.000
lnPcf	0.017	0.029	0.545	0.026	0.043	0.545
lnhhinc	0.249	0.015	0.000	0.370	0.022	0.000
hhsize1	-0.452	0.051	0.000	-0.672	0.076	0.000
hhsize2	-0.086	0.048	0.073	-0.128	0.072	0.073
hhsize3	-0.028	0.046	0.543	-0.042	0.068	0.543
hhsize4	0.003	0.043	0.935	0.005	0.063	0.935
child05	-0.100	0.044	0.023	-0.149	0.066	0.023
child612	-0.160	0.035	0.000	-0.237	0.051	0.000
child1317	-0.108	0.032	0.001	-0.161	0.048	0.001
age_2535	-0.100	0.216	0.642	-0.149	0.321	0.642
age_3545	0.194	0.214	0.364	0.288	0.317	0.364
age_4565	0.260	0.213	0.222	0.386	0.316	0.222
age_ovr65	0.264	0.213	0.215	0.392	0.317	0.215

edu_lesshs	-0.380	0.050	0.000	-0.564	0.075	0.000
edu_hs	-0.196	0.022	0.000	-0.290	0.033	0.000
edu_somecol	-0.067	0.020	0.001	-0.099	0.030	0.001
white	0.336	0.049	0.000	0.499	0.073	0.000
black	-0.700	0.060	0.000	-1.039	0.089	0.000
oriental	-0.309	0.077	0.000	-0.459	0.115	0.000
hispanic	-0.212	0.044	0.000	-0.314	0.066	0.000
east	-0.321	0.032	0.000	-0.477	0.048	0.000
central	-0.221	0.026	0.000	-0.328	0.038	0.000
south	-0.098	0.026	0.000	-0.146	0.039	0.000
Q1	-0.053	0.016	0.001	-0.079	0.024	0.001
Q2	-0.037	0.015	0.015	-0.055	0.023	0.015
Q3	0.033	0.019	0.078	0.049	0.028	0.078
lnadv	0.150	0.029	0.000	0.222	0.043	0.000
lnl2adv	0.203	0.031	0.000	0.302	0.046	0.000

Variables	Unconditional Elasticities	Conditional Elasticities
P02	0.065	0.012
P05	0.404	0.074
P06	0.082	0.015
P14	-1.163	-0.213
Prn	0.118	0.022
Pp	0.081	0.015
P08	0.089	0.016
P09	0.047	0.009
P15	-0.004	-0.001
P17	0.057	0.010
Pcf	0.007	0.001
hhinc	0.101	0.018
adv	0.060	0.011
l2adv	0.082	0.015

5- Remaining natural

Variable	Coefficient	Standard Error	p- value
lnP02	-0.034	0.238	0.887
lnP05	1.034	0.480	0.031
lnP06	0.230	0.209	0.272
lnP14	-0.014	0.316	0.963
lnPrn	-20.010	0.200	0.000
lnPp	0.745	0.141	0.000
lnP08	1.007	0.431	0.019
lnP09	0.582	0.313	0.062
lnP15	-0.406	0.207	0.050
lnP17	0.644	0.186	0.001
lnPcf	-0.288	0.228	0.207
lnhhinc	2.107	0.157	0.000
hhsize1	-6.146	0.545	0.000
hhsize2	-4.016	0.516	0.000
hhsize3	-1.951	0.491	0.000
hhsize4	-1.226	0.453	0.007
child05	2.063	0.464	0.000
child612	-0.508	0.366	0.165
child1317	-0.113	0.344	0.744
age_2535	0.495	2.202	0.822
age_3545	0.675	2.178	0.757
age_4565	0.118	2.170	0.957
age_ovr65	-1.655	2.174	0.447
edu_lesshs	-1.865	0.520	0.000
edu_hs	-0.735	0.239	0.002
edu_somecol	-0.316	0.220	0.151
white	1.046	0.513	0.041
black	-3.021	0.594	0.000
oriental	-3.539	0.792	0.000
hispanic	1.551	0.466	0.001
east	-5.558	0.324	0.000
central	-3.709	0.272	0.000
south	-3.954	0.264	0.000
Q1	-0.731	0.122	0.000
Q2	-0.461	0.113	0.000

Q3	-0.351	0.138	0.011
lnadv	0.434	0.216	0.044
lnl2adv	0.598	0.229	0.009
_cons	-43.305	5.231	0.000
sigma_u	13.233	0.050	0.000
sigma_e	13.764	0.019	0.000
rho	0.480	0.002	
pseudo R2	0.103		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP02	-0.020	0.137	0.887	-0.014	0.099	0.887
lnP05	0.596	0.277	0.031	0.429	0.199	0.031
lnP06	0.132	0.120	0.272	0.095	0.087	0.272
lnP14	-0.008	0.182	0.963	-0.006	0.131	0.963
lnPrn	-11.539	0.120	0.000	-8.295	0.086	0.000
lnPp	0.430	0.082	0.000	0.309	0.059	0.000
lnP08	0.581	0.249	0.019	0.418	0.179	0.019
lnP09	0.336	0.180	0.062	0.241	0.130	0.062
lnP15	-0.234	0.119	0.050	-0.168	0.086	0.050
lnP17	0.372	0.107	0.001	0.267	0.077	0.001
lnPcf	-0.166	0.132	0.207	-0.119	0.095	0.207
lnhhinc	1.215	0.091	0.000	0.873	0.065	0.000
hhsize1	-3.544	0.314	0.000	-2.548	0.226	0.000
hhsize2	-2.316	0.297	0.000	-1.665	0.214	0.000
hhsize3	-1.125	0.283	0.000	-0.809	0.203	0.000
hhsize4	-0.707	0.261	0.007	-0.508	0.188	0.007
child05	1.189	0.268	0.000	0.855	0.192	0.000
child612	-0.293	0.211	0.165	-0.210	0.152	0.165
child1317	-0.065	0.199	0.744	-0.047	0.143	0.744
age_2535	0.285	1.270	0.822	0.205	0.913	0.822
age_3545	0.389	1.256	0.757	0.280	0.903	0.757
age_4565	0.068	1.251	0.957	0.049	0.900	0.957
age_ovr65	-0.954	1.254	0.447	-0.686	0.901	0.447

edu_lesshs	-1.076	0.300	0.000	-0.773	0.216	0.000
edu_hs	-0.424	0.138	0.002	-0.305	0.099	0.002
edu_somecol	-0.182	0.127	0.151	-0.131	0.091	0.151
white	0.603	0.296	0.041	0.433	0.213	0.041
black	-1.742	0.343	0.000	-1.252	0.246	0.000
oriental	-2.041	0.457	0.000	-1.467	0.328	0.000
hispanic	0.894	0.269	0.001	0.643	0.193	0.001
east	-3.205	0.187	0.000	-2.304	0.135	0.000
central	-2.139	0.157	0.000	-1.538	0.113	0.000
south	-2.280	0.152	0.000	-1.639	0.110	0.000
Q1	-0.421	0.070	0.000	-0.303	0.050	0.000
Q2	-0.266	0.065	0.000	-0.191	0.047	0.000
Q3	-0.202	0.080	0.011	-0.146	0.057	0.011
lnadv	0.250	0.124	0.044	0.180	0.089	0.044
lnl2adv	0.345	0.132	0.009	0.248	0.095	0.009

Variables	Unconditional Elasticities	Conditional Elasticities
P02	-0.003	-0.001
P05	0.090	0.016
P06	0.020	0.003
P14	-0.001	0.000
Prn	-1.737	-0.305
Pp	0.065	0.011
P08	0.087	0.015
P09	0.051	0.009
P15	-0.035	-0.006
P17	0.056	0.010
Pcf	-0.025	-0.004
hhinc	0.183	0.032
adv	0.038	0.007
l2adv	0.052	0.009

6- Processed slices

Variable	Coefficient	Standard Error	p- value
lnPps	-16.999	0.345	0.000
lnP11	0.226	0.839	0.787
lnP12	-0.837	0.453	0.065
lnP19	-0.820	0.432	0.058
lnPn	-1.191	0.421	0.005
lnP08	1.047	1.036	0.312
lnP09	-2.267	0.709	0.001
lnP15	-0.152	0.514	0.767
lnP17	-0.874	0.438	0.046
lnPcf	-3.162	0.532	0.000
lnhhinc	-3.819	0.480	0.000
hhsize1	-43.896	1.684	0.000
hhsize2	-23.044	1.590	0.000
hhsize3	-11.779	1.514	0.000
hhsize4	-4.572	1.397	0.001
child05	0.098	1.438	0.946
child612	-1.038	1.128	0.358
child1317	2.812	1.060	0.008
age_2535	13.243	6.919	0.056
age_3545	11.602	6.845	0.090
age_4565	8.955	6.820	0.189
age_ovr65	5.234	6.832	0.444
edu_lesshs	14.575	1.561	0.000
edu_hs	10.967	0.738	0.000
edu_somecol	6.791	0.684	0.000
white	3.044	1.599	0.057
black	-3.137	1.834	0.087
oriental	-12.857	2.477	0.000
hispanic	-1.656	1.453	0.254
east	8.283	0.975	0.000
central	14.975	0.863	0.000
south	15.518	0.809	0.000
Q1	3.270	0.275	0.000
Q2	5.741	0.258	0.000

Q3	6.151	0.317	0.000
lnadv	5.579	0.464	0.000
lnl2adv	6.228	0.508	0.000
_cons	-133.188	12.979	0.000
sigma_u	43.321	0.231	0.000
sigma_e	33.355	0.079	0.000
rho	0.628	0.003	
pseudo R2	0.081		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnPps	-7.867	0.162	0.000	-5.935	0.122	0.000
lnP11	0.105	0.388	0.787	0.079	0.293	0.787
lnP12	-0.387	0.209	0.065	-0.292	0.158	0.065
lnP19	-0.379	0.200	0.058	-0.286	0.151	0.058
lnPn	-0.551	0.195	0.005	-0.416	0.147	0.005
lnP08	0.484	0.479	0.312	0.365	0.362	0.312
lnP09	-1.049	0.328	0.001	-0.792	0.248	0.001
lnP15	-0.070	0.238	0.767	-0.053	0.179	0.767
lnP17	-0.404	0.203	0.046	-0.305	0.153	0.046
lnPcf	-1.464	0.246	0.000	-1.104	0.186	0.000
lnhhinc	-1.767	0.222	0.000	-1.333	0.168	0.000
hhsize1	-20.315	0.783	0.000	-15.326	0.592	0.000
hhsize2	-10.665	0.736	0.000	-8.046	0.556	0.000
hhsize3	-5.451	0.701	0.000	-4.113	0.529	0.000
hhsize4	-2.116	0.647	0.001	-1.596	0.488	0.001
child05	0.045	0.666	0.946	0.034	0.502	0.946
child612	-0.480	0.522	0.358	-0.362	0.394	0.358
child1317	1.302	0.491	0.008	0.982	0.370	0.008
age_2535	6.129	3.202	0.056	4.624	2.416	0.056
age_3545	5.369	3.168	0.090	4.051	2.390	0.090
age_4565	4.145	3.157	0.189	3.127	2.381	0.189
age_ovr65	2.423	3.162	0.444	1.828	2.385	0.444
edu_lesshs	6.745	0.723	0.000	5.089	0.546	0.000

edu_hs	5.075	0.342	0.000	3.829	0.258	0.000
edu_somecol	3.143	0.317	0.000	2.371	0.239	0.000
white	1.409	0.740	0.057	1.063	0.558	0.057
black	-1.452	0.849	0.087	-1.095	0.640	0.087
oriental	-5.950	1.147	0.000	-4.489	0.865	0.000
hispanic	-0.767	0.672	0.254	-0.578	0.507	0.254
east	3.834	0.451	0.000	2.892	0.341	0.000
central	6.930	0.400	0.000	5.228	0.302	0.000
south	7.181	0.375	0.000	5.418	0.283	0.000
Q1	1.513	0.127	0.000	1.142	0.096	0.000
Q2	2.657	0.120	0.000	2.005	0.090	0.000
Q3	2.847	0.147	0.000	2.148	0.111	0.000
lnadv	2.582	0.215	0.000	1.948	0.162	0.000
lnl2adv	2.882	0.235	0.000	2.175	0.177	0.000

Variables	**Unconditional Elasticities**	**Conditional Elasticities**
Pps	-0.407	-0.147
P11	0.005	0.002
P12	-0.020	-0.007
P19	-0.020	-0.007
Pn	-0.029	-0.010
P08	0.025	0.009
P09	-0.054	-0.020
P15	-0.004	-0.001
P17	-0.021	-0.008
Pcf	-0.076	-0.027
hhinc	-0.092	-0.033
adv	0.134	0.048
l2adv	0.149	0.054

7- Loaves

Variable	Coefficient	Standard Error	p- value
lnPps	-0.063	0.217	0.770
lnP11	-16.836	0.340	0.000
lnP12	1.719	0.244	0.000
lnP19	-1.032	0.238	0.000
lnPn	-0.533	0.230	0.021
lnP08	1.151	0.555	0.038
lnP09	1.226	0.399	0.002
lnP15	2.125	0.279	0.000
lnP17	-1.265	0.237	0.000
lnPcf	0.066	0.287	0.819
lnhhinc	-0.266	0.154	0.084
hhsize1	-10.057	0.528	0.000
hhsize2	-5.245	0.496	0.000
hhsize3	-3.623	0.472	0.000
hhsize4	-1.106	0.434	0.011
child05	-1.210	0.450	0.007
child612	-0.101	0.352	0.774
child1317	1.199	0.331	0.000
age_2535	4.751	2.241	0.034
age_3545	5.404	2.218	0.015
age_4565	4.006	2.211	0.070
age_ovr65	1.324	2.214	0.550
edu_lesshs	2.025	0.499	0.000
edu_hs	1.961	0.233	0.000
edu_somecol	1.509	0.216	0.000
white	1.568	0.512	0.002
black	-3.296	0.590	0.000
oriental	-5.601	0.816	0.000
hispanic	-2.902	0.467	0.000
east	-1.267	0.345	0.000
central	2.132	0.280	0.000
south	4.398	0.276	0.000
Q1	-1.179	0.158	0.000

Q2	-2.685	0.151	0.000
Q3	-2.387	0.205	0.000
lnadv	1.387	0.311	0.000
lnl1adv	0.583	0.250	0.020
lnl2adv	1.682	0.320	0.000
_cons	-70.833	5.975	0.000
sigma_u	11.466	0.041	0.000
sigma_e	15.413	0.023	0.000
rho	0.356	0.002	
pseudo R2	0.060		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnPps	-0.023	0.078	0.770	-0.019	0.064	0.770
lnP11	-6.083	0.127	0.000	-4.975	0.102	0.000
lnP12	0.621	0.088	0.000	0.508	0.072	0.000
lnP19	-0.373	0.086	0.000	-0.305	0.070	0.000
lnPn	-0.193	0.083	0.021	-0.157	0.068	0.021
lnP08	0.416	0.200	0.038	0.340	0.164	0.038
lnP09	0.443	0.144	0.002	0.362	0.118	0.002
lnP15	0.768	0.101	0.000	0.628	0.083	0.000
lnP17	-0.457	0.086	0.000	-0.374	0.070	0.000
lnPcf	0.024	0.104	0.819	0.019	0.085	0.819
lnhhinc	-0.096	0.056	0.084	-0.079	0.045	0.084
hhsize1	-3.634	0.191	0.000	-2.971	0.156	0.000
hhsize2	-1.895	0.179	0.000	-1.550	0.147	0.000
hhsize3	-1.309	0.171	0.000	-1.071	0.140	0.000
hhsize4	-0.400	0.157	0.011	-0.327	0.128	0.011
child05	-0.437	0.163	0.007	-0.357	0.133	0.007
child612	-0.036	0.127	0.774	-0.030	0.104	0.774
child1317	0.433	0.120	0.000	0.354	0.098	0.000
age_2535	1.717	0.810	0.034	1.404	0.662	0.034
age_3545	1.952	0.801	0.015	1.597	0.655	0.015
age_4565	1.447	0.799	0.070	1.184	0.653	0.070

age_ovr65	0.478	0.800	0.550	0.391	0.654	0.550
edu_lesshs	0.732	0.180	0.000	0.598	0.147	0.000
edu_hs	0.709	0.084	0.000	0.580	0.069	0.000
edu_somecol	0.545	0.078	0.000	0.446	0.064	0.000
white	0.567	0.185	0.002	0.463	0.151	0.002
black	-1.191	0.213	0.000	-0.974	0.174	0.000
oriental	-2.024	0.295	0.000	-1.655	0.241	0.000
hispanic	-1.048	0.169	0.000	-0.857	0.138	0.000
east	-0.458	0.125	0.000	-0.374	0.102	0.000
central	0.770	0.101	0.000	0.630	0.083	0.000
south	1.589	0.100	0.000	1.299	0.082	0.000
Q1	-0.426	0.057	0.000	-0.348	0.047	0.000
Q2	-0.970	0.055	0.000	-0.793	0.045	0.000
Q3	-0.862	0.074	0.000	-0.705	0.061	0.000
lnadv	0.501	0.112	0.000	0.410	0.092	0.000
lnl1adv	0.211	0.090	0.020	0.172	0.074	0.020
lnl2adv	0.608	0.116	0.000	0.497	0.095	0.000

Variables	**Unconditional Elasticities**	**Conditional Elasticities**
Pps	-0.005	0.000
P11	-1.213	-0.115
P12	0.124	0.012
P19	-0.074	-0.007
Pn	-0.038	-0.004
P08	0.083	0.008
P09	0.088	0.008
P15	0.153	0.014
P17	-0.091	-0.009
Pcf	0.005	0.000
hhinc	-0.019	-0.002
adv	0.100	0.009
l1adv	0.042	0.004
l2adv	0.121	0.011

8- Snacks

Variable	Coefficient	Standard Error	p-value
lnPps	0.479	0.141	0.001
lnP11	4.873	0.278	0.000
lnP12	-7.212	0.125	0.000
lnP19	0.778	0.156	0.000
lnPn	0.092	0.149	0.534
lnP08	0.016	0.344	0.963
lnP09	1.327	0.261	0.000
lnP15	2.341	0.175	0.000
lnP17	0.150	0.155	0.333
lnPcf	-0.147	0.184	0.427
lnhhinc	1.396	0.085	0.000
hhsize1	-2.794	0.295	0.000
hhsize2	-0.157	0.278	0.572
hhsize3	-0.290	0.265	0.275
hhsize4	0.238	0.244	0.331
child05	-1.184	0.255	0.000
child612	0.382	0.197	0.053
child1317	0.211	0.185	0.254
age_2535	2.055	1.307	0.116
age_3545	2.850	1.294	0.028
age_4565	3.542	1.290	0.006
age_ovr65	4.470	1.292	0.001
edu_lesshs	-1.319	0.278	0.000
edu_hs	-0.312	0.127	0.014
edu_somecol	0.210	0.117	0.073
white	0.880	0.281	0.002
black	-5.985	0.334	0.000
oriental	-3.114	0.445	0.000
hispanic	-2.601	0.259	0.000
east	-0.531	0.192	0.006
central	1.611	0.158	0.000
south	2.851	0.155	0.000
Q1	-3.209	0.143	0.000
Q2	-3.557	0.150	0.000

Q3	-3.545	0.115	0.000
lnl1adv	0.373	0.178	0.036
lnl3adv	0.937	0.288	0.001
_cons	-33.808	4.553	0.000
sigma_u	5.256	0.024	0.000
sigma_e	11.142	0.020	0.000
rho	0.182	0.002	
pseudo R2	0.047		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnPps	0.104	0.031	0.001	0.108	0.032	0.001
lnP11	1.058	0.061	0.000	1.101	0.063	0.000
lnP12	-1.566	0.029	0.000	-1.629	0.029	0.000
lnP19	0.169	0.034	0.000	0.176	0.035	0.000
lnPn	0.020	0.032	0.534	0.021	0.034	0.534
lnP08	0.003	0.075	0.963	0.004	0.078	0.963
lnP09	0.288	0.057	0.000	0.300	0.059	0.000
lnP15	0.508	0.038	0.000	0.529	0.040	0.000
lnP17	0.033	0.034	0.333	0.034	0.035	0.333
lnPcf	-0.032	0.040	0.427	-0.033	0.042	0.427
lnhhinc	0.303	0.019	0.000	0.315	0.019	0.000
hhsize1	-0.607	0.064	0.000	-0.631	0.067	0.000
hhsize2	-0.034	0.060	0.572	-0.035	0.063	0.572
hhsize3	-0.063	0.058	0.275	-0.065	0.060	0.275
hhsize4	0.052	0.053	0.331	0.054	0.055	0.331
child05	-0.257	0.055	0.000	-0.267	0.058	0.000
child612	0.083	0.043	0.053	0.086	0.045	0.053
child1317	0.046	0.040	0.254	0.048	0.042	0.254
age_2535	0.446	0.284	0.116	0.464	0.295	0.116
age_3545	0.619	0.281	0.028	0.644	0.292	0.028
age_4565	0.769	0.280	0.006	0.800	0.291	0.006
age_ovr65	0.971	0.281	0.001	1.010	0.292	0.001
edu_lesshs	-0.286	0.060	0.000	-0.298	0.063	0.000

edu_hs	-0.068	0.028	0.014	-0.070	0.029	0.014
edu_somecol	0.046	0.025	0.074	0.047	0.027	0.073
white	0.191	0.061	0.002	0.199	0.064	0.002
black	-1.300	0.073	0.000	-1.352	0.075	0.000
oriental	-0.676	0.097	0.000	-0.703	0.101	0.000
hispanic	-0.565	0.056	0.000	-0.588	0.059	0.000
east	-0.115	0.042	0.006	-0.120	0.043	0.006
central	0.350	0.034	0.000	0.364	0.036	0.000
south	0.619	0.034	0.000	0.644	0.035	0.000
Q1	-0.697	0.031	0.000	-0.725	0.032	0.000
Q2	-0.773	0.033	0.000	-0.804	0.034	0.000
Q3	-0.770	0.025	0.000	-0.801	0.026	0.000
lnl1adv	0.081	0.039	0.036	0.084	0.040	0.036
lnl3adv	0.204	0.063	0.001	0.212	0.065	0.001

Variables	**Unconditional Elasticities**	**Conditional Elasticities**
Pps	0.034	0.006
P11	0.347	0.058
P12	-0.513	-0.086
P19	0.055	0.009
Pn	0.007	0.001
P08	0.001	0.000
P09	0.094	0.016
P15	0.167	0.028
P17	0.011	0.002
Pcf	-0.010	-0.002
hhinc	0.099	0.017
l1adv	0.027	0.004
l3adv	0.067	0.011

9- Cream cheese

Variable	Coefficient	Standard Error	p- value
lnPps	0.611	0.239	0.011
lnP11	3.887	0.497	0.000
lnP12	1.213	0.270	0.000
lnP19	-13.876	0.229	0.000
lnPn	-1.010	0.248	0.000
lnP08	-1.139	0.567	0.044
lnP09	0.141	0.430	0.744
lnP15	0.644	0.293	0.028
lnP17	0.889	0.257	0.001
lnPcf	-0.653	0.315	0.038
lnhhinc	2.125	0.213	0.000
hhsize1	-15.132	0.740	0.000
hhsize2	-7.745	0.699	0.000
hhsize3	-5.935	0.666	0.000
hhsize4	-2.197	0.614	0.000
child05	-1.684	0.633	0.008
child612	1.374	0.497	0.006
child1317	1.277	0.467	0.006
age_2535	-3.023	3.006	0.315
age_3545	-1.835	2.973	0.537
age_4565	-1.463	2.962	0.621
age_ovr65	0.268	2.967	0.928
edu_lesshs	-3.035	0.700	0.000
edu_hs	0.132	0.323	0.682
edu_somecol	1.445	0.298	0.000
white	3.606	0.700	0.000
black	-8.026	0.811	0.000
oriental	-1.529	1.073	0.154
hispanic	-2.140	0.637	0.001
east	2.904	0.433	0.000
central	2.057	0.381	0.000
south	-0.313	0.362	0.388
Q1	-9.778	0.163	0.000
Q2	-8.817	0.152	0.000

Q3	-9.055	0.165	0.000
lnl2adv	2.438	0.249	0.000
_cons	-51.674	4.917	0.000
sigma_u	17.973	0.073	0.000
sigma_e	21.211	0.037	0.000
rho	0.418	0.002	
pseudo R2	0.069		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnPps	0.306	0.120	0.011	0.226	0.088	0.011
lnP11	1.949	0.249	0.000	1.438	0.184	0.000
lnP12	0.608	0.135	0.000	0.449	0.100	0.000
lnP19	-6.956	0.116	0.000	-5.135	0.086	0.000
lnPn	-0.506	0.124	0.000	-0.374	0.092	0.000
lnP08	-0.571	0.284	0.044	-0.421	0.210	0.044
lnP09	0.070	0.215	0.744	0.052	0.159	0.744
lnP15	0.323	0.147	0.028	0.238	0.109	0.028
lnP17	0.445	0.129	0.001	0.329	0.095	0.001
lnPcf	-0.328	0.158	0.038	-0.242	0.117	0.038
lnhhinc	1.065	0.107	0.000	0.786	0.079	0.000
hhsize1	-7.585	0.371	0.000	-5.599	0.275	0.000
hhsize2	-3.883	0.351	0.000	-2.866	0.259	0.000
hhsize3	-2.975	0.334	0.000	-2.196	0.247	0.000
hhsize4	-1.102	0.308	0.000	-0.813	0.227	0.000
child05	-0.844	0.318	0.008	-0.623	0.234	0.008
child612	0.689	0.249	0.006	0.508	0.184	0.006
child1317	0.640	0.234	0.006	0.473	0.173	0.006
age_2535	-1.515	1.507	0.315	-1.119	1.112	0.315
age_3545	-0.920	1.490	0.537	-0.679	1.100	0.537
age_4565	-0.733	1.485	0.621	-0.541	1.096	0.621
age_ovr65	0.134	1.487	0.928	0.099	1.098	0.928
edu_lesshs	-1.522	0.351	0.000	-1.123	0.259	0.000
edu_hs	0.066	0.162	0.682	0.049	0.120	0.682

edu_somecol	0.725	0.149	0.000	0.535	0.110	0.000
white	1.808	0.351	0.000	1.334	0.259	0.000
black	-4.024	0.407	0.000	-2.970	0.300	0.000
oriental	-0.767	0.538	0.154	-0.566	0.397	0.154
hispanic	-1.073	0.320	0.001	-0.792	0.236	0.001
east	1.456	0.217	0.000	1.075	0.160	0.000
central	1.031	0.191	0.000	0.761	0.141	0.000
south	-0.157	0.182	0.388	-0.116	0.134	0.388
Q1	-4.902	0.083	0.000	-3.619	0.061	0.000
Q2	-4.420	0.077	0.000	-3.263	0.057	0.000
Q3	-4.539	0.084	0.000	-3.351	0.062	0.000
lnl2adv	1.222	0.125	0.000	0.902	0.092	0.000

Variables	**Unconditional Elasticities**	**Conditional Elasticities**
Pps	0.027	0.008
P11	0.171	0.054
P12	0.053	0.017
P19	-0.611	-0.192
Pn	-0.044	-0.014
P08	-0.050	-0.016
P09	0.006	0.002
P15	0.028	0.009
P17	0.039	0.012
Pcf	-0.029	-0.009
hhinc	0.094	0.029
l2adv	0.107	0.034

10- Ricotta

Variable	Coefficient	Standard Error	p- value
lnP08	-20.529	0.266	0.000
lnP09	1.329	0.249	0.000
lnP15	1.608	0.170	0.000
lnP17	0.670	0.156	0.000
lnPcf	0.372	0.189	0.049
lnPn	-0.738	0.148	0.000
lnPp	0.515	0.116	0.000
lnhhinc	1.135	0.101	0.000
hhsize1	-2.794	0.354	0.000
hhsize2	-1.591	0.334	0.000
hhsize3	-0.862	0.317	0.007
hhsize4	-0.054	0.292	0.854
child05	-0.214	0.300	0.476
child612	-0.305	0.236	0.196
child1317	0.198	0.223	0.373
age_2535	-0.607	1.402	0.665
age_3545	-1.226	1.386	0.377
age_4565	-1.522	1.381	0.271
age_ovr65	-1.458	1.384	0.292
edu_lesshs	-1.152	0.337	0.001
edu_hs	-0.625	0.155	0.000
edu_somecol	-0.262	0.142	0.065
white	0.612	0.333	0.066
black	-0.878	0.384	0.022
oriental	-0.817	0.510	0.109
hispanic	0.371	0.303	0.220
east	-0.377	0.206	0.067
central	-2.208	0.181	0.000
south	-3.856	0.170	0.000
Q1	0.438	0.093	0.000
Q2	-0.334	0.093	0.000
Q3	0.461	0.098	0.000
lnl1adv	0.022	0.142	0.877

_cons	-44.195	2.439	0.000
sigma_u	7.778	0.041	0.000
sigma_e	10.661	0.014	0.000
rho	0.347	0.003	
pseudo R2	0.070		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP08	-11.263	0.158	0.000	-8.124	0.112	0.000
lnP09	0.729	0.136	0.000	0.526	0.098	0.000
lnP15	0.882	0.093	0.000	0.636	0.067	0.000
lnP17	0.367	0.086	0.000	0.265	0.062	0.000
lnPcf	0.204	0.104	0.049	0.147	0.075	0.049
lnPn	-0.405	0.081	0.000	-0.292	0.058	0.000
lnPp	0.283	0.064	0.000	0.204	0.046	0.000
lnhhinc	0.623	0.056	0.000	0.449	0.040	0.000
hhsize1	-1.533	0.194	0.000	-1.106	0.140	0.000
hhsize2	-0.873	0.183	0.000	-0.630	0.132	0.000
hhsize3	-0.473	0.174	0.007	-0.341	0.126	0.007
hhsize4	-0.030	0.160	0.854	-0.021	0.116	0.854
child05	-0.117	0.165	0.476	-0.085	0.119	0.476
child612	-0.168	0.130	0.196	-0.121	0.094	0.196
child1317	0.109	0.122	0.373	0.078	0.088	0.373
age_2535	-0.333	0.769	0.665	-0.240	0.555	0.665
age_3545	-0.672	0.760	0.377	-0.485	0.549	0.377
age_4565	-0.835	0.758	0.271	-0.602	0.547	0.271
age_ovr65	-0.800	0.759	0.292	-0.577	0.548	0.292
edu_lesshs	-0.632	0.185	0.001	-0.456	0.133	0.001
edu_hs	-0.343	0.085	0.000	-0.247	0.061	0.000
edu_somecol	-0.144	0.078	0.065	-0.104	0.056	0.065
white	0.336	0.182	0.066	0.242	0.132	0.066
black	-0.482	0.211	0.022	-0.347	0.152	0.022
oriental	-0.448	0.280	0.109	-0.323	0.202	0.109
hispanic	0.204	0.166	0.220	0.147	0.120	0.220
east	-0.207	0.113	0.067	-0.149	0.082	0.067

central	-1.211	0.099	0.000	-0.874	0.072	0.000
south	-2.116	0.094	0.000	-1.526	0.068	0.000
Q1	0.240	0.051	0.000	0.173	0.037	0.000
Q2	-0.183	0.051	0.000	-0.132	0.037	0.000
Q3	0.253	0.054	0.000	0.182	0.039	0.000
lnl1adv	0.012	0.078	0.877	0.009	0.056	0.877

Variables	Unconditional Elasticities	Conditional Elasticities
P08	-3.983	-0.231
P09	0.258	0.015
P15	0.312	0.018
P17	0.130	0.008
Pcf	0.072	0.004
Pn	-0.143	-0.008
Pp	0.100	0.006
hhinc	0.220	0.013
l1adv	0.004	0.000

11- Grated cheese

Variable	Coefficient	Standard Error	p- value
lnP08	3.969	0.491	0.000
lnP09	-26.263	0.288	0.000
lnP15	2.504	0.253	0.000
lnP17	0.431	0.234	0.065
lnPcf	0.974	0.281	0.001
lnPn	0.829	0.225	0.000
lnPp	2.030	0.176	0.000
lnhhinc	0.704	0.153	0.000
hhsize1	-9.896	0.521	0.000
hhsize2	-4.848	0.488	0.000
hhsize3	-2.635	0.464	0.000
hhsize4	-1.015	0.425	0.017
child05	-1.088	0.442	0.014
child612	-0.009	0.347	0.979
child1317	0.461	0.326	0.158
age_2535	0.332	2.100	0.874
age_3545	-0.462	2.077	0.824
age_4565	-1.973	2.070	0.340
age_ovr65	-2.790	2.074	0.178
edu_lesshs	-0.229	0.499	0.646
edu_hs	-0.104	0.232	0.654
edu_somecol	0.111	0.215	0.607
white	2.506	0.501	0.000
black	-3.976	0.587	0.000
oriental	-2.940	0.788	0.000
hispanic	0.263	0.452	0.560
east	3.911	0.319	0.000
central	-0.088	0.271	0.746
south	-0.107	0.264	0.687
Q1	-0.106	0.234	0.652
Q2	-1.767	0.216	0.000
Q3	-1.019	0.176	0.000
lnadv	0.592	0.269	0.028

lnl2adv	0.849	0.335	0.011
lnl3adv	0.780	0.417	0.061
_cons	-49.855	8.402	0.000
sigma_u	11.311	0.083	0.000
sigma_e	15.135	0.060	0.000
rho	0.358	0.004	
pseudo R2	0.119		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP08	0.754	0.093	0.000	0.845	0.105	0.000
lnP09	-4.990	0.063	0.000	-5.592	0.063	0.000
lnP15	0.476	0.048	0.000	0.533	0.054	0.000
lnP17	0.082	0.044	0.065	0.092	0.050	0.065
lnPcf	0.185	0.053	0.001	0.207	0.060	0.001
lnPn	0.158	0.043	0.000	0.177	0.048	0.000
lnPp	0.386	0.034	0.000	0.432	0.038	0.000
lnhhinc	0.134	0.029	0.000	0.150	0.033	0.000
hhsize1	-1.880	0.100	0.000	-2.107	0.111	0.000
hhsize2	-0.921	0.093	0.000	-1.032	0.104	0.000
hhsize3	-0.501	0.088	0.000	-0.561	0.099	0.000
hhsize4	-0.193	0.081	0.017	-0.216	0.091	0.017
child05	-0.207	0.084	0.014	-0.232	0.094	0.014
child612	-0.002	0.066	0.979	-0.002	0.074	0.979
child1317	0.088	0.062	0.158	0.098	0.069	0.158
age_2535	0.063	0.399	0.874	0.071	0.447	0.874
age_3545	-0.088	0.395	0.824	-0.098	0.442	0.824
age_4565	-0.375	0.393	0.340	-0.420	0.441	0.340
age_ovr65	-0.530	0.394	0.178	-0.594	0.442	0.178
edu_lesshs	-0.044	0.095	0.646	-0.049	0.106	0.646
edu_hs	-0.020	0.044	0.654	-0.022	0.049	0.654
edu_somecol	0.021	0.041	0.607	0.024	0.046	0.607
white	0.476	0.095	0.000	0.534	0.107	0.000
black	-0.756	0.112	0.000	-0.847	0.125	0.000
oriental	-0.559	0.150	0.000	-0.626	0.168	0.000

hispanic	0.050	0.086	0.560	0.056	0.096	0.560
east	0.743	0.061	0.000	0.833	0.068	0.000
central	-0.017	0.051	0.746	-0.019	0.058	0.746
south	-0.020	0.050	0.687	-0.023	0.056	0.687
Q1	-0.020	0.044	0.652	-0.022	0.050	0.652
Q2	-0.336	0.041	0.000	-0.376	0.046	0.000
Q3	-0.194	0.033	0.000	-0.217	0.037	0.000
lnadv	0.113	0.051	0.028	0.126	0.057	0.028
lnl2adv	0.161	0.064	0.011	0.181	0.071	0.011
lnl3adv	0.148	0.079	0.061	0.166	0.089	0.061

Variables	**Unconditional Elasticities**	**Conditional Elasticities**
P08	0.338	0.070
P09	-2.236	-0.463
P15	0.213	0.044
P17	0.037	0.008
Pcf	0.083	0.017
Pn	0.071	0.015
Pp	0.173	0.036
hhinc	0.060	0.012
adv	0.050	0.010
l2adv	0.072	0.015
l3adv	0.066	0.014

12- Specialty/imported cheese

Variable	Coefficient	Standard Error	p- value
lnP08	2.386	0.300	0.000
lnP09	2.075	0.220	0.000
lnP15	-12.716	0.118	0.000
lnP17	0.994	0.134	0.000
lnPcf	1.286	0.167	0.000
lnPn	1.391	0.128	0.000
lnPp	2.048	0.101	0.000
lnhhinc	2.877	0.099	0.000
hhsize1	-1.805	0.343	0.000
hhsize2	-0.415	0.324	0.201
hhsize3	-0.715	0.309	0.021
hhsize4	0.153	0.285	0.590
child05	-0.575	0.292	0.049
child612	-0.863	0.230	0.000
child1317	-0.443	0.217	0.041
age_2535	-0.757	1.390	0.586
age_3545	0.133	1.375	0.923
age_4565	-0.097	1.370	0.943
age_ovr65	-0.042	1.372	0.976
edu_lesshs	-3.529	0.335	0.000
edu_hs	-2.796	0.150	0.000
edu_somecol	-1.277	0.136	0.000
white	0.873	0.315	0.006
black	-3.477	0.371	0.000
oriental	-0.929	0.483	0.054
hispanic	2.936	0.284	0.000
east	-1.583	0.202	0.000
central	-2.605	0.172	0.000
south	-1.858	0.163	0.000
Q1	-1.201	0.120	0.000
Q2	-1.026	0.124	0.000
Q3	-1.061	0.094	0.000
lnl1adv	0.138	0.147	0.351

lnl3adv	0.786	0.240	0.001
_cons	-33.804	3.980	0.000
sigma_u	7.639	0.029	0.000
sigma_e	9.293	0.015	0.000
rho	0.403	0.002	
pseudo R2	0.114		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP08	0.869	0.109	0.000	0.711	0.089	0.000
lnP09	0.756	0.080	0.000	0.618	0.065	0.000
lnP15	-4.632	0.048	0.000	-3.788	0.037	0.000
lnP17	0.362	0.049	0.000	0.296	0.040	0.000
lnPcf	0.468	0.061	0.000	0.383	0.050	0.000
lnPn	0.507	0.047	0.000	0.414	0.038	0.000
lnPp	0.746	0.037	0.000	0.610	0.030	0.000
lnhhinc	1.048	0.037	0.000	0.857	0.030	0.000
hhsize1	-0.657	0.125	0.000	-0.538	0.102	0.000
hhsize2	-0.151	0.118	0.201	-0.124	0.097	0.201
hhsize3	-0.261	0.113	0.021	-0.213	0.092	0.021
hhsize4	0.056	0.104	0.590	0.046	0.085	0.590
child05	-0.210	0.107	0.049	-0.171	0.087	0.049
child612	-0.315	0.084	0.000	-0.257	0.069	0.000
child1317	-0.161	0.079	0.041	-0.132	0.065	0.041
age_2535	-0.276	0.506	0.586	-0.226	0.414	0.586
age_3545	0.048	0.501	0.923	0.040	0.409	0.923
age_4565	-0.035	0.499	0.943	-0.029	0.408	0.943
age_ovr65	-0.015	0.500	0.976	-0.012	0.409	0.976
edu_lesshs	-1.286	0.122	0.000	-1.051	0.100	0.000
edu_hs	-1.019	0.055	0.000	-	0.045	0.000

edu_somecol	-0.465	0.050	0.000	-0.833 -0.380	0.041	0.000
white	0.318	0.115	0.006	0.260	0.094	0.006
black	-1.266	0.135	0.000	-1.036	0.110	0.000
oriental	-0.338	0.176	0.054	-0.277	0.144	0.054
hispanic	1.069	0.104	0.000	0.875	0.085	0.000
east	-0.577	0.073	0.000	-0.471	0.060	0.000
central	-0.949	0.063	0.000	-0.776	0.051	0.000
south	-0.677	0.060	0.000	-0.553	0.049	0.000
Q1	-0.437	0.044	0.000	-0.358	0.036	0.000
Q2	-0.374	0.045	0.000	-0.306	0.037	0.000
Q3	-0.387	0.034	0.000	-0.316	0.028	0.000
lnl1adv	0.050	0.054	0.351	0.041	0.044	0.351
lnl3adv	0.286	0.087	0.001	0.234	0.072	0.001

Variables	**Unconditional Elasticities**	**Conditional Elasticities**
P08	0.283	0.042
P09	0.246	0.036
P15	-1.508	-0.224
P17	0.118	0.017
Pcf	0.153	0.023
Pn	0.165	0.024
Pp	0.243	0.036
hhinc	0.341	0.051
l1adv	0.016	0.002
l3adv	0.093	0.014

13- Shredded cheese

Variable	Coefficient	Standard Error	p- value
lnP08	1.217	0.988	0.218
lnP09	-1.743	0.688	0.011
lnP15	2.711	0.480	0.000
lnP17	-16.162	0.377	0.000
lnPcf	-3.837	0.516	0.000
lnPn	0.969	0.407	0.017
lnPp	0.271	0.324	0.404
lnhhinc	5.015	0.469	0.000
hhsize1	-38.558	1.646	0.000
hhsize2	-20.992	1.556	0.000
hhsize3	-12.447	1.482	0.000
hhsize4	-4.518	1.366	0.001
child05	-2.873	1.405	0.041
child612	0.295	1.102	0.789
child1317	6.290	1.036	0.000
age_2535	-2.406	6.601	0.715
age_3545	-5.513	6.528	0.398
age_4565	-15.468	6.504	0.017
age_ovr65	-29.942	6.516	0.000
edu_lesshs	-4.106	1.564	0.009
edu_hs	1.749	0.721	0.015
edu_somecol	2.052	0.665	0.002
white	8.318	1.564	0.000
black	-7.104	1.797	0.000
oriental	-16.627	2.414	0.000
hispanic	-8.009	1.426	0.000
east	-8.321	0.946	0.000
central	13.131	0.819	0.000
south	5.317	0.769	0.000
Q1	-1.796	0.405	0.000
Q2	-4.792	0.372	0.000
Q3	-4.524	0.304	0.000
lnadv	0.867	0.462	0.061

lnl2adv	1.723	0.576	0.003
lnl3adv	1.360	0.720	0.059
_cons	-92.383	16.190	0.000
sigma_u	42.365	0.222	0.000
sigma_e	34.135	0.077	0.000
rho	0.606	0.003	
pseudo R2	0.129		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP08	0.594	0.482	0.218	0.445	0.361	0.218
lnP09	-0.851	0.336	0.011	-0.637	0.251	0.011
lnP15	1.323	0.234	0.000	0.991	0.175	0.000
lnP17	-7.889	0.187	0.000	-5.909	0.139	0.000
lnPcf	-1.873	0.252	0.000	-1.403	0.189	0.000
lnPn	0.473	0.199	0.017	0.354	0.149	0.017
lnPp	0.132	0.158	0.404	0.099	0.119	0.404
lnhhinc	2.448	0.229	0.000	1.833	0.172	0.000
hhsize1	-18.820	0.806	0.000	-14.097	0.605	0.000
hhsize2	-10.246	0.760	0.000	-7.675	0.570	0.000
hhsize3	-6.075	0.723	0.000	-4.551	0.542	0.000
hhsize4	-2.205	0.667	0.001	-1.652	0.499	0.001
child05	-1.402	0.686	0.041	-1.050	0.514	0.041
child612	0.144	0.538	0.789	0.108	0.403	0.789
child1317	3.070	0.506	0.000	2.300	0.379	0.000
age_2535	-1.175	3.222	0.715	-0.880	2.413	0.715
age_3545	-2.691	3.186	0.398	-2.015	2.387	0.398
age_4565	-7.550	3.175	0.017	-5.655	2.378	0.017
age_ovr65	-14.615	3.181	0.000	-10.947	2.383	0.000
edu_lesshs	-2.004	0.764	0.009	-1.501	0.572	0.009
edu_hs	0.854	0.352	0.015	0.640	0.264	0.015
edu_somecol	1.002	0.325	0.002	0.750	0.243	0.002
white	4.060	0.764	0.000	3.041	0.572	0.000
black	-3.468	0.877	0.000	-2.597	0.657	0.000

oriental	-8.115	1.179	0.000	-6.079	0.883	0.000
hispanic	-3.909	0.696	0.000	-2.928	0.522	0.000
east	-4.061	0.462	0.000	-3.042	0.346	0.000
central	6.409	0.400	0.000	4.801	0.300	0.000
south	2.595	0.375	0.000	1.944	0.281	0.000
Q1	-0.877	0.197	0.000	-0.657	0.148	0.000
Q2	-2.339	0.182	0.000	-1.752	0.136	0.000
Q3	-2.208	0.148	0.000	-1.654	0.111	0.000
lnadv	0.423	0.226	0.061	0.317	0.169	0.061
lnl2adv	0.841	0.281	0.003	0.630	0.211	0.003
lnl3adv	0.664	0.351	0.059	0.497	0.263	0.059

Variables	Unconditional Elasticities	Conditional Elasticities
P08	0.029	0.011
P09	-0.041	-0.016
P15	0.064	0.025
P17	-0.380	-0.147
Pcf	-0.090	-0.035
Pn	0.023	0.009
Pp	0.006	0.002
hhinc	0.118	0.046
adv	0.020	0.008
l2adv	0.040	0.016
l3adv	0.032	0.012

14- Cottage cheese

Variable	Coefficient	Standard Error	p- value
lnP08	1.156	1.073	0.281
lnP09	-2.582	0.749	0.001
lnP15	-0.410	0.512	0.423
lnP17	0.589	0.448	0.188
lnPcf	-33.328	0.475	0.000
lnPn	-0.372	0.433	0.390
lnPp	1.797	0.337	0.000
lnhhinc	1.886	0.514	0.000
hhsize1	-16.943	1.836	0.000
hhsize2	-6.793	1.740	0.000
hhsize3	-4.786	1.662	0.004
hhsize4	-2.102	1.536	0.171
child05	-3.749	1.583	0.018
child612	-4.284	1.241	0.001
child1317	-5.285	1.164	0.000
age_2535	-1.056	7.497	0.888
age_3545	1.438	7.414	0.846
age_4565	7.146	7.386	0.333
age_ovr65	14.510	7.397	0.050
edu_lesshs	-6.289	1.701	0.000
edu_hs	-3.586	0.793	0.000
edu_somecol	-1.592	0.732	0.030
white	8.715	1.730	0.000
black	-13.728	2.012	0.000
oriental	-9.744	2.674	0.000
hispanic	-1.997	1.570	0.204
east	-12.919	1.027	0.000
central	-4.108	0.888	0.000
south	-13.362	0.838	0.000
Q1	3.441	0.286	0.000
Q2	4.256	0.267	0.000
Q3	4.797	0.327	0.000
lnadv	2.416	0.495	0.000

lnl2adv	1.918	0.544	0.000
_cons	-114.504	13.732	0.000
sigma_u	46.282	0.163	0.000
sigma_e	33.804	0.047	0.000
rho	0.652	0.002	
pseudo R2	0.066		

	Unconditional marginal effects			Conditional marginal effects		
Variables	**dy/dx**	**Standard Error**	**p-value**	**dy/dx**	**Standard Error**	**p-value**
lnP08	0.713	0.662	0.281	0.507	0.471	0.281
lnP09	-1.593	0.462	0.001	-1.133	0.329	0.001
lnP15	-0.253	0.316	0.423	-0.180	0.225	0.423
lnP17	0.363	0.276	0.188	0.258	0.196	0.188
lnPcf	-20.560	0.297	0.000	-14.624	0.212	0.000
lnPn	-0.229	0.267	0.390	-0.163	0.190	0.390
lnPp	1.109	0.208	0.000	0.788	0.148	0.000
lnhhinc	1.164	0.317	0.000	0.828	0.226	0.000
hhsize1	-10.452	1.132	0.000	-7.434	0.806	0.000
hhsize2	-4.190	1.073	0.000	-2.980	0.764	0.000
hhsize3	-2.953	1.025	0.004	-2.100	0.729	0.004
hhsize4	-1.297	0.948	0.171	-0.922	0.674	0.171
child05	-2.313	0.977	0.018	-1.645	0.695	0.018
child612	-2.643	0.766	0.001	-1.880	0.545	0.001
child1317	-3.260	0.718	0.000	-2.319	0.511	0.000
age_2535	-0.652	4.625	0.888	-0.463	3.289	0.888
age_3545	0.887	4.573	0.846	0.631	3.253	0.846
age_4565	4.408	4.556	0.333	3.135	3.241	0.333
age_ovr65	8.951	4.563	0.050	6.367	3.246	0.050
edu_lesshs	-3.880	1.049	0.000	-2.760	0.746	0.000
edu_hs	-2.212	0.489	0.000	-1.573	0.348	0.000
edu_somecol	-0.982	0.451	0.030	-0.698	0.321	0.030
white	5.376	1.067	0.000	3.824	0.759	0.000
black	-8.469	1.241	0.000	-6.023	0.883	0.000
oriental	-6.011	1.650	0.000	-4.276	1.173	0.000
hispanic	-1.232	0.969	0.204	-0.876	0.689	0.204

east	-7.970	0.633	0.000	-5.669	0.451	0.000
central	-2.534	0.548	0.000	-1.802	0.390	0.000
south	-8.243	0.516	0.000	-5.863	0.368	0.000
Q1	2.123	0.177	0.000	1.510	0.126	0.000
Q2	2.626	0.165	0.000	1.867	0.117	0.000
Q3	2.959	0.202	0.000	2.105	0.144	0.000
lnadv	1.490	0.305	0.000	1.060	0.217	0.000
lnl2adv	1.183	0.335	0.000	0.841	0.239	0.000

Variables	Unconditional Elasticities	Conditional Elasticities
P08	0.029	0.008
P09	-0.065	-0.018
P15	-0.010	-0.003
P17	0.015	0.004
Pcf	-0.834	-0.226
Pn	-0.009	-0.003
Pp	0.045	0.012
hhinc	0.047	0.013
adv	0.060	0.016
l2adv	0.048	0.013

VITA

Name:	Yasser Bouhlal
Address:	Department of Agricultural Economics, Office 388 AGLS Building, Texas A&M University, College Station, TX 77843-2124
Email:	yasserbouhlal@gmail.com
Education:	Ph.D., Agricultural Economics, Texas A&M University, 2012
	M.S., Food Marketing, Mediterranean Agronomic Institute of Zaragoza, 2005
	B.A., Food Engineering, Institut Agronomique et Vétérinaire Hassan II, 2003