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SEASONALITY IN THE CONSUMER RESPONSE TO MILK ADVERTISING: IMPLICATIONS FOR MILK PROMOTION POLICY

Henry W. Kinnucan and Olan D. Forker*

In 1980 the average American consumed 526 milk-equivalent pounds of dairy products - 24 percent less than in 1955. Thus, despite a 46 percent growth in population, the aggregate demand for dairy products over this 25-year period increased by less than five percent (USDA). Dairy farmers are naturally concerned about this trend. In an effort to improve the market for milk and milk products, dairy farmers in recent years have increased their investment in dairy product promotion and advertising. In New York alone nearly $8 million will be collected in 1982 under the State Dairy Product Promotion Order (Kling). Nationwide some $130 million will be invested by dairy farmers on nonbrand advertising and promotional activities in 1982 (UDIA).

An economic model developed by Thompson and Eiler provides insights into the important determinants of nonbrand milk advertising effectiveness. Their study found that the profitability of advertising milk is particularly sensitive to (a) the responsiveness of milk sales to advertising, (b) the Class I-Class II price differential, and (c) the proportion of total milk production sold as Class I. Thus, promotional dollars should be allocated to markets which are most responsive to generic advertisement of milk, have the largest Class I-Class II price differential, and have the highest Class I utilization.

The Thompson and Eiler model indicated farmers do receive benefits from advertising efforts. Advertising net of other factors has increased sales from 1.3 to 10.7 percent (Thompson & Eiler, Kinnucan). The return on investment has ranged from 43 percent in Rochester to 607 percent in New York City. This economic model has been used to determine how to best allocate a fixed promotional budget among three New York markets (Thompson, Eiler and Forker).

Because Class I-Class II price differentials, Class I utilization rates, and possibly the sales response to milk advertising (Kinnucan 1981) varies over time as well as across markets the Thompson and Eiler model was extended to issues relating to the optimal temporal allocation of milk advertising expenditures. First, monthly data pertaining to New York City for the years 1971-80 were analyzed to determine if a seasonal response to milk advertising exists. Results from this analysis were then used in simulations based on a modified version of the Thompson and Eiler model to obtain estimates of the optimal monthly expenditure for milk advertising. A regression equation estimated the additional milk sales that would have occurred had the advertising budget been spent according to the "optimal" seasonal pattern. Finally, an estimate of the value to producers of following a prescribed seasonal advertising pattern was computed.

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Seasonality in the Consumer Response to Milk Advertising

The Model

Empirical research on the effects of advertising have yielded three general findings: advertising generally has a positive effect on sales, generally continues to have an effect beyond the initial period of expenditure (Clarke) and is not proportional to expenditure, i.e., advertising is subject to diminishing marginal returns (Simon and Arndt). To take into account these "facts" most econometric studies of advertising effectiveness use a distributed lag specification with variables expressed in logarithms, but this specification is complicated in the study of milk demand because the dependent variable is subject to seasonal variation which is not necessarily attributable to seasonal variation in the independent variables. Under these conditions the milk sales response to advertising may vary with the seasons (Pesando; Trivedi and Lee).

In principle, a seasonal relationship between milk sales and advertising expenditures could be tested using monthly dummy variables to date current and past advertising expenditures (see, e.g., Trivedi and Lee). This approach, however, consumes a large number of degrees of freedom, e.g., if the lag length is seven and there are twelve "seasons" then 84 degrees of freedom are required. An alternative approach, which is suggested by the Nerlove and Arrow treatment of advertising expenditures, is to specify in the demand equation a single variable, "goodwill". In this approach the goodwill variable summarizes the influence of current and past advertising expenditures, i.e.,

$$A_t = \sum_{i=0}^{n} w_i a_{t-i} \qquad (1)$$

where w_i are weights which vary according to the decay structure of goodwill and n is the number of periods (possibly infinite) required for a current stock of goodwill to entirely depreciate. In addition to the intuitive appeal of the approach, it has the advantage of simplicity in terms of constructing tests for seasonality in the advertising response when appropriate restrictions are placed on the form of equation (1).

Incorporating the foregoing considerations, a demand equation of the following type is specified:

$$\begin{aligned} \ln q_t = {} & \alpha_0 + \alpha_1 Z_t + \alpha_2 \ln I_t + \alpha_3 \ln PM_t + \\ & \alpha_4 \ln PC_t + \alpha_5 \ln PCF_t + \alpha_6 \ln RACE_t + \\ & \sum_{j=1}^{12} \eta_j D_{j,t} \ln A_t + \varepsilon_t \end{aligned} \qquad (2)$$

where[1/]

q = per capita daily fluid milk sales adjusted for the calendar composition of the month,

Z = a vector of harmonic variables to denote seasonality in the intercept term,

I = per capita before-tax personal income in 1967 dollars,

PM = retail price of milk in paper quart containers in 1967 dollars,

PC = cola price index deflated by the CPI (1967=100) for all items,

PCF = coffee price index deflated by the CPI for all items,

RACE = percentage of the population which is nonwhite,

D_j = twelve zero-one dummy seasonality variables, and

A = stock of goodwill measured as a weighted average of current and past advertising expenditures.

Equation (2) is similar to the milk demand equation specified in Kinnucan (1982, p. 2) with some notable exceptions. First, milk sales follow a fairly regular seasonal pattern from year to year, dropping to a low point during the summer months. This suggests that harmonic variables (Doran and Quilkey) will adequately substitute for the eleven monthly intercept dummy variables used in the earlier specification. This substitution simplifies the model and, more importantly, reduces multicollinearity problems that arise when intercept and slope coefficients are specified to simultaneously change with the seasons. Second, equation (2) does not contain age and trend variables as did the earlier specification. Although potentially relevant, these variables are highly collinear with the race variable and with each other. Hence their independent effects cannot be determined very precisely by regression procedures and are omitted from the model.[2/] Finally, equation (2) differs fundamentally from previous specifications in that a single "goodwill" variable replaces the distributed lag specification of the advertising variable. Further, the "goodwill effect" is permitted to vary on a month-to-month basis via the use of dummy variables.

To simplify the estimation of an equation containing a goodwill variable, some restrictions are usually imposed on the form of the decay

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[1/] The actual data along with a more complete description of the variables are provided in Kinnucan (1982).

[2/] The nature of the bias introduced into the estimated parameters of the milk demand equation when age and/or race factors are ignored is discussed in Kinnucan (1982).

structure, i.e., w_i in equation (1). Nerlove and Waugh, using annual data to study the demand for oranges, chose a weight of one for current period advertising and a constant proportional weight of 1/10 for each of the previous ten years of advertising. Another approach (Ball and Agrawala) assumes that the contribution of past advertising expenditures to current period goodwill declines geometrically with time, i.e., $w_i = (1-\lambda)^i$. A more flexible approach than either allows the decay structure to follow a Pascal distribution (Theil p. 265) where

$$w_i = \frac{(r + i - 1)!}{(r - 1)\lambda!i!} (1-\lambda) \lambda^i \quad i=0,1,2,\ldots,n.$$

$$\sum_{i=0}^{n} w_i = 1. \tag{3}$$

The Pascal distribution can assume a wide variety of shapes depending upon the choice of values for the two parameters r and λ. For example, for r=1 the weights decline monotonically, but for r=2 they may increase up to a certain maximum and then decline toward zero (table 1).[3/]

Table 1. PASCAL DISTRIBUTIONS FOR VARIOUS VALUES OF λ WHEN r=2.

Weight	λ			
	0.4	0.4	0.6	0.8
w_0	0.64	0.36	0.16	0.04
w_1	0.26	0.29	0.19	0.07
w_2	0.08	0.17	0.17	0.08
w_3	0.02	0.09	0.14	0.08
w_4	0.01	0.05	0.10	0.08
w_5	--	0.02	0.07	0.08
w_6	--	0.00	0.02	0.05
w_7	--	--	0.01	0.04

[3/] Bultez and Naert, using an iterative procedure to select λ, conditional on r, estimated goodwill elasticities based on values of r ranging from 1 to 6 and found that "(a)s r increases, λ diminishes in such a way that the mean lag and its standard deviation stabilize as soon as r equals 2." As an example, when r=2, λ =.44 and η (the sales-goodwill elasticity) equals 0.54; when r=6, λ=0.18 and η =0.52. The estimated goodwill elasticity appears relatively insensitive to alternative values of beyond 2. Hence, the range of choice should be narrowed, a priori, to considerations of various Pascal distributions based exclusively on r=2.

A formal test for seasonality in the milk sales response to goodwill (and by implication to advertising) can be constructed by forming the hypothesis

$$H_N \; : \eta_1 = \eta_2 = \cdots\cdots = \eta_{12} = \eta^* \qquad (4)$$

$$H_A \; : H_N \text{ not true}$$

where η_i are the twelve monthly goodwill elasticities specified in equation (2). Under the null hypothesis that the goodwill elasticity is invariant with respect to seasons, equation (2) is reduced to:

$$\ln q_t = \alpha'_0 + \alpha'_1 Z \quad + \alpha'_2 \ln I_t + \alpha'_3 \ln PM_t +$$

$$\alpha'_4 \ln PC_t + \alpha'_5 \ln PCF_t + \alpha'_6 \ln RACE_t +$$

$$\eta^* \ln A_t + \varepsilon'_t. \qquad (5)$$

An F-test, which compares the residual sums of squares (RSS) from equation (5) with the RSS of equation (2) provides an objective basis for discriminating between the null and alternative hypotheses. In particular, in the formula

$$F = \frac{[RSS(H_N) - RSS(H_A)/R]}{RSS(H_A)/(N-K)} \qquad (6)$$

where R is the number of restrictions--in this case 12--implied by the null hypothesis and (N-K) is the degrees of freedom under the alternative hypothesis, if the computed F-value exceeds some critical F probability value the null hypothesis H_N is rejected in favor of the alternative hypothesis H_A.

<u>The Data</u>: Data pertaining to the New York City metropolitan area were used to estimate the equations. These data were chosen because nonbrand advertising and promotion of milk in this market has been fairly heavy (12.2 million dollars in media advertising since 1971), monthly sales and advertising expenditures for the period January 1971 through June 1980 are readily available,[4/] and the results from previous research relating to this market can be drawn upon.

While the milk sales figures exhibit a fairly regular seasonal pattern, advertising expenditures typically vary widely from one month to the next and show no seasonal pattern (figure 1). The wide variation in

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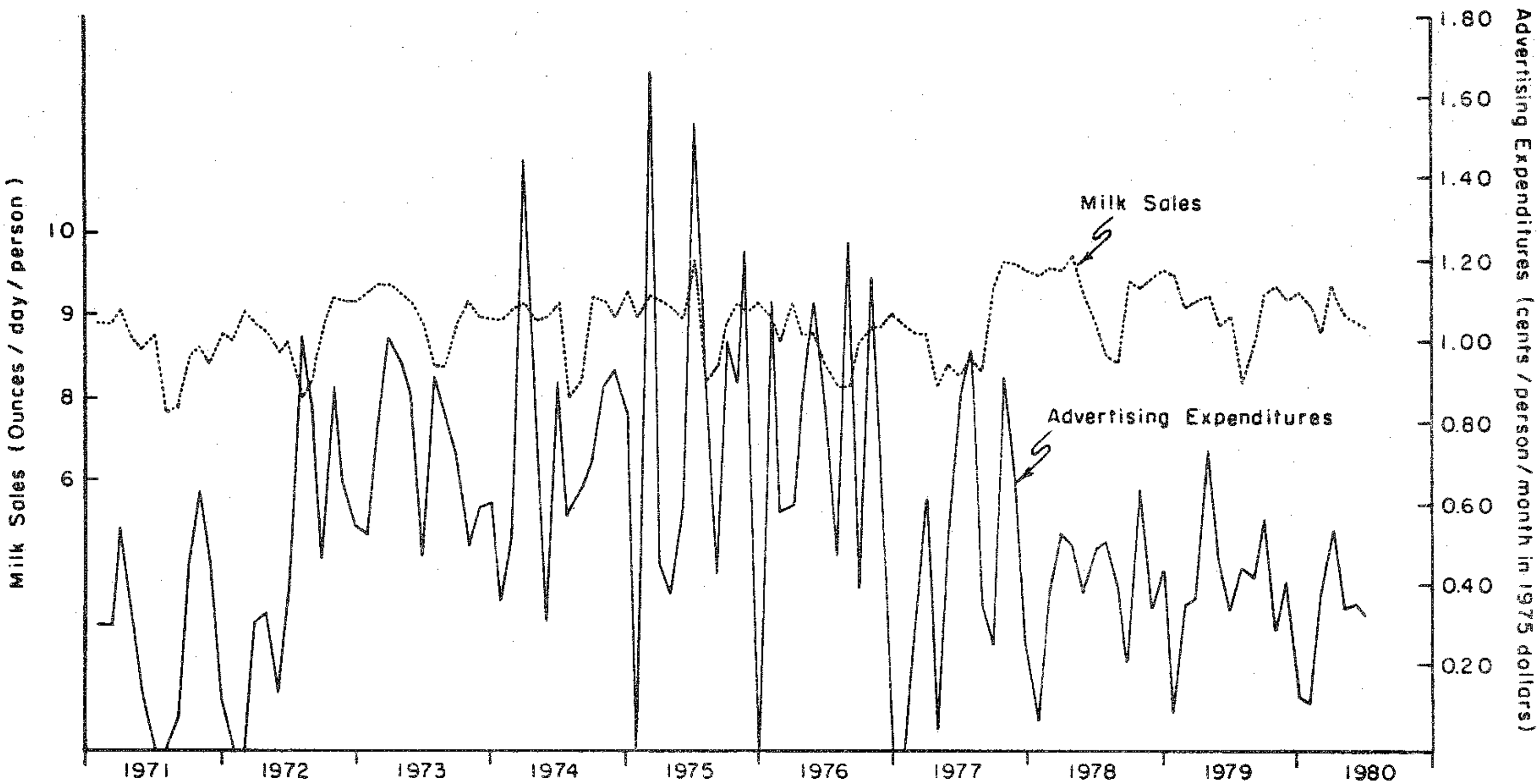
[4/] The milk sales data pertain to the five boroughs plus Nassau, Rockland, Suffolk and Westchester counties. Advertising figures were made available by the American Dairy Association/Dairy Council of New York. The efforts of Lyle Newcomb and Ed Johnston of the New York State Department of Agriculture and Markets in collecting these data are greatly appreciated.

FIGURE 1. PER CAPITA MILK SALES AND NONBRAND MILK ADVERTISING EXPENDITURES
New York City Metropolitan Area, January 1971 - June 1980.



the advertising expenditures is fortuitous because of the efficiency of the regression estimates of the advertising effect and because of the minimizing of the potential problem of spurious correlation between sales and advertising that arise, e.g., when advertising expenditures are budgeted to vary with the volume of sales (e.g., Ashley et al.). Furthermore, the fact that the highest and lowest levels of advertising do not consistently occur in the same months each year means that any seasonality in the advertising effect would not be caused by the level of advertising. For example, if the highest levels of advertising always occurred in June and the regression results indicate that the largest sales response to advertising also occurs in June, one would not know whether this finding is the result of the higher levels of advertising in June or because consumers are more responsive to milk advertising in June.

Regression Results: Equations (2) and (5) were estimated under the assumption that six months after the original expenditure milk advertising ceases to contribute significantly to goodwill, i.e., n in equation (1) is restricted to equal six.[5/] This assumption seems reasonable; Clarke, in a survey of the econometric literature dealing with sales-advertising studies concluded that (p. 355) "...90 percent of the cumulative effect of advertising on sales of mature, frequently purchased, low-priced products occurs within 3 to 9 months of the advertisement." In addition, specific studies relating to milk demand indicate a sales-advertising lag ranging from two to six months (Thompson, Eiler and Forker, and Kinnucan 1982). A further implicit assumption with respect to equation (2) is that the length of the goodwill decay period is invariant across the seasons.

The appropriate value for λ, the Pascal distribution parameter, was determined by applying OLS iteratively to equation (5) allowing λ to assume a range of values within the unit interval. The value of λ (to two decimal places) yielding the highest explanatory power for the model in terms of R^2 is deemed "best." Friedman and Meiselman (quoted in Rao and Miller p. 18) provide the rationale for this approach: "the argument for this procedure is that the precise empirical definition of variables should be selected so as to put the theory in question in its best light."

Equation (5) was originally estimated with all eleven harmonic variables for different values of λ. It was found that regardless of the value of λ, four harmonic variables, $sine_1$, cos_1, $sine_2$ and cos_4, explained the major part (85 percent)[6/] of the seasonal variation in the intercept of the demand equation. Therefore these four variables were

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5/ All regression estimates were computed using the econometric software package, TROLL.

6/ The formula used to compute this percentage is: $V_k = \zeta_k^2 / \sum_{i=1}^{11} \zeta_i^2$ where V_k is a measure of the contribution of kth harmonic term to the total seasonal variation explained by the model, and ζ_i is the OLS estimate of the effect of the ith harmonic term (Doran and Quilkey p. 648).

deemed sufficient to account for the seasonal pattern in the demand for milk and are retained in the remaining analysis.

The regression results indicate that a global maximum in R^2 for the constant-seasonality model was achieved when $\lambda=0.76$ (table 2, model A). The regression equation "explains" 73 percent of the observed variation in milk sales and represents a statistically significant relationship as indicated by the F-value (F=25.6 compared with a 1 percent critical F value of 1.88). The Durban-Watson statistic (D.W.=1.55) suggests the absence of first-order serial correlation. A regression test for twelfth-order serial correlation was also negative.[7/]

The harmonic variables used to capture seasonality in the intercept were all statistically significant at the 1 percent level. The two "fundamental harmonics," sine_1, and $\cos_1$, alone accounted for 61 percent of the total seasonality explained by the eleven harmonic variables originally included in the model. The sine_2 and $\cos_4$ harmonics contributed an additional 24 percent to the explained seasonality, so that these four harmonic variables represented 85 percent of total seasonality explained by the original set of eleven harmonics.

The income elasticity was estimated to be 1.12 and was statistically significant at the 1 percent level. The magnitude of this elasticity seems implausibly large since most studies have found the demand for milk to be income-inelastic. For example, Boehm put the income elasticity for milk in the New York City market at 0.088-0.168 (p. 41). One explanation may be that the omission of age and trend variables from the model resulted in an upward bias. When these two variables were included in the model the estimated income elasticity became a more plausible 0.416 (Kinnucan 1982, p. 6).

The estimated price elasticity for milk was -0.040. This estimate, while imprecise as indicated by its large standard error, is consistent with findings of other studies which show the demand for milk to be price inelastic in the short run. For example, the Boehm study put the own-price elasticity for milk in New York at -0.136 to -0.328. The imprecision of the estimated price effect in the current study was because the real price of milk was nearly constant over the period studied.

The estimated cross elasticities pertaining to soft drinks and coffee were positive but small, indicating that consumers regard these beverages as weak substitutes for milk. The smallness of these elasticities is somewhat misleading however, in the sense that cola and coffee prices can change dramatically over short periods of time and hence can have a significant effect on milk consumption. For example, between January 1976 and July 1977 the real price of coffee increased 138 percent. According to the estimated cross price elasticity for coffee (0.022), a coffee price

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[7/] When monthly data are used to estimate a model where seasonal variation exists in the dependent variable, twelfth-order autocorrelation is more likely to be a problem than first-order autocorrelation, particularly if the regressors inadequately account for seasonality (see Wallis).

Table 2. REGRESSION RESULTS FOR ALTERNATIVE SPECIFICATIONS OF THE MILK DEMAND EQUATION AND ALTERNATIVE ADVERTISING DECAY STRUCTURES[1] New York City Metropolitan Area, July 1971 - June 1980 Data.

Independent Variable	Model A		Model B					
	$\lambda = 0.76$		$\lambda = 0.40$		$\lambda = 0.76$		$\lambda = 0.90$	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Intercept	-6.574	-4.80	-6.448	-5.07	-7.023	-5.78	-6.695	-5.41
sine 1	0.024	6.03	0.066	1.70	0.089	1.83	0.097	1.56
cos 1	0.026	6.87	0.022	0.49	-0.011	-0.23	-0.034	-0.63
sine 2	-0.023	-6.38	-0.134	-3.22	-0.058	-1.26	-0.069	-1.23
cos 4	0.018	4.90	0.029	0.71	0.037	0.83	0.051	0.94
Income	1.124	6.13	1.089	6.45	1.191	7.32	1.150	6.94
Milk Price	-0.040	-0.52	-0.014	-0.19	-0.037	-0.54	-0.033	-0.46
Cola Price	0.151	2.98	0.156	3.29	0.154	3.41	0.146	3.17
Coffee Price	0.022	1.44	0.022	1.53	0.026	1.88	0.022	1.59
Race	-0.395	-2.84	-0.356	-2.81	-0.431	-3.46	-0.398	-3.13
A	0.056	6.60	—	—	—	—	—	—
A* Jan.	—	—	0.028	2.39	0.052	3.32	0.045	2.91
A* Feb.	—	—	0.031	2.80	0.058	3.70	0.052	3.28
A* Mar.	—	—	0.059	4.72	0.076	5.31	0.073	5.03
A* Apr.	—	—	0.075	5.55	0.078	5.80	0.075	5.21
A* May	—	—	0.071	5.25	0.074	5.77	0.072	5.33
A* June	—	—	0.051	3.90	0.068	5.43	0.067	5.43
A* July	—	—	0.029	3.28	0.056	4.33	0.053	3.97
A* Aug.	—	—	0.024	2.78	0.049	3.72	0.045	3.31
A* Sept.	—	—	0.040	2.92	0.050	3.87	0.049	3.67
A* Oct.	—	—	0.056	3.22	0.048	3.66	0.044	3.49
A* Nov.	—	—	0.065	3.64	0.056	4.24	0.049	4.03
A* Dec.	—	—	0.052	3.59	0.062	4.32	0.056	4.09
R^2	0.726		0.791		0.813		0.803	
$\bar{R}^2$	0.697		0.740		0.767		0.755	
F	25.6		15.5		17.8		16.7	
DW	1.55		1.36		1.43		1.34	
RSS	0.07022		0.05342		0.04795		0.05033	

increase of this magnitude would have been associated with an increase in per capita milk consumption of 3.0 percent, ceteris paribus. Similarly, applying the estimated cross price elasticity for cola (0.151) to the 38 percent increase in real cola prices that occurred between January 1974 and May 1975 should have caused a 5.7 percent increase in per capita milk consumption, ceteris paribus. The t-ratios indicated that the cola and coffee cross price elasticities were statistically significant at the 1 percent and 15 percent levels, respectively.

The goodwill elasticity was estimated to be 0.056 and was statistically significant at the 1 percent level. This estimate is consistent with the finding of Lambin (cited in Bultez and Naert p. 463, fn. 23) that most estimated sales-goodwill elasticities are less than 0.10. The decay structure for goodwill implied by the Pascal distribution when λ assumed a value of 0.76 was hump-shaped. Specifically, the weights, normalized to sum to one, were $w_0 = 0.101$, $w_1 = 0.153$, $w_2 = 0.174$, $w_3 = 0.175$, $w_4 = 0.167$, $w_5 = 0.153$, $w_6 = 0.078$. According to the maximum R^2 criterion, the geometrically declining decay structure (λ=0.4) as well as the constant proportional decay structure (λ=0.9 - used by Nerlove and Waugh) were not appropriate for these data.[8/]

OLS estimates of equation (2) indicate that a value of $\lambda = 0.76$ also maximized R^2 in the seasonally varying-slope model (table 2). This model explained 81 percent of the variation in milk sales compared with 73 percent for the constant slope model. An F-test indicated that the hypothesis of no seasonal variation in the goodwill elasticity could be rejected at the 1 percent level of statistical significance (F=3.63 compared with $F_C(0.01;\ 11,\ 86) = 2.47$). Whether the model is specified in constant- or varying-slope form does not seem to make much difference on the estimated parameters of the economic and race variables--(t-ratios for these variables are somewhat larger in the varying-slope model, however). By contrast, the estimated parameters of the harmonic variables change considerably when the model is modified to permit seasonal change in the goodwill elasticity.

In addition to the statistically significant improvement in explanatory power achieved by the model specification which permits seasonal variation in the goodwill effect, the OLS estimates of the individual monthly goodwill elasticities themselves are very precisely determined as judged by their large t-ratios (all in excess of 3.22). These estimates

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[8/] The fact that a fairly large value of λ was required to maximize R^2 suggests that the goodwill generated by nonbrand milk advertising may take longer than six months to dissipate. Consequently, the estimated goodwill elasticity may be downwardly biased because of truncation error. However, the main purpose of this analysis was to investigate potential seasonality in the milk sales response to advertising. Extending the period over which goodwill decays would improve the estimates of the individual goodwill parameters, but probably would not affect the estimated seasonal pattern in this response. To avoid unnecessary complications, the six-month decay period was retained.

trace a fairly smooth seasonal pattern, i.e., peaking in the spring and troughing in the summer months. This finding suggests that the cumulative effects of milk advertising are greatest (least) in months when consumers have the strongest (weakest) preference for milk. In particular, the estimated goodwill elasticities indicate that the cumulative effects of milk advertising during the months of March, April and May are nearly twice as large as during the months of August, September and October. Furthermore, the estimated seasonal pattern in the goodwill elasticities is preserved across a wide range of assumed shapes for the decay structure for goodwill: choosing values of λ less than 0.76 resulted in a more accentuated seasonal pattern; values of λ near unity reduced the seasonal variation (figure 2). This fact, combined with the strong statistical performance of the model which permits seasonal variation in the goodwill elasticity, should increase confidence in the validity of the results.

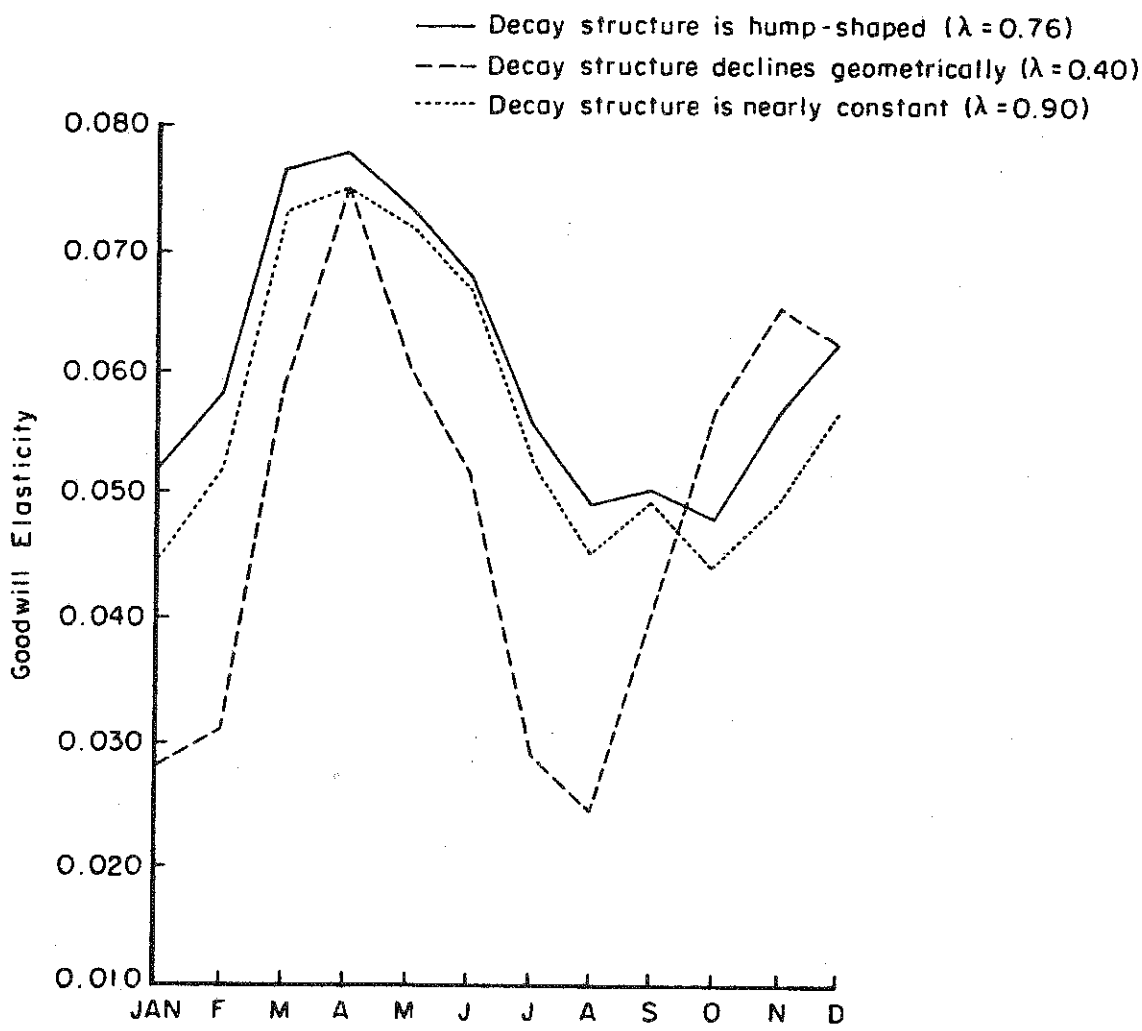
The Optimal Level and Seasonal Allocation of a Generic Advertising Budget for Fluid Milk

The study by Thompson and Eiler revealed that the economic effectiveness of fluid milk advertising is particularly sensitive to (a) the Class I-Class II price differential, (b) the Class I utilization rate and (c) the ability of advertising to increase sales. As each of these parameters increases in size, producer returns from milk advertising increase. Historical data show that Class I-Class II price differentials and Class I utilization rates change throughout the year; in some years quite dramatically. For example, in 1974 the Class I-Class II milk price differential in the New York-New Jersey Federal Milk Marketing Order ranged between \$3.93 in June and \$1.91 in September (see appendix tables). The Thompson, Eiler and Forker study estimated that each 20¢ rise in the Class I-Class II price differential would increase the optimal advertising budget by approximately eight percent.[9/] This suggests that considerations of the Class I-Class II price differential alone in 1974 would have led to an 81 percent larger advertising expenditure for June than for September (\$3.93-\$1.91/\$.20 X 8% = 81%).

As revealed in the statistical analysis of the previous section, there also appears to be a significant seasonal variation in the ability of milk advertising to influence sales. These factors suggest that improved temporal expenditure decisions can be made if seasonal variations in these parameters are taken into account. This section explores this suggestion by utilizing the economic model developed by Thompson, Eiler and Forker to compute an "optimum" monthly advertising budget for the New York City market that is based on monthly variation in Class I-Class II price differential, Class I utilization rate and the seasonal pattern of the sales response to advertising.

[9/] The "optimal" expenditure is that level of advertising which maximizes producers' surplus less the cost of advertising at some specified rate of return on alternative forms of investment. As Nerlove and Waugh point out (p. 825 and p. 833) the "optimal" level so computed actually represents only an upper bound to the optimal level of advertising.

FIGURE 2. ESTIMATED SEASONAL GOODWILL ELASTICITIES FOR FLUID MILK ADVERTISING UNDER ALTERNATIVE GOODWILL DECAY STRUCTURES:[1/] New York City Metropolitan Area



[1/] Monthly estimates based on data covering January 1971 - June 1980

Application of the TEF model requires values for the following parameters:

P_B = blend price of milk,

P_{II} = price of Class II milk,

P_D = price differnce between Class I and Class II milk,

k = Class I utilization rate,

γ = intercept of the milk supply equation,

δ = slope of the milk supply equation,

ψ = intercept of the Class I demand equation, and

β = estimated long-run advertising elasticity.

Data for the P_{II} and P_D parameters are directly available from published sources (appendix tables 3 and 4). The values for the remaining parameters were obtained using procedures described below.

The supply equation parameters were computed from the formulas $\gamma = Q(1-\eta_{Q \cdot P})$ and $\delta = \eta_{Q \cdot P} \cdot Q/P_B$ where Q = total quantity of milk supplied to the market, $\eta_{Q \cdot P}$ = price elasticity of supply, and P_B = uniform blend price of milk. A value for Q was computed from the equation $Q = Q_I/k$ where Q_I is the estimated quantity of Class I milk supplied to the market (based on the regression equation (5)) and k is the proportion of milk production sold as Class I in the Federal Order 2 marketing area. A value of 0.8 was used for $\eta_{Q \cdot P}$.[10] Annual average values, rather than monthly values for P_B and P_{II} were used since model results are not sensitive to these parameters.

Values used for the demand parameters ψ and β were based on the regression estimates of the milk demand equation (model B (λ=0.76), table 2). The intercept ψ is composed of all variables except goodwill evaluated at their mean values. This provides a value of ψ=2.54462.

Values for β were derived from the estimated goodwill elasticities in a two-step procedure. First, the goodwill elasticities were disaggregated using the formula $\beta_{ij} = w_i \eta_j$ where w_i (i=0,1,2...6) are the Pascal lag weights (assumed invariant across seasons) and η_j is the estimated goodwill elasticity corresponding to the jth month (j=1 for January, j=2 for February, etc.). This step provides an estimate of the effect of advertising expenditures placed in the j-i month on sales in the jth month.[11] The β_{ij}'s were then recombined to provide estimates of the

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[10] Sensitivity analysis revealed that the model results are not greatly affected by changes in the price elasticity of supply (Thompson and Eiler). The $\eta_{Q \cdot P}$ = 0.8 is the "best estimate" for long-run supply response used by Thompson (1978).

[11] The actual disaggregated values of the goodwill elasticities are provided in appendix table 1.

implied monthly long-run advertising elasticities.[12/] As expected on the basis of the estimated seasonal pattern in the goodwill elasticities, the corresponding long-run advertising elasticities also exhibited a seasonal pattern - achieving their highest values in the winter and early spring months and the lowest values in the summer months (table 3).

Table 3. ESTIMATED MONTHLY GOODWILL ELASTICITIES AND THE IMPLIED LONG-RUN ADVERTISING ELASTICITIES

Month	Goodwill Elasticity	Long-Run Advertising Elasticity
January	0.05230	0.068201
February	0.05782	0.067834
March	0.07616	0.065244
April	0.07835	0.060499
May	0.07441	0.056281
June	0.06775	0.054074
July	0.05641	0.053081
August	0.04898	0.053476
September	0.05027	0.056346
October	0.04791	0.060592
November	0.05570	0.064731
December	0.06162	0.067310

An interesting aspect of the disaggregation procedure is that it provides some insight into the effects that seasonally varying preferences for milk have on the initial and carryover effects of milk advertising. For example, advertising milk in March, the month when per capita milk consumption is typically at its highest level, has a greater initial, peak, and total effect than does advertising milk in July, a month of relatively low milk consumption (figure 3). Further, March advertising achieves its maximum impact two months later whereas July advertising does not achieve its maximum impact until five months later. These comparisons highlight the importance that seasonally varying preferences in demand may have on the structure of the dynamic response of sales to advertising.

The parameter values discussed above were used in the TEF model to derive an estimate of the optimal seasonal allocation of generic advertising expenditures for fluid milk in the New York City area. Simulations were run for the most recent three years for which complete advertising

[12/] A complete breakdown of these elasticities is provided in appendix table 2.

FIGURE 3. ADVERTISING LAG STRUCTURES FOR MILK ADVERTISEMENTS PLACED IN MARCH VS. JULY, New York City Metropolitan Area

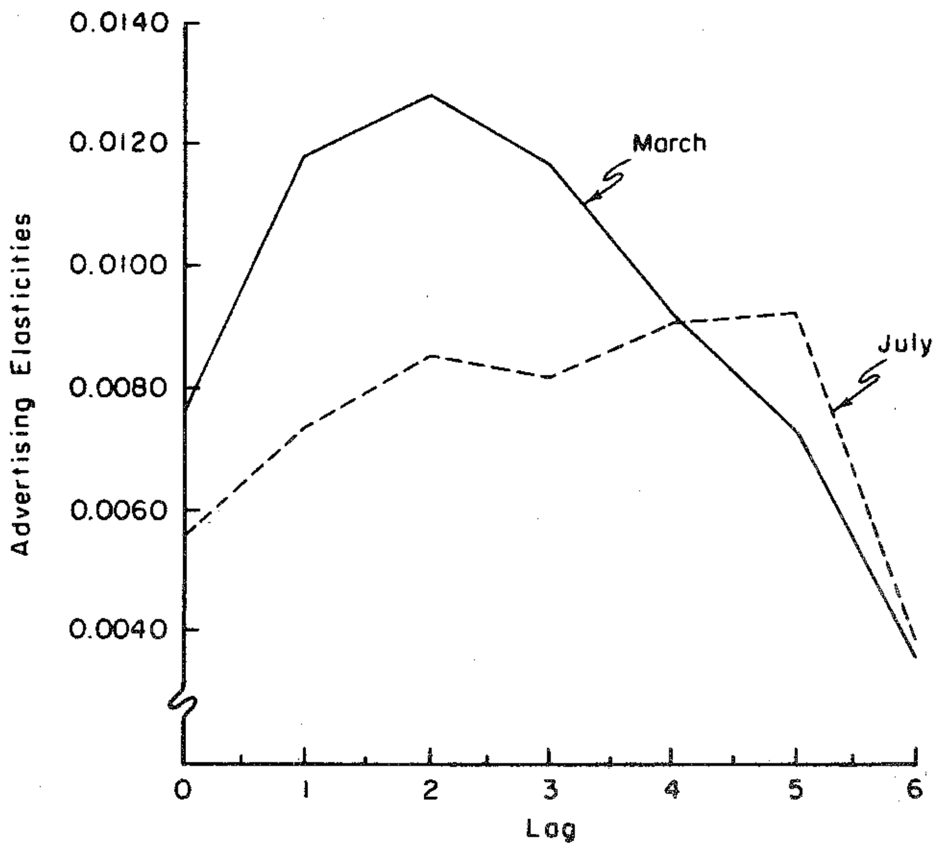

Table 4. MILK ADVERTISING: ACTUAL VS. OPTIMAL[a] MONTHLY EXPENDITURES, New York City Metropolitan Area, 1977-1979

Month	1977 Actual	1977 Optimal	1978 Actual	1978 Optimal	1979 Actual	1979 Optimal
	--------	--------	--------	1975 dollars	--------	--------
January	0	251,504	17,052	214,801	18,454	214,743
February	52,496	230,417	69,988	193,836	63,759	214,065
March	112,587	232,417	95,885	204,138	68,017	227,000
April	10,451	185,516	93,459	191,306	130,741	204,902
May	95,614	197,514	70,331	196,909	84,572	205,262
June	156,222	212,784	89,658	197,089	64,024	186,757
July	175,584	199,877	92,280	181,366	81,546	170,049
August	64,549	192,606	72,946	143,051	76,795	151,544
September	48,044	192,060	40,122	133,111	101,592	144,717
October	164,741	208,785	115,034	152,630	53,424	187,655
November	124,789	202,240	63,134	151,003	74,602	213,166
December	50,428	207,149	79,240	174,860	23,949	212,268
Annual	1,055,505	2,512,869	899,129	2,134,100	841,475	2,332,128

[a] The optimal advertising expenditure is computed using an economic model which maximizes producer surplus less cost of advertising. It is assumed that alternative uses of the advertising funds could earn a 20 percent marginal rate of return.

data were available (1977-79). All model parameters except the Class I-Class II price differential, the Class I utilization rate, and the long-run advertising elasticities are held constant at their annual mean values.

The simulation results indicate that the actual level of advertising in each of the three years was substantially below the maximum-optimal expenditure, e.g., in 1977 $1,055,505 million (in 1975 dollars) was spent on generic advertising of milk in New York City compared with an estimated optimal expenditure of $2,512,869 million (table 4). Similarly, in 1978 and 1979 actual advertising expenditures were $899,129 and $841,475, respectively, compared with corresponding maximum optimal levels of $2,134,100 and $2,332,128.

Optimal monthly expenditures exceed actual monthly expenditures over the entire 36-month period. Furthermore, the optimal monthly expenditure pattern is fairly regular oacross the three years - generally highest in the first quarter and lowest in the third quarter, whereas the actual monthly expenditure pattern is highly irregular from year to year.

This disparity between the actual and optimal monthly allocation of the advertising budget is perhaps more readily apparent when discussed in terms of percentages. During the years 1977-79 actual advertising expenditures in January never exceeded 2.2 percent of the annual budget (table 5). By comparison, the model results suggest that maximization of producer surplus would require an average budget allocation of 9.8 percent for January. Similarly, in September - the month with the smallest average optimal allocation (6.7 percent) - the actual allocation was less than the optimal in 1977 and 1978 (4.6 percent and 4.5 percent, respectively), but considerably larger than the optimal in 1979 (12.1 percent). In general, the actual monthly allocation (as a proportion of the annual budget) tended to be less than the optimal allocation in the first quarter months and greater than optimal in the second and third quarter months, i.e., four months received an overallocation and five months an underallocation.

In summary, the simulation results indicate that the actual annual milk advertising expenditures in New York City for the years 1977-79 were well within the maximum optimal level of investment. Dairy producers could have profitably doubled the level of advertising in all of these years. The simulation results also suggest that the annual advertising budget should be fairly evenly distributed throughout the year varying slightly in concert with seasonal shifts in the consumer demand for milk. Because actual advertising expenditures in any given month over the three-year period ranged from zero to 16.6 percent of the annual advertising budget, and because this monthly variation followed no regular seasonal pattern, considerable gains in the effectiveness of the advertising investment should be apparent when advertising expenditures are changed according to the optimal seasonal pattern. This contention is explored in the next section.

Table 5. MILK ADVERTISING: ACTUAL VS. OPTIMAL MONTHLY ALLOCATION OF THE ANNUAL BUDGET, New York City Metropolitan Area, 1977-1979

Month	1977		1978		1979	
	Actual	Optimal	Actual	Optimal	Actual	Optimal
	percent					
January	0.0	10.0	1.9	10.1	2.2	9.3
February	5.0	9.2	7.8	9.1	7.6	9.2
March	10.7	9.2	10.7	9.6	8.1	9.7
April	1.0	7.4	10.4	9.0	15.5	8.8
May	9.1	7.9	7.8	9.2	10.1	8.8
June	14.8	8.5	10.0	9.2	7.6	8.0
July	16.6	8.0	10.3	8.4	9.7	7.3
August	6.1	7.7	8.1	6.7	9.1	6.5
September	4.6	7.6	4.5	6.2	12.1	6.2
October	15.6	8.3	12.8	7.2	6.4	8.0
November	11.8	8.0	7.0	7.1	8.9	9.1
December	4.8	8.2	8.8	8.2	2.8	9.1
Annual	100	100	100	100	100	100

Producer Returns and Seasonal Allocation of Milk Advertising Expenditures

Producer returns from milk advertising are maximized when the expenditures follow a fairly regular seasonal pattern that varies only slightly from month to month. By contrast, the actual monthly pattern of advertising expenditures over the past ten years is highly irregular. This wide disparity between the actual and optimal expenditure pattern suggests that the economic effectiveness of milk advertising in New York City could have been enhanced had the actual expenditure pattern more nearly approximated the optimal pattern.[13/] Because factors not included in the economic model, such as discounts obtainable by the advertising agency for placing ads in certain months, also affect the calculation of the most effective temporal allocation of advertising budget, it is important to have a measure of the magnitude of the potential gains achievable from following the expenditure pattern indicated by the economic model. To that end, estimated milk sales under a prescribed seasonal pattern of advertising expenditures are compared with estimated milk sales given the actual pattern of expenditures. The farm value of the difference under the two regimes are computed to provide a measure of the potential gains. The estimates pertain to the New York City metropolitan area and cover the period January 1972-June 1980.

A Seasonal Optimization Rule: The econometric model estimated earlier (table 2, model B (λ=0.76)) was used to estimate monthly milk sales assuming that the annual advertising budget on each calendar year had ben allocated across the quarters following a 30-25-20-25 rule.[14/] The same econometric model is then used to estimate monthly sales given the actual pattern of advertising expenditures. The difference in these estimates is the additional milk sales attributable to the seasonal allocation of the advertising expenditures. The farm value of this

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13/ The wide disparity is also fortuitous in that it permits one to empirically validate the results of the simulation analysis based on the economic model.

14/ This rule places 30 percent of the annual advertising budget in the first quarter, 25 percent in the second and fourth quarters and 20 percent in the third quarter. This results in an advertising expenditure pattern that roughly approximates the average "optimal" pattern computed for the years 1977-1979 (see table 5). Because advertising in the final six months of year t affects sales in the first six months of year t+1 the effective period over which advertising influences sales in year t+1 is 18 months. Reallocating advertising expenditures on a calendar year basis may result in different quantities of advertising under the actual and seasonal pattern regimes over the 18 month period. To insure that measured sales differences are due strictly to advertising expenditure pattern differences (and not to differences in the quantity of advertising) the reallocated expenditures were adjusted proportionally over the 18-month period so that they summed to an amount equal to that spent under the actual allocation. For example, actual per capita advertising expenditures for the period July 1971-December 1972 totaled $0.074359 (in 1975 dollars). The corresponding total after reallocating the 1970 and 1972 expenditures is $0.071881. Therefore, the reallocated expenditures over sales difference was computed as the per capita monthly milk sales gain (loss) multiplied by the Class I-Class II price differential of the corresponding month times the New York City SMSA population.

Milk sales in every year but one (1973) would have been higher had the seasonal allocation rule (30-25-20-25) been followed (table 6).[15] Per capita milk sales for the period January 1972-June 1980 were estimated to be 218 ounces (0.78 percent) higher under the seasonal allocation rule. The farm value of this sales gain, in current dollars, is $4,046,557. Compared with estimates of the farm value of the advertising-induced milk sales increase computed earlier for the period 1972-79 ($43.8 million; see Kinnucan 1982) the new estimates suggest that producer returns would have been nine percent higher had the advertising budget been allocated according to the 30-25-20-25 rule.

It is worth noting that the 30-25-20-25 rule used to allocate the annual advertising budget, while fairly accurate for the period 1977-79 as judged from the simulation results, probably deviated to a greater extent from the optimal rule in some of the earlier years because of large irregular monthly swings in the Class I-Class II price differential. (For example, in 1973 the August Class I-Class II price differential was $1.65 vs. $3.11 for December; in 1974 the June price differential was $3.93 vs. $1.91 for October.) Thus the fairly consistent positive annual results obtained from application of this crude rule suggests that even an imprecise seasonal allocation of advertising expenditures along the lines suggested by the economic model is an improvement (in terms of increasing milk sales) upon an allocation which does not take into account monthly changes in the key parameters which determine the economic effectiveness of milk advertising.

A More Precise Rule: The fact that monthly movements in the key determinants of the economic effectiveness of milk advertising, namely the Class I-Class II price differentials and Class I utilization rates can be fairly accurately determined one year in advance (say at the time when advertising policy for the forthcoming year is being decided) means that the efficiency of milk advertising can be improved even further than suggested by the estimates presented in this section. The estimated demand equation can be combined with information in Class I-Class II price differentials and Class I utilization rates to predict one year in advance the expenditure pattern that will be optimum for that particular year.

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this period were multiplied by the factor $0.074359/$0.071881 to insure equivalency in the total quantity of advertising over the effective period. To obtain estimates for all nine years this procedure meant that two sets of forecasts had to be computed - one set for the years 1972, 1974, 1976, 1978 and 1980; another set for the years 1973, 1975, 1977 and 1979.

15/ Note that the reallocation can result in greater producer returns even if no increase in annual milk sales occurs, e.g., the reallocation may simply result in less milk being sold in months when milk is worth less and more sold in months when fluid milk is more highly valued.

Table 6. ESTIMATED MILK SALES UNDER THE SEASONAL AND THE ACTUAL ALLOCATION OF THE ADVERTISING BUDGET, New York City Metropolitan Area, January 1972-June 1980

Year	Estimated Milk Sales Given the: Seasonal Allocation of the Advertising Budget[a/]	Estimated Milk Sales Given the: Actual Allocation of the Advertising Budget	Additional Milk Sales Attributable to the Seasonal Allocation	Farm Value of the Milk Sales Difference[b/]
	ounces per capita	ounces per capita	ounces per capita	(current dollars)
1972	3255	3168	87	1,567,796
1973	3281	3292	-11	- 174,850
1974	3268	3246	22	552,128
1975	3300	3297	3	15,741
1976	3243	3215	28	463,762
1977	3328	3270	58	1,090,715
1978	3410	3395	15	263,648
1979	3336	3327	9	134,254
1980*	1663	1655	7	133,363
1972-1980	28,084	27,866	218	4,046,557

*First six months only.

a/Under the seasonal allocation, 30 percent of the annual advertising budget is spread evenly over the first three months of the year, 25 percent over the second quarter months, 20 percent over the third quarter months, and 25 percent over the fourth quarter months.

b/The farm value is calculated as the monthly per capita sales difference multiplied by the Class I-Class II price differential and the New York SMSA population in the corresponding month.

Limitations

Certain limitations of the study must be pointed out if the results are to be interpreted in their proper perspective. First, the procedure used to estimate the seasonality in the response to advertising (the major innovation of this study) imposes a number of implicit restrictions which may influence the estimated pattern. For example, the assumption that the lag weights and lag lengths are invariant with respect to seasons may be inappropriate. The sensitivity of the estimated goodwill elasticities to this assumption cannot be determined a priori. A longer time series of data is required before these restrictions can be relaxed. In the meantime, the finding by Bultez and Naert (p. 460) that "Different lag structures will not lead to very different implications for decision making" plus the plausibility and statistical quality of the results may mean that the practical implications of the restrictions are fairly innocuous.

Another feature of the econometric procedures which may have affected the estimated pattern in the seasonal response to advertising is the apparent collinearity between the harmonic variables (used to capture seasonality in the intercept) and the seasonally varying slope binary variables. That the estimated seasonal changes in the slope of the milk demand equation mimic intercept changes, i.e., the goodwill elasticity is larger in months when milk demand is greater and smaller in months of less demand, raises the suspicion that part of what is being estimated as slope changes is, in fact intercept changes. That the t-ratio corresponding to the harmonic variables is considerably reduced by the addition of slope dummy variables reinforces this suspicion.[16/] However, on the basis of the F-test one must clearly reject the model that assumes no seasonality in the consumer response to milk advertising.

A more general limitation of the study is that it fails to take into account a number of additional factors that affect seasonal advertising allocation decisions. Advertising behavior by competitive beverage manufacturers is ignored. The tendency for soft drink advertisements to peak during the summer months may explain the apparent reduced effectiveness of milk advertising during these months. If this nexus is valid, then a shift in the seasonal pattern of soft drink ads (or advertisements for other beverages) would result in a shift in the seasonal pattern of consumer response to milk advertising. Similarly, the potential influence of seasonal or short-term changes in the price of competitive beverages is ignored. Presumably, milk advertising would be more effective in months when soft drink, coffee and/or beer prices are higher, ceteris paribus. Given the relatively large short-term changes that have occurred in recent years in coffee and soft drink prices (e.g., the coffee index doubled between July 1976 and June 1977; the cola index advanced 20 points in the

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[16/] The same phenomenon, only to a greater extent, was observed when monthly dummy variables (rather than harmonic variables) were used to capture intercept changes. This factor, plus the regularity over time in the seasonal pattern of the demand for milk lead to the use of harmonic variables in the first place.

first half of 1980) it may be worthwhile to take a closer look at the nature of the relationship between advertising elasticities and cross-price elasticities as they relate to milk demand.

Finally, the study does not explicitly account for the cost savings that advertising agencies may achieve by having complete discretion over the monthly distribution of the annual advertising budget. Apparently the large monthly swings in milk advertising expenditures observed in the past have been dictated largely by cost considerations, i.e., television time being purchased in months when the best buys were available. The economic effectiveness of the seasonal allocation rule would be reduced to the extent that a predetermined monthly allocation of the annual advertising budget would result in fewer advertisements. The estimates presented in table 6 provide a basis for deciding whether potential benefits from this source offset potential costs.

Conclusions

Bearing in mind the limitations enumerated above some conclusions can be drawn. First, the ability of milk advertising to influence sales appears to change throughout the year in a manner consistent with observed seasonal changes in consumer preferences for milk, that is, consumers appear to be more responsive to milk advertising in months of high milk demand than in months of low milk demand. One implication of this finding, as revealed by the results of simulation analysis is that producer returns from milk advertising are maximized when advertising expenditures follow a fairly regular monthly pattern that mimics the normal seasonal milk demand pattern (with some adjustment for the lagged effect of advertising). As an example, producer returns over the period January 1972-June 1980 would have been enhanced an estimated nine percent (about $4.1 million) and per capita milk sales over this period would have increased by an estimated 0.78 percent (218 ounces per person) had advertising expenditures followed a prescribed seasonal allocation. Estimated benefits would have likely been even greater had a more precise allocation rule in each year been implemented.

Milk advertising expenditures being fairly evenly distributed over the year, with only small fluctuation occurring in concert with demand shifts, gains corroborative support at both the theoretical and empirical level. In a theoretical analysis of advertising policy under dynamic conditions, Nerlove and Arrow concluded that (under plausible assumptions) firms should try to keep a constant ratio of sales to advertising. The optimal milk advertising expenditure pattern computed in this study is consistent with this finding. Further corroborative evidence is provided in a "pulsing" study conducted by Zielske who found that (p. 241) "the average weekly number of houewives who could remember the advertising, in the 52-week period covered by the experiment, was higher for thirteen exposures spread out over the year (29 percent) than for the same number of exposures concentrated in the first thirteen weeks of the year (21 percent)."

The results of the simulation analysis also suggest that dairy farmers could have profitably increased their investment in milk advertising in New York City in each of the years analyzed. The maximum optimal annual level of investment was computed to be (in 1975 dollars) $2,512,869, $2,134,100 and $2,332,128 in 1977, 1978 and 1979, respectively. The corresponding actual levels of investment are $1,055,505, $899,129 and $841,475.

The widely fluctuating monthly pattern of milk advertising expenditures in the New York City market over the past ten years has provided an ideal opportunity not only to examine the impact of a more regular expenditure pattern on sales, but also to obtain "good" statistical results when examining the relationship between milk sales and advertising. Consequently, one drawback of a change to a more regular pattern of expenditures is that it might reduce the usefulness of standard econometric tools in providing unambiguous information on the continuing effectiveness of milk advertising. For example, if advertising expenditures are intentionally timed to coincide with seasonal shifts in milk demand, a statistical correlation between milk sales and advertising will exist a priori. Consequently, questions of causality must be addressed if econometric results are to be regarded as nonspurious. Further, reduced variation in advertising expenditures means that the estimated statistical relationship between sales and advertising will be less precise. While these are technical matters, they may affect the quality of evaluative evidence available to promotion managers and public officials charged with the responsibility of monitoring producer-funded promotional schemes.

The results presented in this study suggest that appropriate timing of milk advertising expenditures can significantly increase the effectiveness of the investment. Monthly changes in the farm value of Class I milk, the Class I utilization rate, and the ability of milk advertising to influence sales affect the profitability of the advertising investment. Managers of milk promotional funds may want to take a closer look at the likely changes in these factors so as to allocate annual advertising budgets throughout the year in a manner which provides the maximum possible return from the advertising investment.

APPENDIX

Appendix Table 1. IMPLIED DECAY STRUCTURE OF THE ESTIMATED MONTHLY GOODWILL ELASTICITIES,[a/] New York City, 1971-1980 Data.

Month	B_0	B_{-1}	B_{-2}	B_{-3}	B_{-4}	B_{-5}	B_{-6}	ΣB_i
January	0.5282	0.8002	0.9048	0.9152	0.8734	0.8002	0.4079	5.230
February	0.5840	0.8846	1.0003	1.0118	0.9656	0.8846	0.4510	5.782
March	0.7692	1.1652	1.3176	1.3328	1.2719	1.1652	0.5940	7.616
April	0.7913	1.1988	1.3555	1.3711	1.3084	1.1988	0.6111	7.835
May	0.7515	1.1385	1.2873	1.3022	1.2426	1.1385	0.5804	7.441
June	0.6843	1.0366	1.1721	1.1856	1.1314	1.0366	0.5284	6.775
July	0.5697	0.8631	0.9759	0.9872	0.9420	0.8631	0.4400	5.641
August	0.4947	0.7494	0.8474	0.8571	0.8180	0.7494	0.3820	4.898
September	0.5077	0.7691	0.8697	0.8797	0.8395	0.7691	0.3921	5.027
October	0.4839	0.7330	0.8288	0.8384	0.8001	0.7330	0.3737	4.797
November	0.5626	0.8522	0.9636	0.9747	0.9302	0.8522	0.4345	5.570
December	0.6224	0.9428	1.0660	1.0783	1.0291	0.9428	0.4806	6.162

Note: Divide all numbers by 100 to obtain actual estimates.

[a/] The B_i provide an estimate of the effect of past advertising expenditures on current period goodwill. For example, the B_0 pertaining to January indicates that advertising during January contributes 0.005282 percent to the estimated January goodwill elasticity of 0.05230 percent. Similarly, advertising in December of the previous year contributed 0.008002 percent to the January goodwill elasticity.

Appendix Table 2. SEASONALLY VARYING IMPACT AND LONG-RUN ADVERTISING ELASTICITIES FOR FLUID MILK New York City Market, January 1971-June 1980 Data

Month in which the Expenditure Occurred	Estimated Impact on Sales[a]							
	In the Same Month	One Month Later	Two Months Later	Three Months Later	Four Months Later	Five Months Later	Six Months Later	Estimated Total Effect
January	0.005282	0.008846	0.013176	0.013711	0.01242	0.010366	0.004400	0.068201
February	0.005840	0.011652	0.013555	0.013022	0.011314	0.008631	0.003820	0.067834
March	0.007692	0.011988	0.012873	0.011856	0.009420	0.007494	0.003921	0.065244
April	0.007913	0.011385	0.011721	0.009872	0.00818	0.007691	0.003737	0.060499
May	0.007515	0.010366	0.009759	0.008571	0.008395	0.007330	0.004345	0.056281
June	0.006843	0.008631	0.008474	0.008797	0.008001	0.008522	0.004806	0.054074
July	0.005697	0.007494	0.008697	0.008384	0.009302	0.009428	0.004079	0.053081
August	0.004947	0.007691	0.008288	0.009747	0.010291	0.008002	0.004510	0.053476
September	0.005077	0.007330	0.009636	0.010783	0.008734	0.008846	0.005940	0.056346
October	0.004839	0.008522	0.010660	0.009152	0.009656	0.011652	0.006111	0.060592
November	0.005626	0.009428	0.009048	0.010118	0.012719	0.011988	0.005804	0.064731
December	0.006224	0.008002	0.010003	0.013328	0.013084	0.011385	0.005284	0.067310

[a] The percent change in monthly sales associated with a one percent change in advertising expenditures in the current month. Thus, a one percent increase in expenditures during January increases January sales 0.0053 percent, February sales 0.0088 percent, March 0.0132, etc. The increase continues to affect sales through July for a total sales increase of 0.068 percent.

Appendix Table 3. CLASS I-CLASS II MILK PRICE DIFFERENTIALS, NEW YORK-NEW JERSEY FEDERAL MILK MARKETING ORDER, 1971-1980.

Month	Year									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	dollars per hundredweight									
January	2.54	2.37	2.26	3.09	2.33	2.31	2.44	2.1	2.11	2.12
February	2.5	2.37	2.34	3.37	2.33	3.21	2.47	2.1	2.31	2.22
March	2.6	2.48	2.33	3.13	2.44	2.75	2.33	2.12	2.26	2.08
April	2.54	2.52	2.31	2.9	2.2	2.3	2.05	2.1	2.23	2.01
May	2.58	2.62	2.41	3.74	2.36	2.82	2.21	2.21	2.29	2.3
June	2.54	2.53	2.41	3.93	2.34	2.63	2.51	2.34	2.23	2.36
July	2.36	2.36	2.25	3.01	2.03	1.96	2.34	2.14	2.02	--
August	2.3	2.21	1.65	2.22	1.71	1.63	2.26	1.73	1.82	--
September	2.28	2.27	1.65	1.94	1.42	2.59	2.25	1.62	1.74	--
October	3.35	2.23	1.7	1.91	1.94	3.07	2.24	1.69	2.03	--
November	2.32	2.14	2.39	2.27	1.77	2.54	2.14	1.65	2.24	--
December	2.35	2.11	3.11	2.75	1.96	2.35	2.06	1.77	2.10	--

Source: The Market Administrators' Bulletin. New York-New Jersey Milk Marketing Area. Various issues of the Annual Report.

Appendix Table 4. PROPORTION OF MILK PRODUCTION SOLD AS CLASS I, NEW YORK-NEW JERSEY FEDERAL MILK MARKETING ORDER, 1977-1979.

	Year		
	1977	1978	1979
	--------------	percent	--------------
January	51.5	47.4	50.7
February	49.6	47.6	49.3
March	48.4	45.7	41.9
April	44.4	42.9	38.6
May	41.2	44.5	40.5
June	40.8	42.2	40.8
July	42.7	44.1	41.7
August	45.6	48.2	45.0
September	50.4	52.4	47.3
October	51.4	53.2	50.8
November	53.0	54.6	51.2
December	50.5	51.2	47.8

Source: The Market Administrators' Bulletin. New York-New Jersey Milk Marketing Area. Various issues of the Annual Report.

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