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Optimal Seasonal Allocation of Generic Dairy Advertising Expenditures

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Annual seasonal advertising expenditure allocations were estimated for the national generic advertising programs for fluid milk and cheese with the use of price and advertising elasticities of demand that varied over time. Significant variation in optimal allocations existed both across products and over time, emphasizing the importance of obtaining accurate seasonal forecasts that incorporate changes in market conditions to plan future spending allocations. In the absence of such information, allocating annual budgets equally across quarters still produced positive producer welfare gains on average relative to historical spending that were not statistically different from those realized under the optimal spending strategy.

Key Words: dairy, generic advertising, optimal seasonal allocation

JEL Classifications: Q11, Q13, Q18

U.S. dairy producers' and fluid milk processors' check-off assessments are used to support generic advertising, promotion, and product research aimed at increasing the demand for dairy products. Although generic advertising has historically received the largest share of check-off budgets, escalating media advertising costs have prompted some shifts away from generic advertising to other demand-enhancing efforts, particularly for the farmer-funded programs. The optimal use of given advertising budgets can be explored from several dimensions (e.g., media allocation, target markets, product-type advertising, or temporal allocation). Our focus is on the latter of these dimensions. As advertising budgets become tighter, the issue of the appropriate use of given media budget dollars throughout the year becomes more acute. More importantly, improving the temporal allocation of advertising budgets over time on the basis of market signals can improve producers' returns from their advertising investment.

The purpose of this article is to estimate optimal seasonal generic advertising expenditure shares for the national fluid milk and cheese advertising programs. Although optimal temporal strategies have been estimated for fluid milk programs in New York markets (e.g., Kinnucan and Forker; Liu and Forker; Vande Kamp and Kaiser 2000), they have not been applied to the national level nor evaluated for manufactured dairy products. Although farmer check-off dollars fund both fluid milk and cheese advertising programs, the programs have historically been developed individually by separate marketing agencies. Determining whether optimal seasonal advertising spending shares differ between fluid milk and cheese programs is important to

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understand, particularly given more recent advertising efforts that focus on joint product promotion (e.g., the 3-A-Day program advertises jointly for fluid milk, cheese, and yogurt products). Furthermore, comparing the historical versus optimal allocations from a producer welfare perspective highlights the potential gains to producers in terms of improving returns from advertising investments.

We proceed now with a brief discussion of relevant literature evaluating optimal temporal advertising spending. This is followed by the model application and empirical approach to deriving the optimal seasonal spending shares. Finally, we close with some implications of the results and suggestions for future research.

Background

Dorfman and Steiner evaluated the issue of optimal advertising and concluded that profits from advertising are inversely related to the price sensitivity of demand. Nerlove and Arrow developed a dynamic counterpart to the Dorfman and Steiner model, whereby optimal advertising levels are determined on the basis of maximizing the present value of net industry revenues by appropriate price and advertising policies over time. They concluded that firms should keep a constant advertising-to-sales ratio on the basis of elasticities of demand with respect to price and advertising (Nerlove and Arrow). Although they set the stage for much of the optimal temporal advertising work in generic advertising, both models assume that firms can control both price and output, which is not the case with promotion of agricultural commodities.

Determining optimal temporal advertising strategies in generic dairy promotion has received more recent attention. Kinnucan and Forker allowed for seasonal variation in the response to generic advertising by incorporating monthly dummy variables interacted with an advertising expenditure variable in a demand model for the New York City market. They found significant variation in the advertising elasticities that followed a smooth seasonal pattern and largely mimicked seasonal sales patterns (i.e., peaking in the spring and reaching a low during the summer months). Simulation results concluded that producer returns from advertising would be maximized when expenditures followed a regular seasonal pattern.

Liu and Forker used a deterministic optimal control framework to identify optimal advertising expenditure patterns for the New York State fluid milk promotion program. The control variables were monthly advertising expenditures to maximize the discounted revenue stream from milk sales net of the costs of advertising. Estimation results from econometric models of fluid milk sales and farm supply were used as inputs into the objective function. Similar to Kinnucan and Forker, monthly slope dummy variables were included in preliminary econometric specifications to determine whether seasonal variation existed in the advertising coefficients, but most were insignificant and subsequently excluded (Liu and Forker). Optimal monthly spending levels that varied throughout the season still resulted, however, because of the interaction and variation of seasonal price, demand, and supply-side effects. Their results, like Kinnucan and Forker's, indicate advertising more during the winter and less during the late spring and early summer.

Vande Kamp and Kaiser (2000) developed a dynamic optimization model to determine optimal temporal advertising strategies given the assumption that consumers' response to advertising is asymmetric (i.e., changes in demand from increases in advertising differ from decreases in advertising). The model was applied to the New York City fluid milk market. The asymmetric nature of demand response to generic advertising resulted in an optimal pulsing advertising strategy, in which periods of heavy advertising were followed by little or no advertising. The result was driven by the assumed asymmetric consumer response, as all other exogenous demand shifters outside of generic advertising were assumed constant.

Kinnucan and Myrland derived static decision rules to determine optimal seasonal allocations of fixed generic advertising budgets when substitution effects are important and prices are determined competitively. In contrast to optimal control models, the static framework permits a wider array of economic forces to be accounted for than is often feasible with dynamic models (Kinnucan and Myrland). Optimal allocation decisions are determined by the derived rule with the use of seasonal price elasticities of supply and demand, advertising elasticities, and market revenue shares.

Schmit and Kaiser (2004) developed national demand models for fluid milk and cheese that produced demand elasticities that varied over time. In contrast to Kinnucan and Forker, who estimated seasonal changes in advertising response in a dummy variable framework, Schmit and Kaiser (2004) empirically estimated the effect of changes in generic advertising response over time because of changes in specific economic, demographic, and consumer food spending characteristics.

The use of elasticity estimates from Schmit and Kaiser (2004) based on current market characteristics should provide more useful implications toward future marketing strategies as the influence of changing market factors on the effectiveness of generic advertising will directly affect the optimal seasonal spending strategies. Similar to Liu and Forker, we evaluate the relative contributions of changes in seasonal prices (or revenues) and changes in advertising effectiveness to the determination of optimal advertising spending patterns. However, the variation in advertising effectiveness is determined as a function of specific underlying economic forces such as price, income, population demographic, and consumer food spending changes, rather than more general seasonal dummy variable effects.

Modeling Optimal Seasonal Allocations

The Kinnucan and Myrland (K-M) seasonal allocation rule originates from the traditional equimarginal rule that producer profits are maximized when the last dollar spent on advertising in each season (s) provides exactly the same increment to total revenue. Assuming that there exist four identifiable seasons (s = 1, ... , 4) combined with the constraint that total seasonal advertising spending (a_s) cannot exceed the annual advertising budget ($\bar{A}$), Kinnucan and Myrland derive the expression for optimal seasonal advertising shares (κ_s) as

$$(1) \quad \kappa_s = \frac{r_s E_{ps,as}}{\sum_{s=1}^{4} r_s E_{ps,as}},$$

where $\kappa_s = a_s/\bar{A}$, $r_s = p_s q_s \Big/ \sum_{s=1}^{4} p_s q_s$ is the sth season's revenue share defined over producer price (p_s) and market quantity sold (q_s), and $E_{ps,as} = (\partial p_s/\partial a_s)(a_s/p_s)$ is the reduced-form price elasticity with respect to generic advertising in the sth season.

The result is intuitively appealing in that it clearly distinguishes the two key components driving allocation decisions: season-specific revenue shares and the ability of generic advertising to influence price. Revenue shares are easy enough to compute; however, the reduced-form price elasticities need to be derived from an economic structural model. As shown in Kinnucan and Myrland, and assuming cross-price elasticities of demand are zero (i.e., no substitution effects), the reduced-form price elasticity can be derived as

$$(2) \quad E_{ps,as} = \alpha_s/(\varepsilon_s + \eta_s),$$

where α_s, ε_s, and η_s are the sth season's generic advertising, supply, and demand (absolute value) elasticities, respectively. As a reduced-form elasticity, $E_{ps,as}$ represents the net effect of an increase in generic advertising on price after taking supply response into account (Kinnucan and Myrland).

As Kinnucan and Myrland state, the simplification of ignoring product substitution implies that the advertising price effect is unambiguously positive, which could overstate producer welfare gains from advertising. The existence of clear (or at least strong) substitutes to fluid milk and cheese at the aggregate market level has shown mixed results in the literature. For example, although Capps and Schmitz showed that nonalcoholic beverages were a significant substitute for fluid milk in the Texas market, Vande Kamp and Kaiser (1999) estimated that this substitute relationship was not statistically significant in the New York City market. More common in the literature has been to include no substitute product variables separately, but rather to deflate the fluid milk price by a nonalcoholic beverage price index (e.g., Blisard et. al.; Chung and Kaiser; Kaiser; Schmit and Kaiser 2004), a noted restriction on the more general model. A reasonable substitute for cheese is not particularly straightforward. Some empirical support exists for including a consumer price index for meats (e.g., Blisard et. al.; Sun, Blisard, and Blaylock), but, again, more common has been to use such an index as a cheese price deflator (Kaiser; Schmit and Kaiser 2004). Furthermore, the empirical evidence cited above indicates relatively inelastic substitute relationships, and, as such, we assume the no-substitute restriction is sufficient to provide a reasonable approximation to the optimal allocation results. Substituting Equation (2) into Equation (1) yields the final optimal seasonal allocation rule:

$$(3) \quad \kappa_s = \frac{r_s\alpha_s/(\varepsilon_s + \eta_s)}{\sum_{t=1}^{4} r_t\alpha_t/(\varepsilon_t + \eta_t)}.$$

The time-varying parameter model estimated in Schmit and Kaiser (2004) is useful to the study of optimal temporal allocation decisions because the estimated generic advertising and price elasticities vary over time. Although it is certainly true that alternative demand models, functional forms, or both are available that produce time-varying elasticities, the objective of the paper here is to extend the usefulness of these more recent market characteristic-induced time-varying elasticities to strategic considerations for marketing dairy products to consumers.

From Schmit and Kaiser (2004), the fluid milk demand model was specified as

$$\begin{aligned}(4) \quad \ln RFD_t = {} & \beta_0^m + \beta_1^m \ln RFP_t + \beta_2^m \ln INC_t \\ & + \beta_3^m \ln T_t + \beta_4^m \ln AGE5_t \\ & + \beta_5^m BST_t + \beta_6^m QTR1_t + \beta_7^m QTR2_t \\ & + \beta_8^m QTR3_t + \beta_9^m \ln BMGW_t \\ & + \psi_t^m \ln GMGW_t + e_t^m\end{aligned}$$

and

$$\begin{aligned}\psi_t^m = {} & \exp(\delta_0^m + \delta_1^m RFP_t + \delta_2^m INC_t \\ & + \delta_3^m AGE5_t + \delta_4^m BLACK) + v_t^m,\end{aligned}$$

where the m superscript refers to fluid milk demand parameters; RFD is per capita retail fluid milk demand; RFP is the consumer retail price index (CPI) for fresh milk and cream deflated by the CPI for nonalcoholic beverages; INC is per capita disposable personal income deflated by the CPI for all items; T is a time trend; $AGE5$ is the percentage of the U.S. population under 6 years of age; BST is an intercept dummy variable for availability of bovine somatotropin (bST) (1994–current equals 1, 0 otherwise); $QTR1$, $QTR2$, and $QTR3$ are quarterly seasonal dummy variables; $BMGW$ and $GMGW$ are the national branded and generic fluid milk advertising expenditure stocks, respectively, as defined in the Appendix; and $BLACK$ is the percentage of the population identified as African American.

Similarly, Schmit and Kaiser (2004) specify the retail cheese demand model as

$$\begin{aligned}(5) \quad \ln RCD_t = {} & \beta_0^c + \beta_1^c \ln RCP_t + \beta_2^c \ln INC_t \\ & + \beta_3^c \ln FAFH_t + \beta_4^c \ln OTHER_t \\ & + \beta_5^c QTR1_t + \beta_6^c QTR2_t + \beta_7^c QTR3_t \\ & + \beta_8^c \ln BCGW_t + \psi_t^c \ln GCGW_t + e_t^c\end{aligned}$$

and

$$\begin{aligned}\psi_t^c = {} & \exp(\delta_0^c + \delta_1^c RCP_t + \delta_2^c INC_t + \delta_3^c FAFH_t \\ & + \delta_4^c AGE2044_t + \delta_5^c OTHER) + v_t^c,\end{aligned}$$

where the c superscript refers to cheese demand parameters, RCD is per capita retail cheese demand, RCP is the CPI for cheese deflated by the CPI for meats, $OTHER$ is the proportion of the population identified as Asian or Hispanic (specifically, non-White and non–African American), $FAFH$ is the real per capita expenditure on food eaten away from home, and $BCGW$ and $GCGW$ are the branded and generic cheese advertising expenditure stocks (see Appendix for definition), respectively. The estimated demand model coefficients from Schmit and Kaiser (2004) are included in Appendix Table A1.

The ψ_t^m and ψ_t^c equations define the variation in generic advertising response for fluid milk and cheese, respectively, as a function of economic, demographic, and food spending variables. As market characteristics change, it is reasonable to assume that the overall effectiveness of the advertising program could change as well (Schmit and Kaiser 2004). Given the double-logarithmic functional form of the demand equations and the construction of the advertising stocks as weighted moving averages of past expenditures in which the lag weights sum to unity, ψ_t^m and ψ_t^c can be interpreted directly as the respective long-run generic advertising expenditure elasticities.

It should be noted that the goodwill advertising elasticities are based on the historic lag structures and represent the effect of total advertising demand at each point in time. However, this also implies that the pattern of the distributed lag structure does not differ by season when expenditures are reallocated within a year. In other words, applying the estimated long-run advertising elasticities to the K-M allocation rule assumes that the distributed lag nature of generic advertising is fixed and does not change with reallocation of expenditures. Although it is reasonable to hypothesize that the nature of the lag distribution will change with reallocation of expenditures, we leave this avenue to future research. Hump-shaped distributed lag relationships are estimated in the Schmit and Kaiser models, which is consistent with earlier research on these products (Chung and Kaiser; Kaiser).

The own-price elasticities of demand for fluid milk and cheese are also needed for application to the K-M allocation rule. These can be derived from Equations (4) and (5) and computed as

$$\text{(6a)} \quad \frac{\partial \ln RFD_t}{\partial \ln RFP_t} = \beta_1^m + \delta_1^m \psi_t^m \cdot \ln GMGW_t \cdot RFP_t$$

and

$$\text{(6b)} \quad \frac{\partial \ln RCD_t}{\partial \ln RCP_t} = \beta_1^c + \delta_1^c \psi_t^c \cdot \ln GCGW_t \cdot RCP_t.$$

Allocation Rule Inputs

The estimated demand model parameters and input data in Schmit and Kaiser (2004) were used to compute the quarterly own-price (Equations [6a] and [6b]) and generic advertising (ψ_t^m and ψ_t^c) elasticities of demand from 1997 through 2001 for fluid milk and cheese, respectively. Average quarterly price elasticities of demand for fluid milk and cheese over this time period were −0.051 and −0.303, respectively (Table 1). Although the estimated fluid milk price elasticities are arguably low, it is the relative nature of these elasticities across quarters that drive the optimal allocation results. No clear seasonal pattern in fluid milk price elasticities appears to exist, with estimates generally stable across quarters over the last 2 years (Figure 1). With the exception of 1998, cheese price elasticities were higher in the second half of the year relative to the first half (Figure 1).

Computed quarterly generic advertising elasticities from 1997 through 2001 are illustrated in Figure 2. To the extent that the income, food spending, and population demographic variables trended throughout each individual year, a seasonal trend in elasticities resulted. However, seasonal changes in retail prices also contributed to the seasonal (within-year) variation in these elasticities. Changes over time (across years) were largely due to changes in the nonprice factors that tended to trend monotonically throughout the 1997–2001 sample period (Schmit and Kaiser 2004).

Generic advertising elasticities were relatively similar in magnitude over this time, with average quarterly estimates of 0.029 and 0.030 for fluid milk and cheese, respectively (Table 1). Although the absolute levels of change are not large, clear seasonal patterns appear to exist for cheese where advertising elasticities were consistently higher in the first two quarters of the year relative to the last two quarters (Figure 2). Fluid milk generic advertising elasticities were relatively even across quarters, particularly in the last 2 years. The moderate reductions over the 5-year period were largely the result of declines in the proportion of young children in the population (Schmit and Kaiser 2004).

Table 1. Average Quarterly Input Variables, Elasticities, and Computed Parameters, 1997–2001

Quarter	Generic Advertising Expenditures ($ millions)[a]		Milk Product Prices ($/cwt)		Fluid and Manufactured Product Disappearance (million lbs.)[b]		Price Elasticities		Generic Advertising Elasticities		Revenue Shares[c]		Reduced-Form Price Elasticities	
	Fluid	Cheese	Fluid	Cheese	Fluid	Cheese	Fluid	Cheese	Fluid	Cheese	Fluid	Cheese	Fluid	Cheese
1	43.45	13.94	16.38	12.21	14.00	15.97	−0.046	−0.298	0.031	0.034	0.255	0.226	0.085	0.055
2	43.08	13.32	15.57	11.97	13.49	16.64	−0.052	−0.297	0.029	0.031	0.234	0.231	0.079	0.050
3	37.21	11.57	15.97	14.09	13.59	16.92	−0.055	−0.307	0.028	0.027	0.241	0.276	0.078	0.044
4	39.21	15.06	17.11	12.95	14.16	17.70	−0.050	−0.308	0.029	0.028	0.270	0.266	0.080	0.045
Average	40.74	13.47	16.26	12.81	13.81	16.81	−0.051	−0.303	0.029	0.030	0.250	0.250	0.080	0.048

Sources: DMI (advertising expenditures), USDA (2002; prices, farm supply, and product disappearance), Schmit and Kaiser (2004; price and advertising elasticities).
[a] Advertising expenditures and prices are in real 2001 dollars.
[b] For proper comparison, cheese disappearance represents the equivalent amount of fluid product in its production.
[c] Revenue shares are computed with the product prices and disappearances above.

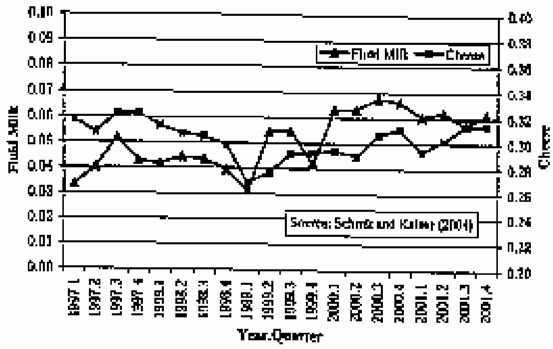

Figure 1. Own-Price Elasticities of Demand (Absolute Value)

From Equation (2), reduced-form price elasticities with respect to generic advertising were computed (Figure 3). Seasonal supply elasticities were not available, so a constant long-run supply elasticity (ε) estimate of 0.313 was used (Schmit and Kaiser 2002). Reduced-form price elasticities for cheese demonstrated a clear seasonal pattern, with higher average elasticities in the first half of the year (Table 1). A consistent seasonal pattern for fluid milk was not apparent for fluid milk but, on average, was largest in the first quarter of the year.

The final input into the optimal allocation rule centers on the seasonal revenue shares for each product. Generally, prices received by dairy producers are based on the distribution of product to alternative uses. Fluid milk processors pay a higher price for farm milk designated for fluid purposes, whereas cheese processors

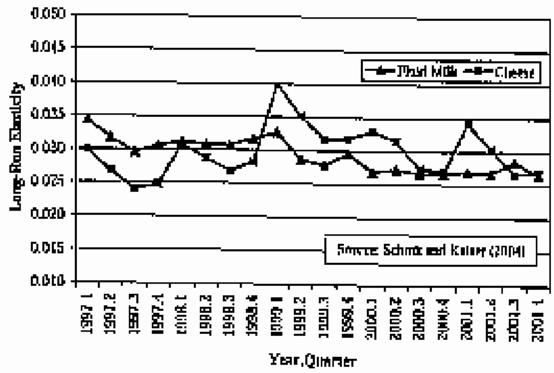

Figure 2. Long-Run Generic Advertising Elasticities of Demand

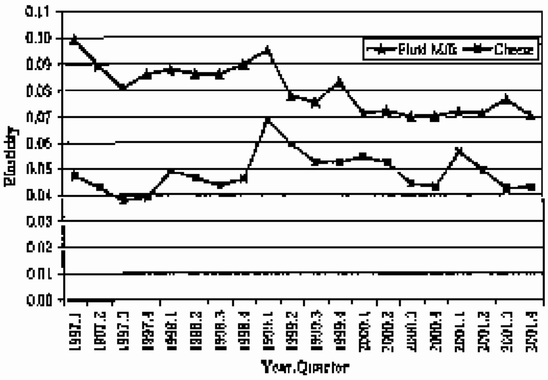

Figure 3. Reduced-Form Price Elasticities with Respect to Generic Advertising

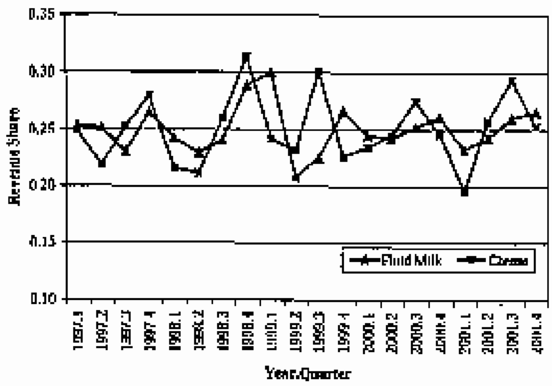

Figure 4. Quarterly Farm-Level Revenue Shares

pay a lower price for farm milk designated for manufactured purposes. Farmers receive a "blend" price depending on the relative utilization of the farm milk supply. For our application, we use the USDA reported national average "class" prices for these designated uses (i.e., the Class I price for fluid milk and the Class III price for cheese). Seasonal farm-level revenue shares for fluid milk and cheese were computed with these quarterly prices and specific fluid milk and cheese product disappearance quantity estimates.

On average, changes in seasonal prices mimicked product disappearance, resulting in higher revenue shares in the first and fourth quarters for fluid milk and third and fourth quarters for cheese (Table 1). Seasonal variation for each of the 5 years (1997–2001) were generally similar to the 5-year averages; however, more recent changes are notable for fluid milk in 2000 and 2001, for which revenue shares increased throughout the year, dominated by higher fluid milk processor prices in the final two quarters of the year (Figure 4).

Allocation Rule Results

For each year, 1997–2001, the K-M allocation rule of Equation (1) was applied, taking annual expenditure budgets as given and using the time-specific revenue shares and reduced-form elasticities to compute the optimal seasonal allocation of advertising funds (Table 2).[1] The results identify the optimal allocation of advertising funds for that year, given the seasonal elasticities and revenue shares that existed at the time.[2]

It is clear from Table 2 that seasonal allocation decisions vary considerably by year. For example, optimal first-quarter allocations for fluid milk varied from approximately 23% in 2001 to nearly 35% in 1999. Similarly, optimal fourth-quarter allocations for cheese varied from approximately 21% in 1999 to over 31% in 1998. Looking across all quarters, optimal allocation patterns for fluid milk advertising were U-shaped from 1997 through 1999, reflecting higher allocations in the first

[1] Standard errors of the seasonal share estimates were computed within the PROC MODEL procedure in SAS (version 9.1) with the ESTIMATE statement. The approximate standard errors are derived from the estimated demand model parameter variance-covariance matrix from Schmit and Kaiser (2004) with a procedure analogous to the delta method (Greene, p. 278).

[2] As noted by a reviewer, the estimated elasticities used to calculate the optimal seasonal shares are conditioned on the actual advertising allocation in the sample. That is, if the actual advertising allocations were different, the estimated elasticities would differ as well and implies a circular issue in determining the optimal allocation of funds. An alternative formulation would be to use elasticity estimates that would have prevailed in the absence of any advertising, but identifying those *a priori* is beyond the scope of this paper and unattainable from the demand models used here. We assume that the approach utilized here presents a close approximation to such an alternative formulation.

Table 2. Optimal Seasonal Generic Advertising Expenditure Shares by Year[a]

Year	Quarter	Fluid Milk			Cheese		
		Actual	Optimal	% Difference	Actual	Optimal	% Difference
1997	1	.273	.291 (.058)	6.6	.274	.288 (.054)	5.1
	2	.256	.252 (.008)	−1.6	.258	.223 (.006)	−13.6
	3	232	.205 (.040)	−11.6	.190	.225 (.035)	18.4
	4	.240	.252 (.014)	5.0	.278	.264 (.026)	−5.0
1998	1	.253	.241 (.017)	−4.7	.250	.235 (.028)	−6.0
	2	241	224 (.016)	−7.0	.269	.213 (.010)	−20.8
	3	.231	.234 (.007)	1.3	.202	.240 (.028)	18.8
	4	.276	.301 (.038)	9.0	.279	.312 (.039)	11.8
1999	1	.287	.346 (.060)	20.5	.250	.288 (.070)	15.2
	2	.260	.194 (.032)	−25.4	.247	.235 (.011)	−4.9
	3	.240	.200 (.037)	−16.7	.195	.269 (.048)	38.0
	4	.213	.260 (.011)	22.1	.307	.208 (.025)	−32.2
2000	1	.217	.242 (.016)	11.5	.273	.267 (.061)	−2.2
	2	.287	.248 (.004)	−13.5	.227	.260 (.018)	14.5
	3	.276	.253 (.008)	−8.3	.242	.252 (.039)	4.1
	4	.219	.257 (.006)	17.3	.258	.221 (.036)	−14.3
2001	1	.306	.233 (.008)	−23.8	.250	.234 (.045)	−6.4
	2	.295	.242 (.007)	−18.0	.233	.268 (.019)	15.0
	3	.147	.266 (.012)	80.9	.244	.265 (.042)	9.0
	4	.252	.259 (.012)	2.8	.273	.234 (.015)	−15.0

[a] Standard errors in parentheses; all share estimates statistically significant at the $p < .01$ significance level or less.

and fourth quarter; however, in 2000 and 2001, the allocation patterns tended to increased throughout the year because of the seasonal flattening of the reduced-form price elasticities in 2000 and 2001 and revenue shares that increased throughout both years. Even larger differences across years were apparent in the optimal allocation patterns for cheese advertising. Specifically, seasonal allocations were U-shaped in the first 2 years, mixed in 1999, declining throughout the year in 2000, and hump-shaped in 2001.

Although the optimal spending patterns across products were relatively similar in 1997 and 1998, the subsequent years show optimal spending patterns that were distinctly different from one another. This is reflective of the differences in seasonal consumption patterns for the two products, as well as the differences in the seasonal price-enhancing effects of the individual advertising programs. In addition, with no consistent seasonal spending pattern in actual advertising expenditures, the relative seasonal adjustments across years varied considerably for both products (Table 2).

As expected, the optimal quarterly allocation estimates each year were all statistically different from zero (Table 2). However, a more appropriate criterion is to test whether the estimated seasonal spending shares are jointly statistically different from one another. If not, and given the difficulty in accurately forecasting future input values, is an advertising expenditure allocation of 25% per quarter a good rule of thumb? Wald test statistics were computed on the null hypothesis that the optimal seasonal expenditure shares were jointly equal (i.e., H_0: $\kappa_1 = \kappa_2 = \kappa_3 = \kappa_4$). Given that the sum of the seasonal shares in any year must sum to 1.0, we specifically test for each product whether $\kappa_1 = \kappa_2 = \kappa_3 = .25$ (Table 3). The test results show that for each product, in all but 1 year, the estimated optimal advertising spending shares are not statistically equal, lending support to optimal allocation results.[3]

[3] Tests were computed with the TEST statement in the PROC MODEL procedure in SAS version 9.1.

Table 3. Test Statistics that Optimal Seasonal Generic Advertising Expenditure Shares are Jointly Equal by Year[a]

	Fluid Milk		Cheese	
Year	Wald Statistic	*p*-Value	Wald Statistic	*p*-Value
1997	875.58	<.001	106.54	<.001
1998	20.86	<.001	117.94	<.001
1999	127.34	<.001	627.32	<.001
2000	2.72	.437	17.55	.001
2001	16.27	.002	3.00	.391

[a] The null hypothesis that optimal shares are equal (i.e., $\kappa_1 = \kappa_2 = \kappa_3 = \kappa_4$) is specifically tested as $\kappa_1 = \kappa_2 = \kappa_3 = .25$, given that the sum of the individual shares must equal 1, and is distributed $\chi^2(3)$.

Given the multiplicative relationship between revenue shares and reduced-form price elasticities in the optimal allocation rule, a closer inspection of the percentage changes in these factors can shed light on the driving forces of the within-year and across-year variation in the allocation results. Table 4 displays computed average coefficients of variation (CVs) in revenue shares and reduced-form price elasticities for fluid milk and cheese. The within-year (or across-season) CVs represent the average variation (relative to the mean) in seasonal revenue shares and reduced-form price elasticities within each year, whereas the across-year CVs represent the average variation in the season-specific revenue shares and reduced-form elasticities across years.

From the computed CVs, changes in the advertising expenditure allocations by season (within-year) were relatively more affected by changes in revenue shares than changes in reduced-form price elasticities (i.e., the within-year CVs for revenue shares were larger than the CVs for the reduced-form price elasticities for both products). This is likely because of the strong and consistent seasonal nature of consumption for these products. In contrast, changes in expenditure allocations across years were more affected by the variation in the reduced-form price elasticities over time. Although changes in prices play a role in both revenue shares and reduced-form elasticities, the reduced-form elasticities are also affected by changes in consumer income levels, food spending behavior, and market demographic changes.

It is intuitively appealing that the within-year results are consistent with previous research (i.e., highlighting the important relationship between seasonal spending allocations and seasonal industry revenues). However, variation in the across-year results highlights the importance of considering changing market conditions over time when determining specific annual allocations. That is, although considering seasonal revenue shares is important in determining seasonal allocations, if changing market income, food spending, and demographic conditions are not factored in, annual allocation decisions could be far from optimal.

Although the results for some years are consistent with previous results, the annual results here highlight the existence of substantial variability around those estimates on the basis of changes in market conditions. The implication of changing optimal seasonal patterns over time is that the historic seasonal patterns might not be particularly useful in *ex ante* decision making and emphasizes the importance of obtaining accurate seasonal forecasts to plan future spending allocations. We explore this in more detail next, when computing the producer welfare effects from the proposed reallocations.

Table 4. Average Coefficients of Variation (CV) in Revenue Shares and Reduced-Form Price Elasticities, Across and Within Years, 1997–2001

	Across Years		Within Years	
Product	Revenue Share	Reduced-Form Price Elasticity	Revenue Share	Reduced-Form Price Elasticity
Fluid Milk	6.93	11.11	8.52	5.31
Cheese	9.58	12.86	13.34	10.86

Table 5. Total Producer Surplus Changes for Actual-to-Optimal and Actual-to-Equal Spending Adjustments by Year[a]

Year	Fluid Milk			Cheese		
	Optimal	Equal	Difference	Optimal	Equal	Difference
1997	2.77 (.64)	−2.37 (.70)	5.14 (.67)	3.96 (.24)	3.93 (.52)	0.03 (.99)
1998	2.07 (.65)	−2.76 (.49)	4.83 (.57)	9.59 (.30)	3.94 (.41)	5.65 (.45)
1999	35.07 (.32)	1.57 (.74)	33.51 (.38)	35.30 (.14)	21.42 (.15)	13.88 (.20)
2000	10.24 (.07)	9.95 (.07)	0.29 (.60)	3.38 (.10)	1.79 (.34)	1.59 (.54)
2001	82.10 (.10)	69.56 (.10)	12.54 (.11)	6.52 (.25)	3.09 (.12)	3.43 (.37)
Average	26.45 (.14)	15.19 (.12)	11.26 (.37)	11.75 (.15)	6.83 (.19)	4.92 (.26)
Proportion of Average Annual Advertising Investment[b]						
	.16	.09	.07	.22	.13	.09

[a] Millions of dollars (deflated 2001 dollars), *p*-values in parentheses.

[b] Average annual advertising investment: $162.96 fluid milk, $53.89 cheese.

Producer Welfare Impacts

To determine the potential economic gains from optimizing the allocation of advertising expenditures, changes in producer surplus were calculated for each quarter and summed each year.[4] These welfare gains can be considered an upper bound estimate because they reflect the gains in producer surplus that would have been achieved if agents had had perfect foresight in predicting the seasonal revenue shares and reduced-form elasticities for the coming year and allocating expenditures accordingly. Given the ability to accurately forecast input statistics might be difficult, an alternative strategy of allocating expenditures equally across the four quarters of the year was also evaluated.

The total annual gains in producer surplus for each strategy are shown in Table 5. As expected, years with actual spending allocations more disparate from the estimated optimal allocations resulted in higher annual welfare gains. Producer welfare gains from reallocating fluid milk advertising spending ranged from $2.07 million to $82.10 million per year, but only the two more recent years were statistically different from zero. On average, producer welfare gains were $26.45 million and were marginally significant. Reallocating cheese advertising expenditures to the optimal shares resulted in estimated producer welfare gains from $3.38 million to $35.30 million with a similar number of statistically significant outcomes. On average, welfare gains from the optimal reallocations of cheese advertising spending were $11.75 million per year, again with marginal significance.

As expected, the actual-to-equal scenario resulted in lower welfare gains each year (Table 5). Although 2 years of reallocating fluid milk spending under this scenario resulted in modest reductions in producer welfare, on average, the argument that producers would gain from this strategy was weak (i.e., *p*-values on the estimated welfare gains were .12 and .19 for fluid milk and cheese, respectively). Interestingly, in only 1 year (2001), and for only fluid milk, were the differences in welfare gains between the optimal and equal spending strategies at least weakly statistically different from each other. This could be reasonable because the average optimal allocations for fluid milk (.27-.23-.23-.27) and cheese (.26-.24-.25-.25) were not too distant from an equal quarterly spending strategy.

Although the potential gains under either strategy are small relative to annual industry revenues (i.e., around 1% for fluid milk and

[4] Following Kinnucan and Myrland, quarterly producer surplus changes (ΔPS_k) were computed with the formula: $\Delta PS_k = p_s q_s E_{ps,as} a_s^*(1 + 0.5\varepsilon E_{ps,as} a_s^*)$, where a_s^* is the relative change in advertising expenditures needed to equal the optimal allocation. This calculation inherently assumes parallel demand shifts and a linear supply curve in the relevant region.

0.5% for cheese), they are more substantial relative to the annual advertising investments. Average annual gains in producer welfare from reallocating existing annual budgets to optimal(equal) quarterly allocations are approximately 16(9)% and 22(13)% of the annual advertising investments for fluid milk and cheese, respectively (Table 5). To put these numbers in perspective, simulation results published in the 2002 USDA Report to Congress estimated an annual benefit-cost ratio of the farmer-funded programs at 6.26:1 for the period of 1999–2001 (i.e., a $420 million change in producer surplus divided by a $67 million change in generic advertising for fluid milk and cheese; USDA 2003). Taking the more conservative equal quarterly spending strategy, the additional average producer surplus gained from reallocating existing expenditures from 1999 through 2001 would amount to $27.0 million from fluid milk and $8.7 million for cheese. Adding these to the numerator of the benefit-cost ratio calculation would imply an increase in the benefit-cost ratio to 6.80, or an increase of about 9%.

Conclusions

Annual seasonal advertising expenditure allocations were estimated for the national generic advertising programs for fluid milk and cheese. The empirical results revealed several key implications. First, although the within-year variation in expenditures was more the result of seasonal variation in industry revenues and is consistent with prior empirical research, significant changes in the optimal seasonal allocations across years exists. The across-year variation was, in contrast, more the result of changes in the reduced-form price elasticities with respect to generic advertising as a result of changes in other market factors, including rising consumer incomes and food spending away from home, and changes in age and race/ethnic demographic patterns. The implication of changing optimal seasonal patterns over time is that the historic seasonal patterns might not be particularly useful in *ex ante* decision making and emphasizes the importance of obtaining accurate seasonal forecasts that incorporate changes in these other market conditions to plan future spending allocations.

Second, the optimal seasonal spending patterns differed between the fluid milk and cheese products, particularly in the more recent years evaluated. This was because of differences in both seasonal revenue share and reduced-form elasticity patterns across the two products. Given that the farmer-funded advertising efforts have more recently moved from individually designed advertising programs for dairy products to a joint advertising strategy, future recommendations on spending allocations are difficult to postulate. This implies a need for future empirical work analyzing the effectiveness of the joint advertising program and demand enhancing effects.

Finally, the estimates of historical producer welfare gains that could have been achieved from reallocating the annual advertising budgets were approximately 16% and 22% of the fluid milk and cheese annual advertising investments, respectively. However, these estimates provide an upper bound on potential gains assuming perfect foresight of future market conditions. The costs and reliability of obtaining such estimates need to be considered before adopting such a planning policy, particularly given that a simple 25% expenditure allocation each quarter results in positive welfare gains on average that are not statistically different from gains estimated under the perfect foresight optimal spending strategy.

Although the allocation investment rule is general enough to allow for product substitution effects, the empirical application here ignores these and therefore likely overstates welfare gains from the spending reallocations. Future research should examine more rigorously the importance of substitution effects for these products, particularly given more recent industry efforts to expand fluid milk product lines and increase the profile of fluid milk products in the nonalcoholic beverage category. In addition, if changes in optimal seasonal spending strategies occur over time as suggested here, optimal spending should be evaluated over a longer-term planning horizon that allows for such things as holding current-year budget dollars for spending in more beneficial future time periods.

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APPENDIX. ADVERTISING EXPENDITURE GOODWILL STOCKS

To allow for carryover effects of advertising, both current advertising and lagged advertising are assumed to affect current demand. From Schmit and Kaiser (2004), the weights on lagged advertising spending were approximated with a quadratic exponential distributed lag structure (EDL). Following Cox (p. 149), the EDL structure for generic advertising can be expressed as

$$\text{(A1)} \quad GGW_t = \sum_{j=0}^{J_g} w_{j,g} GADV_{t-j}$$

and

$$w_{j,g} = \exp(\lambda_{0,g} + \lambda_{1,g} j + \lambda_{2,g} j^2),$$

where the subscript g identifies the generic advertising parameter, $w_{j,g}$ represents the $J_g + 1$ lag weights, $GADV_{t-j}$ is the $(t-j)$th generic advertising expenditure, and $\lambda_{i,g}$ $(i = 0, 1, 2)$ are the estimated generic advertising EDL parameters. The

Table A1. Econometric Estimates from Time-Varying Parameter Model

Variable	Parameter	Fluid Milk[a]	Cheese[a]
Intercept	$\beta_0^{fm}, \beta_0^{c}$	−2.704 (1.050)	−10.236 (1.539)
ln *Price*	$\beta_1^{fm}, \beta_1^{c}$	−0.160 (0.190)	−0.377 (0.140)
ln *Income*	$\beta_2^{fm}, \beta_2^{c}$	0.107 (0.140)	0.691 (0.187)
ln *T*	β_3^{fm}	−0.078 (0.019)	na
ln *FAFH*	β_3^{c}	na	0.694 (0.247)
ln *AGE5*	β_4^{fm}	−0.250 (0.417)	na
ln *OTHER*	β_4^{c}	na	0.121 (0.106)
BST	β_5^{fm}	−0.043 (0.013)	na
QTR1	$\beta_6^{fm}, \beta_5^{c}$	−0.008 (0.004)	−0.082 (0.007)
QTR2	$\beta_7^{fm}, \beta_6^{c}$	−0.051 (0.004)	−0.050 (0.008)
QTR3	$\beta_8^{fm}, \beta_7^{c}$	−0.049 (0.003)	−0.052 (0.007)
ln *BAGW*	$\beta_9^{fm}, \beta_8^{c}$	−0.004 (0.007)	−0.001 (0.017)
Intercept (ψ)	$\delta_0^{fm}, \delta_0^{c}$	−10.986 (3.504)	−3.011 (10.545)
Price (ψ)	$\delta_1^{fm}, \delta_1^{c}$	0.948 (1.551)	1.033 (3.166)
Income (ψ)	$\delta_2^{fm}, \delta_2^{c}$	0.022 (0.014)	−0.008 (0.043)
FAFH (ψ)	δ_3^{c}	na	−0.044 (0.043)
AGE5 (ψ)	δ_3^{fm}	1.258 (0.498)	na
AGE2044 (ψ)	δ_4^{c}	na	0.071 (0.117)
BLACK (ψ)	δ_4^{fm}	−0.456 (0.292)	na
OTHER (ψ)	δ_5^{c}	na	1.562 (0.968)
Auto-Regressive, order 1	AR(1)	0.221 (0.140)	na
Brand Weight Parameter	$\lambda_{2,b}$	−1.918 (0.310)	−1.490 (0.450)
Generic Weight Parameter	$\lambda_{2,g}$	−5.545 (0.743)	−2.099 (0.558)
Adjusted R^2		.945	.988
Test $\delta_i = 0 \; \forall \; i > 0$	LR Stat.	17.61	12.62
	$\Pr > \chi^2$	0.002	0.027

Source: Schmit and Kaiser (2004).

[a] Standard errors are in parentheses. Dependent variable is the natural logarithm of per capita disappearance.

weight on the sixth lag is defined to be approximately zero (exp[−30]) and the current period is set to one. Applying these assumptions to Equation (A1), the lag weights become

$$\text{(A2)} \quad w_{j,g} = \exp\left[-5j + \lambda_{2,g}(j^2 - 6j)\right] \quad j = 1, \ldots, 6,$$

with $\lambda_{2,g}$ the single parameter to estimate. To force the lag weights to sum to unity, the individual weights were normalized over the sum of the individual lag weights. In all cases, the weights were estimated to be essentially zero by the fourth-quarter lag. Branded advertising stocks were similarly constructed.