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Abstract

A two-step sample selection model is used to estimate household demand equations for fluid milk and cheese products incorporating national generic advertising. This approach allows us to disentangle the incidence of the advertising effect on the probability of purchase and changes in the level of consumption. Generic advertising for fluid milk had a predominantly intensive effect on at-home fluid milk demand, implying that advertising was relatively more effective at increasing the consumption of current consumers. Conversely, the at-home cheese demand response to generic cheese advertising was almost exclusively extensive, with virtually the entire increase in quantity demanded due to an increase in the household's probability of purchase.

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Executive Summary

U.S. dairy producers and milk processors contribute substantial dollars each year to fund national generic advertising programs for fluid milk and cheese. Producers, marketers, and legislators are all uniquely interested in whether generic advertising increases consumer demand for dairy products. The household approach followed here allowed us to estimate the relative effectiveness of these programs on increasing at-home consumption of fluid milk and cheese products. In addition, the two-stage estimation procedure allowed us to decompose the total effect of generic advertising on household demand into its extensive (probability of purchase) and intensive (level of consumption) components. This is particularly important when evaluating advertising programs to determine to whom the message has been successfully delivered, new or current consumers.

In general, long-run generic advertising elasticities were positive and significant for all milk products. The generic advertising message appears to have a predominantly intensive effect. For total fluid milk, the unconditional long-run advertising elasticity was 0.081, 88% of which can be attributed to increasing the demand for milk from current consumers, while only 12% can be attributed to increasing the probability of households to purchase. This is consistent across all categories, with reduced fat (0.081) and skim milk (0.082) showing the largest relative response from the generic campaign, followed closely by whole (0.074) and light milk (0.072).

Generic cheese advertising also had a positive, significant effect on cheese demand. The total long-run cheese advertising elasticity was estimated to be 0.024; however, the entire amount of this was realized from the extensive margin. That is, cheese advertising appears to be effective at increasing the probability of purchase, but has no significant effect on increasing the demand of current consumers. This is consistent across all cheese products in which no conditional demand elasticities were significantly different from zero. The largest contributors to the total cheese result were from Other cheese (0.069) and American cheese (0.063), while the Processed (0.021) and Mozzarella (0.021) advertising elasticities were lower.

It is clear that the fluid milk and cheese generic advertising campaigns are inducing response from different types of consumers. While fluid milk advertising seems most effective at increasing the demand of current consumers, its effect on new buyers is less pronounced. Conversely, the effect that cheese advertising has had on total household demand is clearly from the response of new buyers to the market or from increasing the probability of purchase for U.S. households, not from increasing the consumption of current consumers. Information such as this provides valuable information to dairy product marketers in developing future advertising campaigns with respect to their target audience.

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Introduction

Since 1984, U.S. dairy producers have contributed $0.15 per hundredweight of milk sold to increase the demand for dairy products through generic advertising, promotion, and product research. In 1995, fluid milk processors joined the advertising efforts by enacting processor assessments of $0.20 per hundredweight on fluid milk sales through the MilkPEP program. Combined, these checkoff programs collect more than $300 million annually.

Prior research on the impacts of generic dairy advertising is substantial; however, most studies focus on either national- or state-level response and, accordingly, use aggregated national- or state-level data. Far less empirical work has been done on household-level dairy product demand and the relative effectiveness of a generic advertising message across individual dairy products. While demand analyses involving aggregated or time series data can incorporate responses of consumers to changes in prices, income, advertising, and other exogenous factors in a continuous manner, this is not necessarily so in more disaggregated demand studies where the censored nature of the data needs to be accounted for. In addition, it is useful in understanding complex demand relationships to determine whether overall changes in demand are reflective of intensive responses (a continuous adjustment), extensive responses (a discrete change), or both. As explained in Pudney (p. 138):

> *"… beneath the surface of the aggregate, individuals may make non-marginal changes, switching from one regime to another. In reality there are two distinct types of response involved."*
>
> *"At the* ***intensive*** *margin, consumers of the good are prompted to consume marginally more, …"*
>
> *"However, there is also an* ***extensive*** *margin, where people who were not previously consumers of the good are now induced to purchase it in positive quantities; this type of response is a discrete switch, rather than a smooth adjustment, …"*

This additional information will be important to dairy product marketers in determining whom the advertising message has affected most.

Accordingly, the objectives of this paper are to (1) estimate the household demand for both total and disaggregated fluid milk and cheese products, (2) decompose the total demand effects into their discrete and continuous components, and (3) evaluate the relative effectiveness of the generic advertising across individual milk and cheese products. We proceed with a brief description of the model, followed by a summary of the data used in the empirical application. Next, household demand results are reported via estimated elasticities highlighting the incidence of both types of demand effects. We close with a few summary conclusions and directions for future research.

The Model

One-step decision models, such as the Tobit model, restrict the decision to consume and the decision on the amount to consume to be the same. Haines, Guilkey, and Popkin (1988) argue that food consumption decisions should be modeled as a two-stage decision process where the determinants of each stage may differ. In this application, we adopt a Heckman-style two-stage sample selection model, where the first stage is represented by the dichotomous choice of whether to purchase, and the second stage determines the level of consumption given the decision to consume (Heckman, 1979). From this, we can isolate the intensive and extensive effects from the total quantity effect of the various model regressors.

A second reason for using this type of model has to do with the censored nature of the household data. As Greene notes, ordinary least squares estimation leads to biased parameter estimates since the residuals do not have mean zero, and estimation of demand parameters from only the sub-sample of consuming households may result in inconsistent parameter estimates (pp. 959-962). Two-step sample selection models have been applied to models of food consumption (e.g. Haines, Guilkey, and Popkin, 1988), dairy product demand (e.g. Heien and Wessells, 1988), and household cheese purchases (e.g. Gould and Lin, 1994).

To illustrate, consider the household demand for an individual product *i* as:

$$(1) \quad \begin{bmatrix} z_{it}^* \\ y_{it}^* \end{bmatrix} = \begin{bmatrix} \mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i \\ \mathbf{X}_{\text{it}}\boldsymbol{\beta}_i \end{bmatrix} + \begin{bmatrix} v_{it} \\ u_{it} \end{bmatrix}, \text{ and } \qquad \begin{array}{l} y_{\text{it}} = y_{it}^* \text{ if } z_{it}^* > 0; \text{else } y_{\text{it}} = 0, \\ z_{\text{it}} = 1 \text{ if } z_{it}^* > 0; \text{else } z_{\text{it}} = 0 \,, \end{array}$$

where y_{it}^* and z_{it}^* are the unobserved (latent) variables for product *i*, observation *t*, corresponding to the observed dependent variables y_{it} (the continuous consumption variable) and z_{it} (the binary response variable), respectively; $\mathbf{X}_{\text{it}}$ and $\mathbf{W}_{\text{it}}$ are vectors of exogenous variables relative to the consumption and response equations, respectively; $\boldsymbol{\beta}_i$ and $\boldsymbol{\gamma}_i$ are conformable parameter vectors for product *i*, and u_{it} ~N(0, s_{ui}^2) and v_{it} ~N(0, 1). Since y_{it} is observed when z_{it} is greater than zero, we have a potential sample selection problem since the expected value of the demand equation error term is not zero if the error terms across the equations are correlated (i.e. corr(u_{it},v_{it}) 0). Following Greene (p. 975), we can write the conditional demand as:

$$(2) \quad E[y_{it} \mid \mathbf{X}_{\text{it}}, v_{it} > -\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i] = \mathbf{X}_{\text{it}}\boldsymbol{\beta}_i + r_i s_{ui} \frac{f(\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i)}{\Phi(\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i)},$$

where $f(\cdot)$ and $\Phi(\cdot)$ are the standard normal density and cumulative distribution functions, respectively, and r_i=corr(u_{it}, v_{it}). Defining $b_{li} = r_i s_{ui}$ and the Inverse Mills Ratio (IMR) as $l_{it} = \frac{f(\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i)}{\Phi(\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i)}$, we can rewrite (2) as:

$$(3) \quad E[y_{it} \mid \mathbf{X}_{\text{it}}, v_{it} > -\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i] = \mathbf{X}_{\text{it}}\boldsymbol{\beta}_i + b_{li}\, l_{it} \,.$$

Consistent estimates of $\boldsymbol{\beta}_i$ and b_{li} can be obtained by maximum likelihood (ML) or least squares on the bias-corrected model, conditional on positive purchase observations, as:

(4) $y_{it} \mid \mathbf{X}_{\text{it}}, v_{it} > -\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i = \mathbf{X}_{\text{it}}\boldsymbol{\beta}_i + b_{l\,i}\, l_{it} + e_{it}$.[1]

The presence of sample selection bias can be parametrically tested by evaluating the significance of $b_{l\,i}$. Estimates of the parameter vector $\boldsymbol{\gamma}_i$ are obtained from a probit estimation of the first equation in (1) by ML.[2] The probit model corresponds to a binary choice problem in which the objective is to estimate the probability of response. The parameter estimates of $\boldsymbol{\gamma}_i$ are used to estimate the values of $f(\cdot)$, $\Phi(\cdot)$, and l_{it} for each observation.

Since the error term of the second stage regression is heteroskedastic and the specification uses estimated values of the true first-stage parameters, the usual calculation of the covariance matrix of $\hat{\boldsymbol{\beta}}$ is incorrect. Denoting the log-likelihood of the probit equation as $L_1(\boldsymbol{\gamma})$, and the log-likelihood of the second stage equation as $L_2(\hat{\boldsymbol{\gamma}}, \boldsymbol{\beta})$, we apply the Murphy and Topel (1985) correction procedure to derive the consistent asymptotic covariance matrix of $\hat{\boldsymbol{\beta}}$, say $\mathbf{V}_2^*$, as (Greene, p. 142):

(5) $\mathbf{V}_2^* = \mathbf{V}_2 + \mathbf{V}_2\left[\mathbf{C}\mathbf{V}_1\mathbf{C}' - \mathbf{R}\mathbf{V}_1\mathbf{C}' - \mathbf{C}\mathbf{V}_1\mathbf{R}'\right]\mathbf{V}_2$

where

$\mathbf{V}_1 = \text{Asy. Var}\left[\hat{\gamma}\right] \text{ from } L_1,$

$\mathbf{V}_2 = \text{Asy. Var}\left[\hat{\boldsymbol{\beta}}\right] \text{ from } L_2 \mid \boldsymbol{\gamma},$

$$\mathbf{C} = E\left[\left(\frac{\partial L_1}{\partial \boldsymbol{\beta}}\right)\left(\frac{\partial L_2}{\partial \boldsymbol{\gamma}'}\right)\right], \mathbf{R} = E\left[\left(\frac{\partial L_2}{\partial \boldsymbol{\beta}}\right)\left(\frac{\partial L_1}{\partial \boldsymbol{\gamma}'}\right)\right].$$

By similar derivation of (2), we can express the unconditional demand equation as:

(6) $E(y_{it} \mid \mathbf{X}_{\text{it}}, \mathbf{W}_{\text{it}})) = \left[\Phi\left(\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i\right)\right] \mathbf{X}_{\text{it}}\boldsymbol{\beta}_i + r_i s_{ui} f\left(\mathbf{W}_{\text{it}}\boldsymbol{\gamma}_i\right)$.

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[1] It can be shown that the second-stage error distribution is: $e_{it} \sim N(0, s_{iu}^2(1 - r_i^2 d_{it}(a_{iv})))$, where $a_{iv} = -\mathbf{W}_{\text{it}}\boldsymbol{\gamma}$ and $d_{it}(a_{iv}) = l_{it}(a_{iv})\left[l_{it}(a_{iv}) - a_{iv}\right]$ (Greene, p.975).

[2] The corresponding log likelihood function is (Greene, p. 882): $L_1 = \sum_{z_{it}=0} \ln\left(1 - \Phi\left(\mathbf{W}_{it}\boldsymbol{\gamma}_i\right)\right) + \sum_{z_{it}=1} \ln\left(\Phi\left(\mathbf{W}_{it}\boldsymbol{\gamma}_i\right)\right)$.

Following our focus of decomposing the intensive and extensive effects of household demand, we can derive the probability, conditional, and unconditional elasticities. From the first-stage equation, the probability of purchase can be expressed as

(7) $\Pr[z_{it} = 1] = \Phi(\mathbf{W}_{\mathrm{it}} \boldsymbol{\gamma}_i)$.

The corresponding marginal probability elasticity for a variable, say w^{k}, can be written as:

(8) $$t_{w_i^k} = [f(\mathbf{W}_{it} \boldsymbol{\gamma}_i) \cdot \boldsymbol{\gamma}_{ik}] \cdot \left[\frac{w_{it}^{k}}{\Pr[z_{it} = 1]} \right].$$

The subsequent demand elasticities depend not only on the parameters in the second stage, but also on the parameters from the first stage and the density and distribution values computed from the first stage results. The conditional and unconditional demand elasticities for a change in a variable common to both $\mathbf{X}_{\mathrm{i}}$ and $\mathbf{W}_{\mathrm{i}}$, say x_{k}, can be expressed, respectively, as:

(9) $$h_{x_i^k | y_{it>0}} = [b_{ik} - g_{ik} b_{li} l_{it} (l_{it} + \mathbf{W}_{\mathrm{it}} \boldsymbol{\gamma}_i)] \cdot \left[\frac{x_{it}^{k}}{E[y_{it} \mid \mathbf{X}_{\mathrm{it}}, \mathbf{W}_{\mathrm{it}}, v_{it} > -\mathbf{W}_{\mathrm{it}} \boldsymbol{\gamma}_i]} \right]$$

and

(10) $$h_{x_{i\,i}^{k}} = [b_{ik} \Phi(\mathbf{W}_{\mathrm{it}} \boldsymbol{\gamma}_i) + g_{ik} f(\mathbf{W}_{\mathrm{it}} \boldsymbol{\gamma}_i)(\mathbf{X}_{\mathrm{it}} \boldsymbol{\beta}_i) - g_{ik} b_{li} f(\mathbf{W}_{it} \boldsymbol{\gamma}) \mathbf{W}_{it} \boldsymbol{\gamma}_i] \cdot \left[\frac{x_{it}^{k}}{E[y_{it} \mid \mathbf{X}_{\mathrm{it}}, \mathbf{W}_{it}]} \right].$$

The significance of the elasticities can be determined by computing standard errors of the elasticities using the delta method (Greene, p. 278).

The Data

Fluid milk and cheese purchase data for at-home consumption and annual household demographic data were obtained from the ACNielsen Homescan Panel sample of U.S. households from January 1996 through December 1999.[3] The dairy product purchase data is purchase-occasion data where households use hand-held scanners to record food purchase

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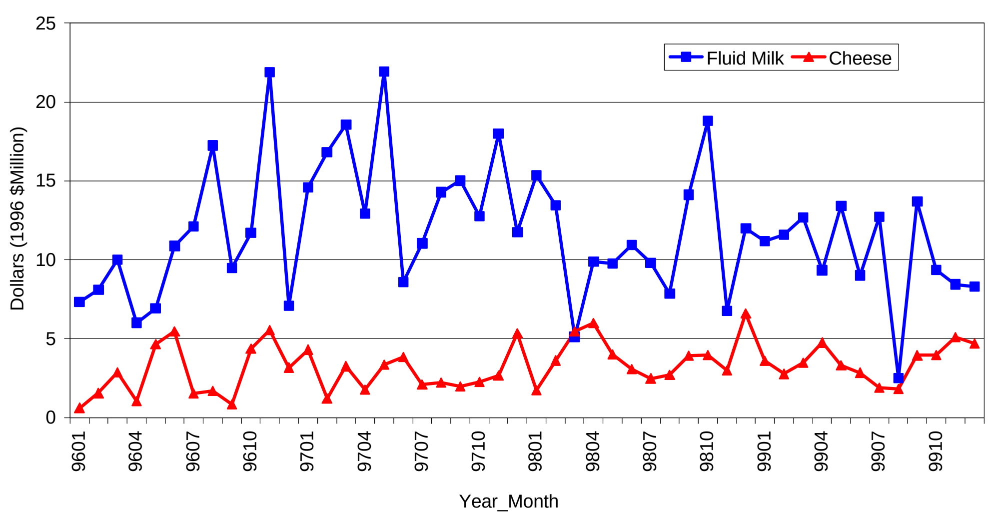
information including date of purchase, UPC code, total expenditure, and quantities purchased. Along with this, sample households submit annual demographic information.

To allow for estimation using all households in the final sample, purchase and advertising data was aggregated to a monthly basis. In addition, Clark (1976) recommends the use of monthly data in most situations to avoid “data interval bias” in the estimation of advertising effects. Monthly demand models also permitted expected inventory effects to be minimal, which were therefore ignored in the final demand estimation.

National generic fluid milk and cheese advertising expenditures were merged with the household data, aggregated across media type. As such, the advertising data varied across time, but not across households. Levels of generic advertising expenditures for the fluid milk and cheese campaigns are illustrated in Figure 1. While generic fluid milk advertising had considerably larger expenditure levels (average monthly expenditures for fluid milk was $11.7 million versus $3.3 million for cheese), the coefficient of variation (CV) was somewhat larger for cheese (CV_{cheese} = 0.45 versus CV_{milk} = 0.36), and the peaks and troughs in expenditures do not necessarily coincide.

Figure 1. Generic Advertising Expenditures by Month



There is vast empirical evidence suggesting that both current and lagged advertising affect current demand and that the response exhibits a hump-shaped lag distribution. As in previous research, the advertising effect in the household demand equations is modeled as a polynomial distributed lag (PDL), with end-point restrictions equal to zero (e.g. Liu et al., 1990; Suzuki et al., 1994; Kaiser, 1999). This structure requires the estimation of only one parameter and represents the quadratic PDL parameter on the lag-weighted advertising variable. In general notation, the PDL structure with end-point restrictions can be written as:

$$(11) \quad y_t = a + \sum_{i=0}^{L} b_i ADV_{t-i} + e_t$$

subject to:

$$b_i = l_0 + l_1 i + l_2 i^2$$

$$b_{-1} = b_{L+1} = 0,$$

where L is the total lag length and all other variables are suppressed into a, for notational convenience. After substituting, (11) simplifies to:

$$(12) \quad y_t = a + l_2 ADV_t^* + e_t$$

where,

$$ADV_t^* = \sum_{i=0}^{L} (i^2 - Li - (L+1)) ADV_{t-i}.$$

Generic advertising is included in all milk and cheese models with a six-month PDL structure. Alternative lag lengths were evaluated based on previous generic advertising studies for dairy products (e.g. Kaiser, 1999; Lenz et al., 1998) and the final lag selection was based on overall goodness of fit. In addition, the six-month lag length is well within the boundaries established by Clarke (1976), who concluded that 90% of the cumulative effects of advertising for frequently purchased products are captured within three to nine months. The advertising parameter estimated represents the quadratic PDL parameter as illustrated above, from which long-run advertising effects can be computed.[4]

The number of households participating in the ACNielsen panel ranged from 29,290 to 33,508 over the four-year sample period. In order to track household purchase decisions and the impact of advertising over the entire sample period, only those households that were included in the sample each year were retained. This reduced the sample households to 21,765. While this may be a source of sample selection, it is necessary to track advertising response across the entire sample profile. The estimation is also simplified by reducing the sample size through imposition of a minimum purchase requirement. Intuitively, this elimination was done to retain only those households that were "potential" customers in the fluid milk and cheese markets. Households were retained that had, on average, at least six purchase occasions each year. This had a relatively minor impact on the final sample, reducing the milk (cheese) households to 20,452 (19,167). The data also include weight projection factors to make the analysis representative of the U.S. household population.

Fluid milk was disaggregated into four sub-categories: whole, reduced fat (2%), light (0.5%-1%), and skim milk. Total at-home milk consumption averaged approximately 16 gallons per capita (gpc), and decreased slightly over the sample period (Table 1). The trend is similar to national disappearance statistics, but the level is below the national average for beverage milk consumption (excluding buttermilk), which for 1997 was 24 gpc (USDA, 1999). However, the household data does not contain any fluid milk consumed outside of the home (e.g. restaurants), or used in school lunch and related programs, which would be accounted for by the USDA estimate using disappearance data. Reduced fat milk was the most common product, followed

[4] If desired, the individual lag advertising parameters can be recovered from the estimated value of l_2; i.e. $b_i = l_2(i^2 - \mathrm{L}i - (\mathrm{L}+1))$. Also since $(i^2 - \mathrm{L}i - (\mathrm{L}+1)) < 0 \ \forall\ i$, the sign$(b_i) = -sign(l_2)\ \forall\ i$.

Table 1. Average consumption, prices, and coupon use, by year.[†]

Variable	1996	1997	1998	1999
Consumption				
Milk (gallons per capita)				
All Milk	16.1	16.0	15.6	15.4
Whole Milk	3.2	3.1	3.0	2.9
Reduced Fat Milk	5.8	5.5	5.3	5.3
Light Milk	2.8	2.9	2.8	2.7
Skim Milk	4.1	4.3	4.3	4.2
Cheese (pounds per capita)				
All Cheese	9.9	10.4	10.3	10.3
American	2.1	2.2	2.3	2.3
Mozzarella	1.1	1.2	1.1	1.1
Processed	3.9	4.0	4.0	3.9
Other cheese	2.8	3.0	2.9	3.0
Net Prices Paid[††]				
Milk ($/gallon)				
All Milk	2.76	2.69	2.77	2.92
Whole Milk	2.92	2.86	2.98	3.11
Reduced Fat Milk	2.68	2.61	2.70	2.84
Light Milk	2.74	2.65	2.76	2.90
Skim Milk	2.84	2.77	2.80	2.95
Cheese ($/pound)				
All Cheese	3.20	3.17	3.22	3.31
American	3.40	3.36	3.39	3.47
Mozzarella	3.47	3.44	3.44	3.53
Processed	2.96	2.87	2.88	2.93
Other cheese	3.53	3.54	3.65	3.76
Proportion of Purchase Months where Coupon is Used				
Milk				
All Milk	0.04	0.05	0.05	0.04
Whole Milk	0.02	0.02	0.02	0.02
Reduced Fat Milk	0.04	0.04	0.04	0.04
Light Milk	0.03	0.04	0.04	0.03
Skim Milk	0.03	0.04	0.04	0.04
Cheese				
All Cheese	0.19	0.19	0.16	0.16
American	0.14	0.14	0.11	0.10
Mozzarella	0.12	0.13	0.13	0.11
Processed	0.13	0.11	0.10	0.12
Other cheese	0.14	0.16	0.13	0.12

[†] Mean statistics weighted by household national projection factors included in the ACNielsen data.
[††] Gross price less coupon value, constant 1996 dollars, milk price deflated by the U.S. CPI for nonalcoholic beverages, cheese price deflated by U.S. CPI for fats and oils. Mean prices and coupon use calculated for purchase observations

by skim and then whole and light milk. The proportion of households that were regular (common) consumers of the various fluid milk products were: total milk, 88% (97%); whole, 12% (18%); reduced fat, 28% (39%), light, 13% (19%); and skim milk, 24% (32%).[5]

Average at-home cheese consumption was approximately 10 pounds per capita (ppc), and after a small increase in 1997 has been relatively stable since. Again, this is below the USDA estimate of aggregate cheese consumption, which for 1997 was 28 ppc. However, the USDA estimate accounts for all cheese consumption, both within and outside the home; and including cheese contained in commercially manufactured and prepared foods. This non-home component has been estimated to account for two-thirds of total cheese consumption (USDA, 1999). Given this, the ACNielsen consumption data is consistent with USDA consumption projections. Since generic cheese advertising is predominantly aimed at home consumption of cheese, our household-level data is more appropriate for this analysis.

Cheese was disaggregated into American, Mozzarella, Processed, and Other cheese categories.[6] Processed cheese had the highest average consumption, followed by Other cheese and American. Mozzarella was a distant fourth. The proportion of households that were regular (common) at-home consumers of total cheese was lower than that for fluid milk, approximately 62% (93%). The specific product proportions were considerably lower: American, 8% (26%); Mozzarella, 2% (10%); Processed, 14% (38%); and Other, 13% (42%). The fact that the sum of household proportions of the disaggregate products is considerably lower than the aggregate product indicates a high degree of multiple (although infrequent) product type purchasing households.

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[5] Regular (common) consuming households are defined as households that purchased, on average, at least ten (six) months per year.
[6] The Other cheese category contains numerous varieties, including Ricotta, Muenster, Farmers, brick, and cream cheese.

Net prices were calculated as total gross monthly expenditures for the particular product, less any coupon value redeemed, divided by the quantity purchased.[7] For those months in which households did not purchase, no price data is available and the average Dominant Market Area (DMA) price paid by purchasing households was used.[8] In 1999, the average price paid for total fluid milk was $2.92 per gallon and the average price paid for total cheese was $3.31 per pound (Table 1). Milk prices were highest for whole milk, followed by skim, light, and then reduced fat. As expected, the highest average cheese prices were for Mozzarella and Other cheese, followed by American, and then Processed cheese. Coupon use proportions show little use for milk (2-5%), but considerably higher for cheese (10-19%), and reflect either store or manufacturer coupons redeemed.

Weighted average household demographic statistics for the total fluid milk and cheese data files for 1999 are included in Table 2. The average household size compares favorably with the 1998 U.S. Census estimate of 2.61.[9] These households were predominantly adult and middle-aged; i.e. the age of the household head was approximately 51 years and over 60% of household members were between the ages of 18 and 64.[10] Average total household pretax income is slightly below the U.S. Census 1996 estimate of $47,123.[11] Approximately one-quarter of the households had a four-year college education and nearly one-half contained

[7] Milk (Cheese) expenditures are converted to constant 1996 dollars using the U.S. CPI for nonalcoholic beverages (U.S. CPI for fats and oils).
[8] Other non-purchase price assumptions are available in the literature. For example, Cox and Wohlgenant (1986) introduce an auxiliary regression approach to account for quality differences across commodities and Dong et al. (1998) extends this approach to a simultaneous estimation procedure. We leave this direction for future research.
[9] U.S. Census reference: http://www.census.gov/population/estimates/housing/stuhh1.txt.
[10] The age of the household head is based on the age of the female household head, the presumed member making household purchase decisions. In the case that no female household head exists, the male household head is used. The female household head characteristic is also used for classification of the education and race variables.
[11] Household income was converted to current 1996 dollars by the U.S. CPI for all items. Original income data is categorical in nature. The income data was converted to a continuous variable by using mid-point levels for the income categories. U.S. Census reference: http://www.census.gov/hhes/income/histic/h05.html.

"working moms".[12] Decomposition by race shows that roughly 82% of the households were White, 10% Black, 1% Asian, and 7% Spanish. The racial composition is similar to Census projections; however, Asian and Black households were slightly under-represented.[13]

Table 2. Descriptive household statistics for fluid milk and cheese, 1999.†

	Fluid Milk		Cheese	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Household Size	2.47	1.40	2.56	1.40
Income, $000 ††	44.5	34.4	45.2	34.5
Age of Household Head	50.3	15.3	49.9	15.2
"Mom" Works	0.48	0.52	0.48	0.52
College Education	0.26	0.45	0.25	0.45
Young (<35) & Single	0.02	0.15	0.02	0.14
Double Income/No Children	0.08	0.28	0.09	0.29
Metropolitan Location	0.80	0.42	0.79	0.42
Household Age Composition:				
Proportion 0-12	0.11	0.20	0.11	0.21
Proportion 13-17	0.05	0.13	0.05	0.14
Proportion >65	0.21	0.39	0.20	0.38
Race:				
Black	0.09	0.30	0.08	0.29
Asian	0.01	0.08	0.01	0.07
Hispanic	0.07	0.26	0.07	0.27
Geographic Regions:				
North East	0.05	0.22	0.05	0.22
Mid-Atlantic	0.17	0.39	0.17	0.39
South Atlantic	0.16	0.38	0.16	0.38
East South Central	0.08	0.29	0.08	0.28
East North Central	0.18	0.40	0.18	0.40
West North Central	0.05	0.22	0.05	0.22
West South Central	0.11	0.33	0.12	0.33
Mountain	0.07	0.26	0.07	0.26
Generic Advertising ($ mill)*	10.19	3.10	3.51	1.05

† Mean statistics weighted by household national projection factors included in the ACNielsen data.
†† Constant 1996 dollars, income deflated by the U.S. CPI for all consumers.
* Monthly average, constant 1996 dollars, deflated by the Media Cost Index.

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[12] The working mom binary variable is equal to one if the following holds (else zero): "The female household head works at least 30 hours outside of the home, or, if there is no female household head, then the male household head works at least 30 hours per week."
[13] U.S. Census reference: http://www.census.gov/population/projection/nation/hh-fam/table4n.txt.

Estimation Results

Following the general structure of equation (1), two-stage sample selection models were estimated for aggregated fluid milk and cheese, as well as for the individual product classes, assuming a constant *iid* variance structure. Single-equation models were estimated rather than treating the individual product categories as a simultaneous system. Lack of data on household purchases in addition to fluid milk and cheese prevents demand system estimation unless one assumes that the fluid milk and cheese products are at least a weakly separable commodity group. Furthermore, simultaneous equation procedures may have a minimal impact if, as Bronsard and Salvas-Bronsard (1984) suggest, price endogeneity is relatively unimportant in demand system estimation when the commodities in question constitute a small portion of the consumer budget.

Net price, household income, household size, and generic advertising are the basic exogenous variables included in the demand models. However, milk and cheese products can be purchased in different package sizes (e.g. quart or gallon) and at different store types (e.g. grocery, convenience, or mass merchandise), with substantial variation in per unit prices. In order to separate these components from the "real" price effect, we include variables that account for the proportion of monthly purchases in various package sizes and store types.[14] To account for differences in household composition, age of the household head and the proportion of family members aged 0-12, 13-17, and over 65 were also included. To avoid singularity in the regressor matrix, the proportion of household members aged 18 to 64 was excluded. Price, income and

[14] Specifically, variables reflecting the proportion of monthly purchases (by volume) made in quart or smaller containers, in half-gallon containers, and in convenience stores were included for milk. Variables reflecting the proportion of monthly purchases made in half-pound or less packages, one-pound packages, and in mass merchandise/super centers were included for cheese. While the proportions varied by product, for total milk approximately 10% of purchases were in quart containers or less, 33% were in half-gallon containers, and 8% of purchases were in convenience stores. For total cheese, 46% of purchases were in half-pound packages or less, 41% in pound packages, and 10% of purchases were made in mass merchandise/super centers.

advertising were converted to their square-roots to reflect the diminishing returns characteristic associated with these variables.

Significant race effects on dairy product consumption are well established in the literature, and accordingly we included racial binary variables for Blacks, Asians, and Hispanics. However, it also been hypothesized that the mother's working status can affect household consumption as well (Horton and Campbell, 1991; Yen, 1993). While the income effect of mom working is captured in the household income variable, we expect a negative working mom effect due to less monitoring of children's diets and less time to prepare meals, which increases the proportion of meals eaten outside of the home.

Additional household characteristic binary variables included college education of the household head, young and single household, double income no kid household (DINK), location in a metropolitan area, geographic region, and monthly dummy variables to account for any seasonality in consumption. Preliminary model testing showed little significance of seasonality variables in the first-stage equations and hence these variables were eliminated from the probit models. Also, since no package size or store type proportion exists for non-purchase months, these share variables are included only in the second stage of the model.

For ease of exposition and to focus more on the advertising results, computed average effects of the binary variables are not discussed here. In summary, relatively large significant responses for geographic region, coupon use (positive), Black and Asian households (negative), and working mom households (negative) highlighted the importance of incorporating these factors in the specification of household demand for fluid milk and cheese.[15]

[15] Parameter estimates of the probit and second-stage equations, as well as computed average effects of the binary variables, are available from the authors upon request.

Since the focus of this paper is on the decomposition of the extensive and intensive effects on total demand (particularly for advertising), attention will be directed to the computation of elasticities following equations (8), (9), and (10). Recall that the probability (i.e. stage 1) elasticity represents the percentage change in probability of purchase for a 1% change in the selected variable (i.e. the extensive effect), while the conditional (i.e. stage 2) elasticity represents the percentage change in the quantity demanded, given purchase, for a 1% change in the selected variable (i.e. the intensive effect). The total, or unconditional, elasticity represents the sum of the extensive and intensive effects.

<u>Results: Fluid Milk</u>

Price effects were negative and highly significant for all products (Table 3). Only light milk had a positive conditional price elasticity, but this was not significantly different from zero. The unconditional price elasticity for total milk was -0.173, while the specific categories ranged from –0.529 for skim milk to –0.772 for whole milk. The larger overall price elasticities on the individual products were predominantly due to the contribution from the high probability elasticities. The high first-stage elasticities may reflect product switching across similar products, which would not affect the total milk model estimates. The relatively small conditional price elasticities imply that once the decision to purchase a particular product has been made, price has little effect on the quantity purchased. This seems reasonable given milk's classification as more or less a staple food product.

The product price elasticities are similar to those found by Gould (1996), who estimated household price elasticities for whole, 2%, and skim/1% milk products of –0.80, -0.51, and –0.59, respectively. In the aggregate, it is clear that the intensive price response exceeds that of the extensive component, likely as a result of milk's being a staple and having limited shelf time.

Table 3. Probability, Conditional, and Unconditional Elasticities of Continuous Variables, Milk. †

	Total Milk			Whole Milk			Reduced Fat Milk		
Variable	Probability	Conditional	Unconditional	Probability	Conditional	Unconditional	Probability	Conditional	Unconditional
Price	-0.037 **	-0.136 **	-0.173 **	-0.605 **	-0.167 **	-0.772 **	-0.529 **	-0.128 **	-0.657 **
Income	0.007 **	0.006 **	0.013 **	-0.176 **	-0.027 **	-0.204 **	-0.035 **	-0.004	-0.039 **
Household Size	0.040 **	0.324 **	0.364 **	0.206 **	0.120 **	0.326 **	0.192 **	0.238 **	0.430 **
Age HH Head	0.031 **	0.063	0.094 **	-0.095 **	0.114 **	0.019	0.138 **	0.034	0.172 **
HH Propn Age <13	0.006 **	0.061 **	0.066 **	0.009 **	0.099 **	0.109 **	0.028 **	0.041 **	0.068 **
HH Propn Age 13-17	0.003 **	0.028 **	0.032 **	-0.019 **	0.013 **	-0.006 **	0.016 **	0.033 **	0.049 **
HH Propn Age >65	0.008 **	0.009	0.016 **	-0.024 **	-0.018 **	-0.042 **	0.019 **	0.004	0.023 **
Propn Quart or Less		-0.108	-0.108 **		-0.207 **	-0.207 **		-0.095 **	-0.095 **
Propn Half Gallon		-0.217	-0.217 **		-0.257 **	-0.257 **		-0.214 **	-0.214 **
Propn Convenience Store		0.009	0.009 **		0.005 **	0.005 **		0.006 **	0.006 **
Advertising Long Run	0.010 **	0.071 **	0.081 **	0.011 **	0.063 **	0.074 **	0.009 **	0.073 **	0.081 **

	Light Milk			Skim Milk		
Variable	Probability	Conditional	Unconditional	Probability	Conditional	Unconditional
Price	-0.563 **	0.027	-0.535 **	-0.522 **	-0.007	-0.529 **
Income	0.035 **	0.020 **	0.179 **	0.188 **	0.015 **	0.203 **
Household Size	0.094 **	0.204 **	0.298 **	-0.068 **	0.166 **	0.099 **
Age HH Head	-0.024 **	-0.059 **	-0.083 **	0.227 **	-0.034 *	0.193 **
HH Propn Age <13	-0.007 **	0.033 **	0.026 **	-0.011 **	0.037 **	0.025 **
HH Propn Age 13-17	0.002 *	0.024 **	0.026 **	-0.003 **	0.023 **	0.020 **
HH Propn Age >65	0.049 **	0.010 **	0.059 **	0.010 **	0.023 **	0.033 **
Propn Quart or Less		-0.080 **	-0.080 **		-0.145 **	-0.145 **
Propn Half Gallon		-0.248 **	-0.248 **		-0.307 **	-0.307 **
Propn Convenience Store		0.013 **	0.013 **		0.001 **	0.001 **
Advertising Long Run	0.014 **	0.058 **	0.072 **	0.016 **	0.066 **	0.082 **

† Evaluated at sample means. Significance is based on standard errors of elasticities calculated using the delta method (Greene, p. 278).

* Significance at the 5% level, ** Significance at the 1% level.

Controlling for container size and purchases made in convenience stores was significant in all product equations. As expected, monthly purchases were lower when milk was purchased in containers of less than a gallon. Increases in the proportion of purchases made at convenience stores appear to have a small positive effect on monthly milk purchases; however, no elasticity was above 0.013.

Income elasticities were relatively high for light and skim milk (0.179 and 0.203, respectively), and surprisingly negative for whole and reduced fat (-0.204 and -0.039, respectively). It certainly appears that as household incomes grow, there is a shift towards lower fat-content milk. While negative income effects for whole milk are not uncommon (e.g. Cornick et al., 1994; Boehm, 1975; Reynolds, 1991), the result for reduced fat category is interesting as it is the next highest fat-content product, although the effect is quite small. The negative and positive results across individual products seem to cancel each other out in the total milk category. In all products, extensive income effects dominated the total effects. Income elasticities are very similar to those estimated by Cornick et al. (1994), as well as Reynolds (1991). Both indicate higher elasticities for whole and skim milk products and relatively high extensive effects.

Except for a small negative extensive effect for skim milk, all other household size effects were positive in both stages. Household size effects are predominantly intensive in total, but extensive effects are larger for the specific products. The results are similar in magnitude to that of Cornick et al. (1994), who also estimated low household size elasticities for skim milk. Age of the household head appears to have a small positive effect in total, but the results vary in sign and significance by product type. The age effects were negative for light milk, while age had no overall effect for the whole milk category. Differences in sign across the individual categories appear to dampen the relatively large positive contributions from the reduced fat and skim milk categories.

Household composition effects indicate a significant, positive effect of children in the household, *ceterus paribus*. Only for the teenager proportion for whole milk is the elasticity negative. With the exception of the small unconditional price elasticity for the proportion of teenagers on the whole milk equation, it is clear that there is a direct correlation between the size of the effect of the proportion of children in the household and fat content of the milk; i.e. as the fat-content of the products decreases, so does the effect of children in the household. The relatively lower teenager elasticity compared with young children seems consistent with the concern of milk marketers that teenagers are turning towards other non-alcoholic beverages as their diet becomes less closely monitored.

The effect of the proportion of older members in the household was also significant in all equations. Relative to the children effect, the effect of older members in the household was lower for the high-fat products, but larger for the low-fat products. This is intuitive, given the higher dietary need of growing children for higher-fat milk products. What is also interesting is that while the children effects were largely intensive, the effect of older members in the household is more of an extensive effect on demand.

Long-run generic advertising elasticities were positive and significant for all milk products. Interestingly, the generic advertising message appears to have a predominantly intensive effect. For total fluid milk, the unconditional long-run advertising elasticity was 0.081, 88% of which can be attributed to increasing the demand for milk from current consumers, while only 12% can be attributed to increasing the probability of households to purchase. This is consistent across all categories, with the largest relative response from the generic campaign shown for reduced fat (0.081) and skim milk (0.082), followed closely by whole (0.074) and light milk (0.072). Whether the results would be similar from a more differentiated campaign is an empirical question and cannot be gleaned from these results; however, the relative similarity in response across all products seems consistent with the generic advertising message.

The all milk advertising elasticity is higher than the 0.051 estimated by Kaiser (1999) using aggregate quarterly disappearance data from 1975-1999, accounting for both at-home and away-from-home consumption. While not directly comparable, if the elasticity reported by Kaiser (1999) can be interpreted as a total, or weighted average effect of at-home and away-from-home consumption, then it may be the case that away-from-home response would be lower than that for at-home consumption. However, an appropriate theoretical framework and empirical application would be necessary before such a conclusion could be reached. In the literature on household milk demand it is rare to find advertising as an explanatory variable. One exception is Reynolds (1991), who used current national Canadian advertising expenditures and estimated considerably higher elasticities for total and whole milk as 0.365 and 1.044, respectively. However, no significant response was found for low fat or skim milk.

Results: Cheese

Price effects for cheese were negative and highly significant for all products in both stages of the decision process (Table 4). The extensive purchase probability effect contributed considerably more towards the unconditional price elasticity for total cheese than what we saw for total milk, and resulted in an overall price elasticity (-0.341) about twice the size exhibited for total milk. Extensive effect contributions were again relatively more important for the individual products, and in the case of American and Mozzarella, were elastic contributions to the total effect on demand. The unconditional price elasticity was lowest for the Processed

Table 4. Probability, Conditional, and Unconditional Elasticities of Continuous Variables, Cheese. †

	Total Cheese			American			Mozzarella		
Variable	Probability	Conditional	Unconditional	Probability	Conditional	Unconditional	Probability	Conditional	Unconditional
Price	-0.157 **	-0.184 **	-0.341 **	-1.027 **	-0.221 **	-1.248 **	-1.235 **	-0.342 **	-1.577 **
Income	0.008 **	0.028 **	0.036 **	0.043 **	0.000	0.042 **	0.065 **	0.023 **	0.087 **
Household Size	0.078 **	0.169 **	0.248 **	0.156 **	0.069 **	0.225 **	0.250 **	0.031 **	0.281 **
Age HH Head	-0.065 **	-0.132 **	-0.196 **	-0.336 **	-0.020 *	-0.356 **	-0.596 **	-0.064 **	-0.661 **
HH Propn Age <13	0.011 **	0.029 **	0.039 **	0.016 **	0.022 **	0.038 **	0.077 **	0.023 **	0.100 **
HH Propn Age 13-17	0.006 **	0.025 **	0.031 **	0.010 **	0.019 **	0.029 **	0.025 **	0.026 **	0.051 **
HH Propn Age >65	0.000	-0.023 **	-0.023 **	0.009 **	-0.016 **	-0.008 **	-0.017 **	-0.010 **	-0.027 **
Propn Half Lb or Less		-0.592 **	-0.592 **		-0.837 **	-0.837 **		-0.943 **	-0.943 **
Propn Lb Package		-0.443 **	-0.443 **		-0.353 **	-0.353 **		-0.400 **	-0.400 **
Propn Mass Merch. Store		0.018 **	0.018 **		0.008 **	0.008 **		0.020 **	0.020 **
Advertising Long Run	0.023 **	0.000	0.024 **	0.062 **	0.001	0.063 **	0.025 **	-0.004	0.021 **

	Processed			Other cheese		
Variable	Probability	Conditional	Unconditional	Probability	Conditional	Unconditional
Price	-0.500 **	-0.113 **	-0.613 **	-0.438 **	-0.289 **	-0.726 **
Income	-0.035 **	-0.045 **	-0.079 **	0.103 **	0.065 **	0.167 **
Household Size	0.198 **	0.125 **	0.323 **	0.112 **	0.070 **	0.182 **
Age HH Head	-0.018 *	-0.010	-0.028 *	-0.044 **	-0.013	-0.057 **
HH Propn Age <13	0.023 **	0.015 **	0.038 **	0.014 **	0.002	0.016 **
HH Propn Age 13-17	0.022 **	0.014 **	0.036 **	0.008 **	0.004 **	0.012 **
HH Propn Age >65	-0.011 **	-0.024 **	-0.036 **	0.002	-0.022 **	-0.020 **
Propn Half Lb or Less		-0.212 **	-0.212 **		-1.463	-1.463 **
Propn Lb Package		-0.823 **	-0.823 **		-0.209	-0.209 **
Propn Mass Merch. Store		0.032 **	0.032 **		0.010	0.010 **
Advertising Long Run	0.024 **	-0.003	0.021 **	0.067 **	0.002	0.069 **

† Evaluated at sample means. Significance is based on standard errors of elasticities calculated using the delta method (Greene, p. 278).

* Significance at the 5% level, ** Significance at the 1% level.

cheese category (-0.613), followed closely by the Other cheese category (-0.726). American and Mozzarella both demonstrated unconditional price elasticities above unity. Again, product switching may have a large influence on the purchase probability effects, especially given the nature of cheese as a non-staple product and the prevalence of multiple product purchases in the household purchase data profile.

Price elasticities of cheese demand are quite variable in the literature. The household total price elasticity is very similar to the –0.37 reported by Heien and Wessells (1990), but below the –0.57 estimated by Gould and Lin (1994). Gould and Lin (1994) estimated elastic price elasticites for all cheese products, except for the American and Other Processed cheese category. Blisard et al. (1997), using total household cheese purchase data, estimated Natural and Processed cheese own-price elasticities of –0.559 and –0.844, respectively. Monthly cheese purchases were lower when cheese was purchased in packages of a pound or less, and increases in the proportion of cheese purchased at mass merchandise stores had a positive effect on monthly cheese demand.

Income effects were generally small and, with the exception of Processed cheese, all cheese types have positive probability and conditional demand elasticities. That is, household income is positively related to both probability of purchase and the quantity consumed. The relative influences of these effects varied by product, but in aggregate were largely intensive. Income for Processed cheese exhibited a negative effect in both stages and resulted in an unconditional income elasticity of –0.079. These income elasticities are below those in Blaylock and Smallwood (1983) using expenditure data that ranged from 0.105 to 0.425 across cheese products; but they are close to the aggregate cheese estimate of 0.045 in Gould and Lin (1994), and in Gould et al. (1994) for full fat Natural American (0.06) and Processed (-0.05) cheeses.

Household size elasticities were positive and similar across products, ranging from 0.182 for Other cheese to 0.323 for Processed. While in the aggregate, household size had a predominant intensive effect, elasticities for the disaggregated products showed consistently higher purchase probability effects, especially for Mozzarella cheese. In contrast to fluid milk, age of the household head elasticities were generally higher. Age elasticities were consistently negative across all cheese products, with a total cheese unconditional elasticity of –0.196. The total cheese age elasticity was largely the result of large negative contributions from Mozzarella (-0.661) and American (-0.356), whereas Processed and Other cheese elasticites were considerably lower. As with other determinants, specific product results are influenced largely by extensive contributions, while in the aggregate age of the household head was more intensive.

Household composition elasticities for children were lower for cheese than for fluid milk; however, a teenager contribution less than that of young children was still evident. Only in the case of Mozzarella cheese was the total elasticity above 0.10. This may reflect wide usage of Mozzarella cheeses in foods prepared for children, e.g. pizza. Increases in the proportion of older members of the household had a negative effect for all cheese products but, in contrast to milk, was predominantly the result of intensive contributions. As evidenced with fluid milk, household composition effects were weighted higher on the intensive side for total cheese, but the aggregation appears to dilute higher relative purchase probability effects for specific cheese products. Gould et al. (1994) also estimated positive age composition effects for household members under age 17 for all cheese products except for reduced-fat American cheese; however, they did show positive contributions for members above 65.

While positive and significant in the total cheese category, the effectiveness of the generic cheese advertising campaign appears lower than that estimated for fluid milk. The total cheese advertising elasticity was estimated to be 0.024; however, the entire amount of this was realized from the extensive margin. That is, cheese advertising appears to be effective at increasing the probability of purchase, but has no significant effect on increasing the demand of current consumers. This is consistent across all cheese products in which no conditional demand elasticities were significantly different from zero. The largest contributors to the total cheese result appear to be from Other cheese (0.069) and American cheese (0.063), while the Processed (0.021) and Mozzarella (0.021) advertising elasticities were more similar in magnitude to that of the aggregate product.

The advertising results here are consistent with Blisard et al. (1997), who found that generic advertising was successful in inducing people into the natural cheese market, but that it did not influence current consumers. However, for Processed cheese they found both effects to contribute positively to household demand. While a substantial amount of cheese advertising is brand-specific, they found no significant brand effect for Natural cheese and combined the generic and branded components in the Processed cheese model. Appropriate branded advertising data was not available for this study.

As evidenced with the fluid milk results, the total cheese elasticity is higher than the 0.015 estimated by Kaiser (1999) using aggregated quarterly data from 1975-1999. It is important to remember that the results estimated here reflect only at-home consumption of cheese. Since the 0.015 estimated by Kaiser incorporates both at-home and away-from-home consumption, it may be the case that the away-from-home response to cheese advertising is lower than that of its at-home counterpart.

From the wide disparity in extensive versus intensive response, it appears that the fluid milk and cheese advertising campaigns, though both generic in nature, are inducing response from different types of consumers. While fluid milk advertising seems most effective at increasing the demand of current consumers, its effect on new buyers is less pronounced. Conversely, even though the advertising elasticity for cheese is lower than for milk, the effect that cheese advertising has on total household demand is clearly from the response of new buyers to the market or at increasing the probability of purchase for U.S. households. It certainly seems clear that advertising has not been effective at increasing the monthly consumption of current consumers. It may be that the cheese results are influenced by the lack of branded advertising efforts in the model. However, while increasing the consumption of cheese is certainly a goal of any advertising program, branded advertising efforts also heavily concentrate on taking current consumption away from competitors' products. Therefore, it is unlikely that including such information in the model would reverse the conclusions reached here.

Conclusions

U.S. dairy producers and milk processors contribute substantial dollars each year to fund national generic advertising programs for fluid milk and cheese. Producers, marketers, and legislators are all uniquely interested in whether generic advertising increases consumer demand for dairy products. The household approach followed here allowed us to estimate the relative effectiveness of these programs on increasing at-home consumption of fluid milk and cheese products. In addition, the two-stage estimation procedure allowed us to decompose the total effect of the demand determinants into their extensive (probability of purchase) and intensive (level of consumption) components. This is particularly important when evaluating advertising programs to determine to whom the message has been successfully delivered, new or current consumers.

In general, most demand effects were predominantly intensive—that is affecting the consumption levels of current consumers. However, household income and the proportion of older members in the household for fluid milk, and price and generic advertising for cheese, had relatively large extensive contributions. In addition, looking beneath the surface of the total fluid milk and cheese categories revealed that individual products demonstrated considerably higher extensive effects that were diluted in the aggregate categorization, likely the result of product switching.

At the margin, generic advertising appears more effective at increasing the demand for fluid milk products than it does for cheese. Furthermore, the incidence of response to these programs is clearly different. While fluid milk advertising has been largely effective at increasing the demand of current consumers, demand response to the generic cheese campaign has been almost exclusively the result of increases in the probability of purchase. Information such as this provides valuable information to dairy product marketers in developing future advertising campaigns with respect to their target audience.

Given the complexities associated with modeling household purchase behavior, these estimates provide a preliminary assessment of household demand behavior and are generally consistent with those found in the literature. Future model developments are multi-dimensional. Analyzing advertising response by specific product groups within the fluid milk and cheese categories is an ongoing component of this effort; however, modeling this response is more difficult. Given that price, advertising, and other effects may induce product switching, the simple single equation two-step procedure may be inappropriate. If small changes in price, for example, cause households to switch from, say, reduced fat milk to light milk, this needs to be accounted for. However, the fact that the price offered for one product is not available when an alternative product is purchased leads to some difficult data and modeling problems. Can we adopt the same two-step decision process to the particular products, or is an alternative approach along the lines of brand choice models more appropriate?

More specific advertising information (e.g. geographically differentiated), including the influence of branded advertising, is needed to more accurately associate household response to advertising. Incorporating purchase dynamics may also be important when evaluating households over multiple time periods, including correlated responses and inventory effects. Finally, further investigation of differences in product quality would be helpful to isolate that component now included in the total price effect.

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