Demographic Versus Media Advertising Effects on Milk Demand: The Case of the New York City Market

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An advertising-sales response model is extended to include the effects of demographic factors (age and race) as additional determinants of milk demand. Previous research indicates that the age structure of a population and its racial composition are primary factors influencing fluid milk sales. Failure to incorporate these factors in the milk demand model results in a 30 percent downward biased estimate of the advertising effect. Consequently, the economic effectiveness of milk advertising is understated when the effects of demographic variables are ignored. Changes in demographic factors (growing nonwhite population and shrinking teenage market) appear to explain the relatively flat trend in per capita milk sales in the New York City market over the period 1971–80—a period in which dairy producers spent $12 million on generic advertising of milk. Net returns to Federal Order 2 dairy farmers from generic advertising of fluid milk is estimated to average $6.07 per media dollar invested over the 1972–79 period.

The declining trend in per capita milk consumption in the United States over the past two decades has implications that go beyond the economic concerns of the dairy industry. Calcium intake for one-third of the population is below the 1980 Recommended Dietary Allowances (USDA SEA) and Americans depend on milk products for some 75 percent of their calcium intake (Brewster and Jacobson). Dairy surpluses during the 1980–83 fiscal years cost taxpayers a record 8.1 billion (USDA ERS) and will likely cost an additional 1.6 billion in the 1984 fiscal year.

To more adequately address the varying concerns of dairy farmers, nutritionists and taxpayers, the underlying forces responsible for the declining trend in milk consumption need to be identified and quantified. This information could then be used to gauge the extent to which public measures, e.g., price or income policies, and private measures, e.g., promotional efforts, might be effective in expanding overall demand for milk.

Numerous studies have documented the importance of age, race and sex as determinants of milk demand (recent examples are Boehm, Boehm and Babb and Salathe). These studies reveal that milk consumption declines with age, that blacks consume less milk than whites, and that females consume less milk than males. Both the average age of the U.S. population and the proportion of nonwhites is increasing steadily. The adverse effects of these trends on milk consumption are the central focus of this paper. The New York City metropolitan area serves as the basis for analysis because data readily exist and the demographic trends of interest are even more marked than those occurring nationally. Moreover, because milk has been heavily promoted in the New York City area since 1972, the opportunity is available to measure the extent to which non-brand advertising of milk might be expected to offset the effects of demographic trends.

Previous research has shown the economic effectiveness of fluid milk advertising to be critically dependent on three factors: (1) the proportion of total milk production used for

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fluid purposes (called the Class I utilization rate), (2) the magnitude of the price difference between drinking and manufactured milk (called the Class I–Class II price differential), and (3) the magnitude of the sales response to advertising, i.e., the advertising elasticity (Thompson and Eiler, 1977). Information relating to Class I utilization rates and Class I–Class II price differentials across milk markets is published regularly by the government; therefore, knowledge of these parameter values is readily obtained. Much less certainty surrounds actual values of long run advertising elasticities for fluid milk since empirical research on this topic is scant. Studies to date suggest long run advertising elasticity values of less than .20 for fluid milk but marked intermarket differences appear to exist (Kinnucan, 1981a, 1983; Thompson; and Thompson and Eiler, 1975). A necessary ingredient for evaluating and improving upon the economic effectiveness of farm funded milk promotion programs is accurate estimates of the long run advertising elasticity (Kinnucan, 1984). This paper contributes to past research by highlighting various aspects of modeling and estimation procedure which appear to importantly influence the accuracy of estimated advertising elasticities.

In this paper, a model of milk demand is presented and data are discussed. Information regarding the effects of milk prices, substitute beverage prices and incomes on milk demand in New York City is generated. Estimates of milk sales in the absence of demographic change are compared with actual milk sales, and bias in estimated long run advertising elasticities associated with ignoring demographic change is examined. The increased farm value of the milk attributable to advertising based on a more completely specified model is computed. Finally, implications of the study are discussed.

The Model

In addition to advertising and demographic factors, other variables influence the demand for milk. These variables include seasonality in consumer preferences for milk, consumer income, the price of milk and the prices of other beverages. Further, the total effect of a given advertising expenditure may not be realized immediately but instead may be distributed over time. To take into account these factors, a demand function of the form

$$(1)\quad \ln q_{It} = \alpha + \sum_{j=1}^{11} \phi_j Z_{jt} + \theta \ln I_t + \lambda \ln PM_t + \gamma \ln PC_t + \delta \ln PCF_t + \sum_{i=0}^{N} \beta_i \ln A_{t-i} + \zeta \ln AGE_t + \pi \ln RACE_t + \tau T_t + \epsilon_t$$

is specified where $t = 1,2, \ldots 114$ (January 1971 to June 1980), N = specified finite lag length, q_{It} = per capita daily Class I milk sales in ounces adjusted for the calendar composition of the month, i.e., the number of Sundays, Mondays, etc. (Schenkler and Christ, pp. 28–30), Z_{jt} = eleven zero-one dummy seasonality variables with December as the base class, I_t = deflated (by CPI, 1967 = 100) NYC annual personal income before taxes, PM_t = deflated (by CPI) NYC retail price in dollars of whole fluid milk in paper quart containers, PC_t = U.S. cola price index deflated by the CPI, PCF_t = U.S. coffee price index deflated by the CPI, A_{t-i} = deflated per capita monthly generic advertising expenditures on fluid milk, AGE_t = the percentage of the population in NYC under age 20, $RACE_t$ = the percentage of the population in NYC which is nonwhite, and T_t = a trend variable, incremented by one for each successive month in the data series.[1]

Equation (1) is specified in double-log form to permit advertising to have a diminishing marginal effect on sales.[2] A trend variable is included in the model to account for the potential combined influence of the following

[1] The advertising data represent actual (not invoiced) expenditures made by producers for media advertising on fluid milk in the New York City area. Per capita figures were obtained by dividing actual advertising expenditures by the population of New York City's media coverage area. A media cost index specific to the New York City area was used to deflate the per capita figures. The actual data along with a more complete description of the variables and sources are available upon request from the author.

[2] Other functional forms commonly used in food demand analysis such as the log-inverse, inverse and semilogarithmic also permit diminishing marginal returns and therefore could have been used. Previous research on functional form selection in an advertising context found these alternative forms empirically indistinguishable from the logarithmic form based on chi-squared tests of goodness of fit (Kinnucan, 1983). Furthermore, using the logarithmic form permits direct comparison of results with previously published studies (e.g., Thompson and Eiler, 1977, and Nerlove and Waugh). Finally, specifying age and race varibles in alternative forms had no significant effect on elasticities evaluated at mean data points. Consequently the simpler logarithmic specification is used.

omitted factors: (1) nonmedia promotional activities conducted by the American Dairy Association, (2) nutrition education and research efforts by the Dairy Council of New York and (3) possible secular improvements in milk quality (Bandler). Specifying the trend variable in linear form allows the coefficient of T to be interpreted as the instantaneous rate of change in milk sales due to the passage of time.

The length of the lag distribution, N, is unknown a priori. While theoretically the lag length could be indefinite, as a practical matter the major effect of the advertising expenditure can be expected to occur within some finite period. The procedure here for choosing the lag length is to "let the data decide" by terminating the lag at the point where an additional lagged term in A is not significantly different from zero.

Generally, lagged regressors of economic time series are highly collinear because of serial correlation in the series or a secular decreasing or increasing trend in the data. Under these circumstances the ordinary least squares (OLS) regression estimates of the individual lag parameters can be imprecise. To reduce this problem, researchers have used procedures which restrict the shape of the lag distribution in various ways. One such procedure, the Almon method, restricts the lag distribution to follow a low order polynomial. This method, as well as the more general Shiller procedure, was applied in an earlier analysis of parts of the data used in this study. Results showed the Almon method to be inappropriate for these data (Kinnucan 1981a).[3] On the basis of this finding, restrictions other than lag length were not imposed on the parameters in equation (1).

The Data

Monthly data for the period January 1971 through June 1980 pertaining to the New York City metropolitan area were used to estimate equation (1) and its variants discussed below. Annual averages of these data for the 1971–1979 period are presented in Table 1. Inter-year variation in the data is irregular except for the demographic variables, where a steadily increasing trend in the non-white proportion of the population and a decreasing trend in the under age 20 population proportion is observed. The relative stability of real milk prices combined with rapidly increasing real cola and even more rapidly increasing real coffee prices (76 percent between 1976 and 1977 alone) are factors favoring enhanced milk demand as are the overall rises in real incomes and advertising efforts. Yet the figures pertaining to per capita milk sales indicate a relatively flat trend over the period. This suggests that the favorable effect of the sympathetic trends in the economic factors and advertising have been negated by the trends in demographic factors. This hypothesis is tested below.

Regression Results

The OLS estimates of equation (1) along with regression results pertaining to alternative specifications of equation (1) are presented in Table 2. All regressions were computed using the econometric software package, TROLL (MIT).

Regression results indicate that equation (1) "explains" 87 percent of the variation in milk sales. The dummy variables, which account for the major portion of the explanatory power of the model, suggest a distinct seasonal pattern in milk demand, i.e., a drop in sales during the summer months.

Estimated effects of the economic variables agree with a priori expectations. A one-sided t-test indicates that the estimated income elasticity of 0.416 is significantly greater than zero at the 5 percent probability level. The own-price elasticity is estimated to be −0.095 but is not significant. This should not be interpreted to mean that milk price has no significant effect on milk demand. Rather, lack of variation in the real price of milk over the sample period precluded a precise determination of the effect of this variable.

The cross-price elasticities pertaining to cola and coffee are positive and significant, suggesting that increases in the prices of these beverages induce consumers to purchase more milk. Note that because of the large increases in cola and coffee prices that can occur over relatively short time periods (be-

[3] Statistical tests revealed that the Almon estimates had a significantly larger mean squared error than the corresponding OLS estimates. This result was not surprising because of the nature of the advertising data: month-to-month variation in milk advertising was typically erratic, reducing the possibility of serial correlation or a significant trend in the series. In fact, simple correlations between the lagged values never exceeded 0.4.

Table 1. Milk Sales, Advertising Expenditures, Prices, Income, and Demographic Data, New York City Metropolitan Area, 1971–1979

Year	Annual Per Capita Milk Sales	Per Capita Advertising Expenditures 1975 Dollars	Per Capita Personal Income 1967 Dollars	Retail Milk Price 1967 Dollars	Cola Price Index 1967=100	Coffee Price Index 1967=100	Percent Population Nonwhite	Percent Population Less than Age 20
	(gallons)	(cents)	(dollars)	(cents/qt.)	percent			
1971	24.5	3.3	4191	24.8	100	97	17.9	33.4
1972	25.1	5.7	4290	24.5	98	91	18.4	32.7
1973	25.8	8.9	4250	25.1	94	97	19.0	32.4
1974	25.6	9.0	4206	27.3	105	104	19.4	32.0
1975	25.8	9.5	4176	25.6	121	104	19.9	31.4
1976	25.1	8.2	4185	25.4	110	138	20.5	30.9
1977	25.5	5.8	4303	24.8	110	243	20.7	30.2
1978	26.6	5.0	4460	24.1	112	210	21.1	29.6
1979	26.0	4.7	4463	25.0	112	181	21.5	29.1

Table 2. Regression Results for Various Double-Log Specifications of the Milk Demand Equation

Independent Variable	Regression No. 1		Regression No. 2		Regression No. 3		Regression No. 4[a]	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Intercept	1.781	0.32	−4.26	−4.31	−10.06	−5.01	−1.866	−2.35
January	0.001	0.10	−0.002	−0.17	0.003	−0.29	−0.003	−0.28
February	0.001	0.06	−0.001	−0.07	0.002	−0.15	0.000	0.000
March	0.019	1.61	0.018	1.50	0.017	1.41	0.015	1.31
April	−0.004	−0.36	−0.007	0.58	0.008	−0.68	−0.008	−1.67
May	−0.012	−1.07	−0.015	−1.33	0.018	−1.50	−0.020	−1.61
June	−0.018	−1.52	−0.121	−1.89	0.024	−2.08	−0.024	−1.96
July	−0.105	−9.49	−0.104	−9.39	−0.101	−9.19	−0.107	−9.13
August	−0.103	−9.89	−0.101	−9.53	−0.106	−9.25	−0.100	−8.58
September	−0.026	−2.47	−0.023	−2.18	−0.023	−2.06	−0.021	−1.75
October	−0.011	−1.03	−0.009	−0.83	−0.009	−0.80	−0.005	−0.44
November	−0.023	−2.20	−0.022	−2.06	−0.022	−1.97	−0.018	−1.50
Income	0.416	1.71	0.858	6.60	1.047	6.20	0.454	4.57
Milk Price	−0.095	−1.30	−0.072	−1.17	−0.106	−1.68	−0.126	−1.81
Cola Price	0.149	2.99	0.214	5.24	0.202	4.69	0.061	2.08
Coffee Price	0.044	2.93	0.048	3.72	0.035	2.88	—	—
Race	−2.738	−2.97	−0.593	−5.24	—	—	—	—
Age	1.177	0.80	—	—	0.722	4.49	—	—
Trend	0.006	1.70	—	—	—	—	—	—
A_t	0.00811	3.43	0.00730	3.06	0.00666	2.72	0.00342	1.93
A_{t-1}	0.00487	2.04	0.00384	1.61	0.00300	1.23	0.00473	4.76
A_{t-2}	0.01008	4.32	0.00929	3.95	0.00859	3.55	0.00545	7.44
A_{t-3}	0.00532	2.26	0.00432	1.84	0.00343	1.42	0.00556	6.49
A_{t-4}	0.01179	4.93	0.01078	4.60	0.00978	4.06	0.00507	5.33
A_{t-5}	0.00295	1.22	0.00191	0.81	0.00087	0.36	0.00398	4.62
A_{t-6}	0.00784	3.33	0.00735	3.30	0.00613	2.69	0.00229	4.17
Sum	0.05096	—	0.04479	—	0.03846	—	0.03050	—
R^2		0.866		0.855		0.845		0.792
$\bar{R}^2$		0.825		0.816		0.803		0.755
DW		1.53		1.41		1.33		1.31
COND(X)[b]		149.5		6.97		7.57		6.28
RSS		.03423		.03700		.03960		.05332

[a] A second degree polynomial (Almon) restriction with a tail point constraint is imposed on the lag structure of this equation.
[b] The COND(X) statistic indicates the degree of multicollinearity in the raw data matrix. Multicollinearity is considered severe when this statistic exceeds 100. COND(X) statistic values less than 30 indicate multicollinearity is not adversely affecting the precision of the individual regression coefficients.

tween January 1976 and July 1977, the real price of coffee increased 138 percent and between January 1974 and May 1975, the real price of cola increased 38 percent), these variables can have a greater impact on milk consumption than would be inferred on the basis of their relatively small elasticities.

Media advertising effects. Generic media advertising of milk has a positive, significant effect on milk sales in the New York City metropolitan area. Carry-over effects are estimated to last six months with the maximum impact occurring four months after the initial expenditure. The estimated long run advertising elasticity (the sum of the initial and carry-over effects) is 0.051. The irregular pattern of the estimated lag distribution is surprising in light of the low collinearity among the lagged regressors.[4] One plausible explanation for this phenomenon is that the advertising expenditure series does not adequately reflect monthly variations in the effectiveness of the advertising message. This may occur as the result of (a) constantly changing commercials (e.g., during the period February 1975 through June 1980, 61 different milk commercials were used) and (b) monthly variations in the media mix among television, radio and newspapers. If monthly variations in the quality of the advertising signal are not well correlated with the actual level of expenditures, a perturbed pattern in the estimated response may occur. An additional explanation for the peculiar pattern in the estimated lag response is the possibility of a seasonal response to the advertising message (see Kinnucan 1981b). In any case, for the purposes of this paper, it is the *sum* of the lag coefficients, not the individual coefficients themselves, that is of key importance.

The long run advertising elasticity estimated from equation (1) is large compared to previous estimates obtained from a double-log specification of the sales response function. Thompson and Eiler (1977), using New York City data for the period January 1971 to March 1974, put the elasticity at 0.021. In a later study Thompson (1978), employing data for the January 1975 to June 1977 period, estimated the elasticity at 0.029. The difference in the estimates may be ascribed to three factors: (1) differences in data period, (2) differences in model specification, and (3) differences in techniques used to estimate the distributed lag relationship between milk sales and advertising expenditures. The likely effect of these differences is examined below.

The equation (1) estimate is based on data covering the period January 1971 through June 1980 and hence the Thompson and Eiler (1977) and Thompson estimates may be regarded as subperiod estimates. The subperiod estimates (0.021 and 0.029) are in close enough agreement to suggest no significant changes in the advertising elasticity over time.[5] Hence the estimated elasticity based on the longer time period should be superior on this score because larger samples generally yield statistically superior results.

Relative to equation (1), the subperiod elasticity estimates flow from models which exclude all or most of the following relevant explanatory variables: cola price, coffee price, age, race and trend. If a statistical correlation between these excluded variables and advertising expenditures exists, the omission of these variables will bias the estimated advertising effect. Comparing the 1971–1980 estimate ($\eta_{s \cdot a} = 0.051$) with the subperiod estimates ($\eta_{s \cdot a} = 0.021$ and $\eta_{s \cdot a} = 0.029$) one would expect the direction of the bias to be downward. To check this, equation (1) was re-estimated omitting the age, race, coffee price and trend variables.[6] The resulting long run advertising elasticity estimate is 0.032, suggesting that excluding these variables from the milk sales response function leads to a 33 percent downward bias in the estimated long run advertising elasticity (excluding the demographic variables alone results in a 30 percent downward bias in the elasticity). Apparently then, 86 percent (0.032–0.051)/(0.029–0.051) × 100) of the discrepancy between the overall and the subperiod estimates can be attributed to the omission of relevant explanatory variables.[7]

[4] Imposing an Almon polynomial restriction on the shape of the lag distribution produces a nice-looking lag pattern (see, e.g., regression no. 4 in Table 2), but this procedure results in an eight percent downward bias in the estimated long-run advertising elasticity and is inappropriate when data are not highly collinear.

[5] In fact, the difference between the two subperiod estimates may be ascribed to the omission of cola prices in the earlier study.

[6] Cola price is retained since the later subperiod study does include this variable.

[7] A reviewer suggested that perhaps the larger advertising elasticity of equation (1) is due to multi-collinearity (which can affect the estimated coefficients of all variables, not just the highly collinear ones). This explanation appears implausible, however, because regression nos. 2–4 exhibit a similar degree of multicollinearity (compare the COND(X) numbers in Table 2) but estimated advertising elasticities differ considerably in these equa-

In addition to time period and model specification differences, the estimates based on the subperiod samples use a procedure which restricts the distributed-lag advertising response to follow a low-order polynomial which terminates with a zero response. In contrast the 1971–1980 estimates impose no restrictions on the form of lag. A study employing the same model and data used by Thompson shows that the imposition of polynomial and end-point restrictions results in a downward bias of six percent in the estimated long run advertising elasticity (Kinnucan, 1981a). Indeed, as indicated by regression no. 4, Table 2, when a second degree polynomial restriction with an end-point constraint is imposed on the misspecified milk demand equation, the resulting estimated long-run advertising elasticity is 0.031. This estimate is close enough to the later subperiod estimate (0.029) to argue that earlier estimates of the long-run milk advertising elasticity for the New York City market has downward biases as large as 59 percent (0.021 compared with 0.051), due to the omission of relevant explanatory variables and the use of inappropriate procedures for estimating the distributed lag.

Demographic effects. Compared to the economic variables and advertising, the elasticities for the demographic factors are quite large. According to the estimates in regression no. 1, for each one percent increase in the proportion of the population under 20, milk sales increase by 1.2 percent, ceteris paribus; and for each one percent increase in the nonwhite portion of the population, milk sales decrease by 2.7 percent, ceteris paribus. Given the relatively large changes in these factors over the sample period (the nonwhite proportion of the population increased 20 percent; the under-age-20 population proportion decreased 13 percent), the magnitudes of these elasticities imply implausibly large reductions in per capita milk consumption. Furthermore, the estimated age effect is not significant.

Further analysis reveals that the age, race and trend variables are highly collinear (simple correlations between the variables is in excess of 0.98 in absolute value). To increase the precision with which these elasticities could be estimated, it became necessary to re-estimate equation (1) dropping the trend term and, alternatively, the age and race variables (the results are represented by regression nos. 2 and 3 of Table 2). This approach, while introducing bias into the estimated age and race elasticities, produces elasticities of a more reasonable magnitude, i.e., a race elasticity of −0.593 and an age elasticity of 0.722. Moreover, the very large t-ratios corresponding to these estimates (in excess of 4.5 in absolute value) suggest that the biased estimates probably have a lower mean squared error than the unbiased estimates obtained from the more completely specified model represented by equation (1). Note further that the TROLL-produced diagnostic statistic for multicollinearity is significantly reduced by the elimination of the trend and age or race variables (compare COND(X) numbers in Table 2 and see footnote b). Therefore, these elasticities will form the bases for further analysis with respect to the effects of changes in demographic characteristics on milk demand in the New York City market.

One way to gain some additional insight regarding the magnitude of age and race effects on milk consumption is to compare milk sales in the absence of changes in these factors with actual sales. Looking at the age effect first, the model (regression no. 3) predicts that if the age structure in 1979 had remained unchanged from 1972 (i.e., with 32.6 percent of the population under 20), then milk sales would be 28.5 gallons or 9.6 percent higher than actual sales (Table 3). If the racial composition had remained unchanged since 1972 (at 18.4 percent nonwhite), the model (regression no. 2) predicts milk sales in 1979 of 28.8 gallons, a 10.8 percent rise over the actual sales.

Although the estimated age and race effects obtained from equations (2) and (3) are more conservative than those of equation (1) they nonetheless overstate the independent effect of each factor.[8] Thus adding the estimated ef-

tions. In particular, the long-run advertising elasticity estimate of regression no. 4 (which differs from the other two regressions primarily in that age and race variables are omitted) is as much as 32 percent smaller than the corresponding estimate from the other two regressions. This reinforces the notion that specification error (and *not* multicollinearity) is the primary factor responsible for differences in estimated advertising elasticities. It lends support to the basic conclusion that the estimated impact of generic advertising on milk demand can be seriously understated if demographic factors are ignored.

[8] Specification error analysis (see e.g., Rao and Miller) can be used to show that the age and race elasticities of equations (2) and (3) contain upward biases in absolute value. The intuition behind this result is that in equation (2), for example, omitting the age variable causes the race coefficient to reflect the combined impact of age and race because the two variables are highly correlated. The bias is upward because the age variable, as defined, is expected to have a positive impact on milk consumption, and age and race variables are negatively correlated over the sample period.

Table 3. Estimated Per Capita Milk Sales in 1979 when Age and Race Factors are Held at 1972 Levels. New York City Metropolitan Area

Population Nonwhite	Population Under 20	Estimated Milk Sales in 1979[a]
percent	percent	gallons
21.5 (1979 level)	29.0 (1979 level)	26.0
21.5 (1979 level)	32.6 (1972 level)	28.5
18.4 (1972 level)	29.0 (1979 level)	28.8

[a] Actual milk sales in 1979 were 26 gallons per person. Estimates are OLS projections based on regression nos. 2 and 3 of Table 2.

fects of each variable to obtain an estimate of the combined effect of race and age on milk demand would be inappropriate. However, if one assumes (conservatively) that, for example, the race elasticity of equation (2) is measuring the *full* impact of age changes as well, then the impact on sales reflected by this coefficient (-10.8 percent) may be taken as a lower bound estimate of the combined impact of the two factors. (The age elasticity in equation (3) could be interpreted in an analogous fashion, suggesting a decrease in sales due to age *and* race effects of 9.6 percent.) While these estimates cannot be regarded as precise, their general magnitude hints at the importance of demographic changes in understanding the observed trend in milk sales in the New York City market.

Producer Returns from Milk Advertising

Statistical results suggest a distinct positive relationship between milk sales and generic advertising. Yet, as Hadar points out, for advertising to be profitable it must bring about a sufficiently large shift in demand to compensate for costs. One way to determine if generic advertising in the New York City metropolitan area has been profitable for producers is to compute the farm value of the sales increase attributable to advertising and compare this figure with the cost of advertising.[9] This is done for 1972–1979 (Table 4).

Estimated milk sales with "no" advertising was computed via equation (1) by setting the advertising variables at their lowest observed levels (approximately $9,000 per month in real terms) and letting the model predict milk sales, given the actual changes occurring in the other variables. The increase in milk sales attributable to advertising was computed as the difference between estimated actual milk sales and estimated milk sales with "no" advertising. The farm value of the sales gain was then computed by multiplying the sales gain with the Class I–Class II milk price differential (Thompson and Eiler, 1975), and then multiplying the result by the NYC population. The advertising cost is the portion of the media expenditure in the market that pertains to the SMSA population (generally this represented approximately 60 percent of the total expenditure in the New York City market). For the dairy producer, the profitability of the advertising investment is the difference between the net farm value of the sales increase and the cost of advertising.

The estimated annual increase in per capita milk sales attributable to advertising ranges from 1.6 to 3.1 gallons for an annual average increase of 2.5 gallons per person over the 1972–1979 period.[10] On average, this represents a 10 percent increase in milk sales. The farm value of this sales increase over the eight-year period is approximately $44 million. When compared to the cost of achieving this sales increase ($7.2 million),[11] dairy producers realized a net return of $37 million from advertising which translates into a $6.07 average net return per media dollar invested. Thus, it appears that the investment in the New York City metropolitan area has stimulated demand sufficiently to make advertising profitable for affected dairy producers.

Conclusions and Implications

Results of the study suggest that trends in the demographic factors of age and race have strong negative consequences for fluid milk demand. In the New York City metropolitan area during the 1971–1979 period, the nonwhite proportion of the population grew by 20 percent and the under 20 population propor-

[9] An alternative procedure, suggested by Hadar, is to measure the price reduction required to offset the loss in sales when advertising is reduced to zero. Under this criterion, for advertising to be profitable "one dollar's worth of advertising per unit of output must in some sense be more effective than a discount of one dollar" (p. 128).

[10] Thompson and Eiler's (1975) estimates of the sales gain are much smaller (less than one gallon per year) due to the severe downward bias in the estimated long-run advertising elasticity. The nature of this bias is discussed earlier in the text.

[11] This $7.2 million is the portion of the total advertising expenditure ($12.2 million) that relates to the portion of the media coverage area population for which milk sales figures are available.

Table 4. Estimated Costs and Returns to Generic Milk Advertising, New York City Metropolitan Area, 1972–1979

Year	Estimated Annual Milk Sales	Estimated Annual Milk Sales with Advertising at Its Lowest Observed Level	Sales Gain Attributable to Advertising	Farm Value of the Sales Increase	Advertising Cost	Producers' Net Return from Advertising	Net Return Per Media Dollar Invested
	gallons per person			undeflated dollars			
1972	25.1	23.5	1.6	$3,631,353	$510,479	$3,120,874	$7.11
1973	25.8	22.7	3.1	6,681,778	814,357	5,867,422	8.21
1974	25.6	22.7	2.9	8,290,977	891,476	7,399,501	9.30
1975	25.8	23.0	2.8	5,525,433	1,066,910	4,458,523	5.18
1976	25.1	22.5	2.6	6,280,930	1,160,988	5,119,942	5.41
1977	25.5	23.6	1.9	4,080,726	965,281	3,115,445	4.23
1978	26.6	24.0	2.6	4,793,009	870,600	3,922,409	5.51
1979	26.0	23.7	2.3	4,540,687	936,976	3,603,711	4.85
Totals: 1972–1979	205.5	185.7	19.8	43,824,893	7,217,067	36,607,827	6.07

tion decreased by 13 percent. Econometric results suggest that these trends may have decreased per capita milk consumption in New York City by 9.6 percent or more over the sample period.

The fact that per capita milk sales in this market remained relatively constant over this period suggests that the favorable trends in economic factors affecting milk consumption (nearly constant real milk prices, large increases in real cola and even larger increases in real coffee prices, and increasing real per capita incomes) as well as the $12.2 million investment in media advertising have worked to offset the adverse effects of the demographic trends. The statistical results verify this contention: the estimated average annual increase in milk sales attributable to advertising (2.5 gals./person/year) nearly matches the estimated decline in milk sales associated with the demographic changes studied.

The study suggests that generic advertisement of milk in the New York City metropolitan area is a profitable activity for affected dairy producers. The model estimates a ten-percent average increase in per capita milk sales as a result of the promotion effort. This sales increase translates into an average $6.07 return on investment to Federal Order 2 dairy farmers per media advertising dollar invested.

Omitting relevant explanatory variables (e.g., demographic factors) from the model was shown to result in a downward bias in the estimated long run advertising elasticity of 30 percent. Inappropriate restrictions on the lag structure of the advertising effect may further downward bias the estimated long run effect. Because long run advertising elasticities, along with Class I utilization rates and Class I–Class II price differentials, are critical determinants of milk advertising effectiveness, analysts will need to carefully consider these model specification and estimation issues when attempting to evaluate program effectiveness and make recommendations regarding more efficient use of advertising funds.

With the passage of the Dairy and Tobacco Adjustment Act of 1983 dairy farmer investment in advertising and promotion increased from $60 to $200 million (Novakovic). A significant portion of these new funds ($50–$60 million) is controlled by a national board. An economic incentive exists for the board to allocate fluid milk advertising funds to those areas of the U.S. where Class I utilization rates and Class I–Class II price differentials are relatively high (Thompson and Eiler, 1977). One such area, the Southeast, contains a sizeable nonwhite population. The research presented in this paper suggests that in evaluating regional differences in fluid milk advertising effectiveness, demographic differences among the regions will need to be carefully considered.[12]

[12] The promotion provision in the Dairy and Tobacco Adjustment Act of 1983 requires that the Secretary of Agriculture submit to Congress an analysis of the effectiveness of the program each year the promotion order is in effect. Analysis relating to regional or market allocation of advertising funds will almost surely be done either as a direct requirement of the annual Congressional report or among private or public sector researchers interested in improving the economic efficiency of the investment.

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