THE RESPONSE OF MILK SALES TO GENERIC ADVERTISING AND PRODUCER RETURNS IN THE NEW YORK CITY MARKET REVISITED*

by

Stanley R. Thompson**

January 1978 No. 78-8

*Presented at the Dairy Promotion Board Meeting in Syracuse, New York, February 1, 1978.

**Assistant Professor, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48824.

PREFACE

Stanley Thompson, author of this report was formerly a graduate student in the Department of Agricultural Economics. He conducted the research reported herein at the request of the Department. He presented the results at the February 1978 meeting of the New York Dairy Promotion Order Advisory Board. The research was supported with funds from a contract with the New York Department of Agriculture and Markets.

Olan D. Forker
Chairman of Department

THE RESPONSE OF MILK SALES TO GENERIC ADVERTISING AND PRODUCER RETURNS IN THE NEW YORK CITY MARKET REVISITED

Stanley R. Thompson

I. INTRODUCTION

In September 1974, Thompson and Eiler[1] attempted to measure the response of fluid milk sales to generic advertising expenditures and the corresponding returns to producers in three New York State markets. In this quest, the estimation of the demand structure for fluid milk was required. During the period analyzed in this study, an expanded program became effective in May 1972 under the auspices of the New York State Dairy Promotion Order which levied a mandatory assessment rate of five cents per hundredweight on milk produced in the state. The returns to the expanded advertising effort were estimated by comparing returns at the advertising expenditure levels prior to the implementation of the Order to those estimated at the higher expenditure levels which followed the implementation of the Order. The results showed that generic milk advertising was clearly a profitable venture in the New York City market while there was some doubt as to the profitability of advertising in the Albany and Syracuse markets. At present, an expanded advertising program in New York State remains operative.

---

[1] Thompson, Stanley R. and Doyle A. Eiler, "An Econometric Analysis of the Response of Milk Sales to Advertising in Selected New York State Markets," Cornell Agricultural Economics Staff Paper No. 74-23, Department of Agricultural Economics, Cornell University, September 1974, 15 pp. For a more comprehensive analysis of the effectiveness of generic milk advertising in New York State together with some guidelines to appropriate advertising investment levels among alternative markets, see: Thompson, Stanley R., Doyle A. Eiler and Olan D. Forker, "An Econometric Analysis of Sales Response to Generic Milk Advertising in New York State," Cornell University Agricultural Experiment Station Search (Agricultural Economics No. 9), 1976, 24 pp.

The above analysis utilized milk sales, advertising, and other monthly data from January 1971 to March 1974. However, since March 1974, two major events have taken place that effect the demand structure for fluid milk. First, a change in the basic advertising theme was implemented in August 1974. Secondly, a truckers' strike in December 1974 severely hampered milk deliveries in New York City causing milk sales to differ substantially from the expected December sales.

Because of the character and magnitude of changes that have taken place since the original Thompson and Eiler study, those supporting and responsible for managing the ongoing advertising program need information regarding the nature of the new demand structure. However, to ensure proper model specification, the relevant time period for analysis is subsequent to the occurrence of these events. Thus, the purpose of this report is to update previous findings by reestimating the response of fluid milk sales to generic advertising and the corresponding returns to producers in the New York City market.

II. THE SALES RESPONSE MODEL

Methodology:

Because of the suspected severity of the occurrences at the end of 1974, data from January 1975 to March 1977 were used for estimation purposes. However, prior to this data set selection, a rigorous statistical test for possible changes in the structural model was employed. A statistical test was used to determine if pooling the earlier (January 1971 to March 1974) and later (January 1975 to March 1977) time series would not increase the sum of

squared errors of the separate regressions.[2] Upon performing this test with the previously specified structure, it was concluded that a significant change in the structure has indeed occurred.

In light of the above test, the sample period for this analysis was restricted to begin after December 1974. Specifically, monthly data for the NY-Metro SMSA from January 1975 to March 1977 were used. The data include monthly observations on fluid milk sales, generic milk advertising expenditures, retail milk prices, consumer income, competitive beverages (i.e., colas), and both the consumer price index for the NY-Metro area and an index of the cost of prime time spot advertising.[3] Throughout the selected data period the basic media advertising theme remained unchanged. Substantial variation in fluid milk sales and advertising expenditures occurred during the period January 1975 to March 1977 (see Figure 1). These data were used to estimate the sales response model. In particular, the following polynomial lag model was estimated:

$$q_{I_t} = \alpha + \sum_{j=1}^{11} \phi_j Z_{jt} + \theta I_{t-1} + \delta P_t^c + \lambda P_{t-1}^m + \sum_{i=0}^{N} \beta_i a_{t-i} + e_t$$

where:

t = 1, 2, ...27 (January 1975 to March 1977),

N = specified finite lag length,

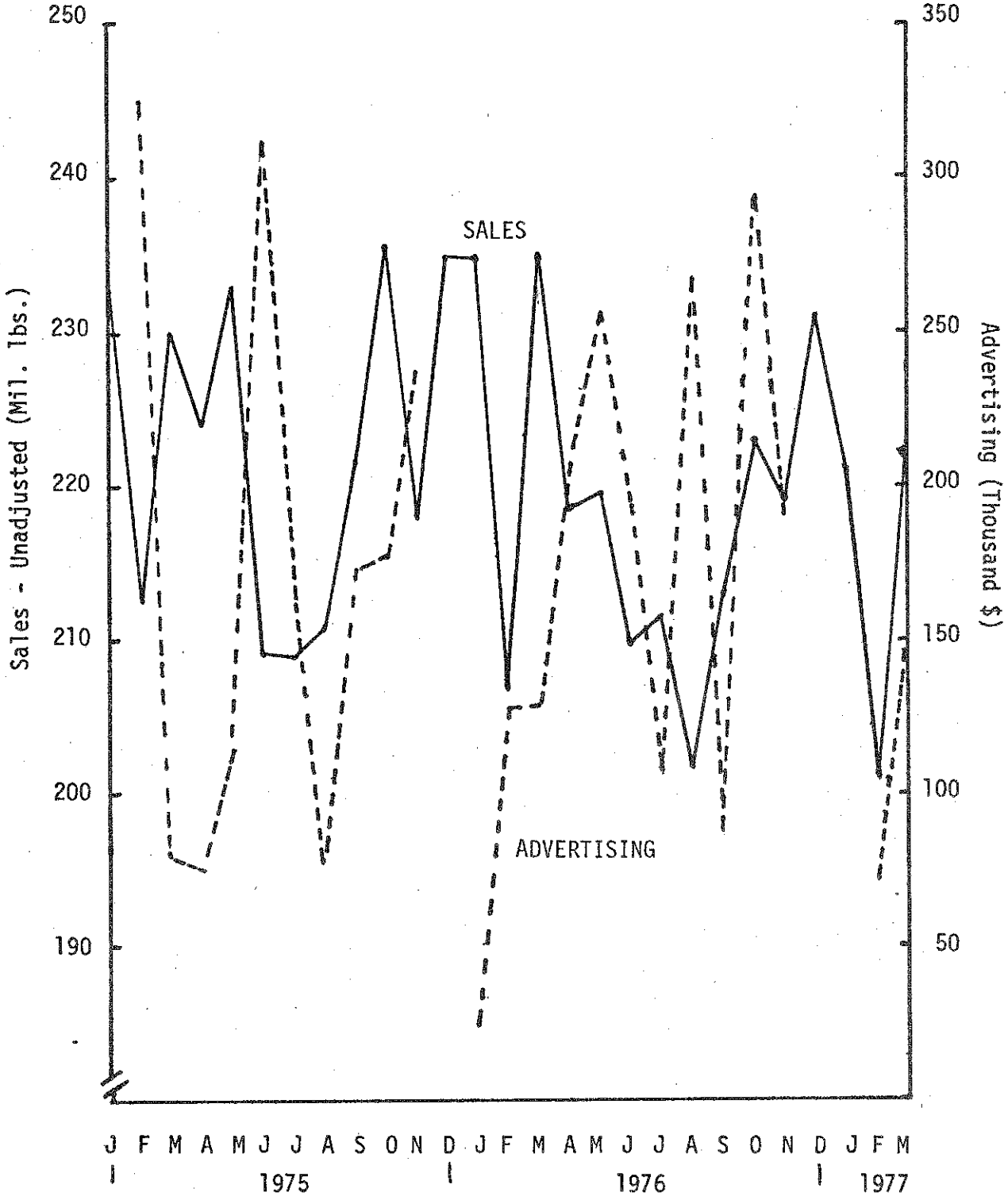
q_I = per capita dairy Class I milk sales in ounces adjusted for the number of each type of day in the month (i.e., number of Sundays, Mondays, etc.),

---

[2]The above test is often referred to as the "Chow Test," from Chow, Gregory, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica 28(1960):591-605.

[3]See Appendix Table 1 for a complete listing of the data and their sources.

Figure 1. Actual Monthly Fluid Milk Sales and Generic Advertising Expenditures - New York City SMSA, January 1975 to March 1977



Z = eleven, zero-one dummy seasonality variables with December as the base class,

I = per capita real income in 1967 dollars,

p^c = real price of colas in NY-Metro SMSA in 1967 dollars,

p^m = real price of fluid whole milk (quarts) in 1967 dollars, and

a = actual per capita monthly media advertising expenditures in 1971 dollars.

The above equation is a finite distributed lag model of lag length N.[4] The estimation is the general distributed lag model after imposing the restriction that the lagged parameters follow a polynomial relationship over some finite time period N. The polynomial lag structure is defined in terms of a Lagrangian interpolation polynomial.[5]

The length of the advertising lag structure considered most representative of the data was obtained by comparing the results of various polynomial specifications estimated with different lag lengths. In these specifications the lagged effects of advertising were positive during and immediately following the initial advertising expenditure and then, at a later point, became negative and statistically insignificant. Since economic theory

---

[4]The reader familiar with this author's previous results will note some minor differences in model specification over that presented in previous works. Specifically, the addition of P^c, I_{t-1}, and P_{t-1}. These decisions were made on both theoretical and statistical considerations. That is, the price of colas (P^c) was omitted previously because data on P^c were not available for all markets considered and for the only market where it did exist (NYC) it was not statistically different from zero. Also, the price of milk and income were lagged one period because they provided improved estimates of the price and income elasticities respectively and improved the general empirical results. This "new" structure was estimated for the "old" time period (January 1971 to March 1974). A Chow Test indicated that the "new" structure was not applicable to the "old" time period.

[5]Almon, S., "Distributed Lag Between Capital Appropriation and Expenditure," Econometrica, 33(1965):178-196.

suggests that the effect of advertising on sales is positive, the length of the lag structure was constrained to equal zero at or near the end of the first detected negative and statistically small influence.

In addition, the degree of the polynomial must be selected. The second degree polynomial has relatively little multicollinearity for these data while exhibiting adequate flexibility in terms of the shape of the lag vis-a-vis third degree specification.[6]

Estimated Coefficients:

The estimated coefficients for the fluid milk demand function are presented in Table 1. Two models are presented--an "uncorrected" and "corrected" version of the same specification. The Durbin-Watson statistic of the "uncorrected" model indicated the presence of serially correlated residuals. Hence, the Cochrane-Orcutt iterative procedure was implemented to "correct" for the serial correlation problem.[7] The "corrected" model is considered to be statistically superior and is employed in the following economic analysis.

The estimated coefficients of the eleven, zero-one dummy variables assess the seasonal variation in milk sales relative to December, the base month. Interpretation of the price coefficient in the "corrected" model reveals that

---

[6]Model robustness necessitates an existence of an adequate number of observations relative to the number of parameters in the model. In view of the relative short time series available here (i.e., 27 observations) some alternative model specifications were examined. Specifically, various polynomial and rational lag specifications were estimated and found to be inferior to the estimated polynomial structure presented here. The criteria used for model selection are discussed in greater detail in: Thompson, Stanley R. and Timmothy D. Mount, "Comparing Polynomial and Rational Lag Models, Michigan State University Agricultural Economics Staff Paper No. 77-10, 1977.

[7]Cochrane, D. and G.H. Orcutt, "Application of Least Squares Regressions to Relationships Containing Auto-Correlated Error Terms," J. Am. Statist. Assoc., 44(1949):32-61.

Table 1. Estimated Coefficients for Second Degree Polynomial Lag Model, Both Corrected and Uncorrected for Serial Correlation--New York City SMSA[a/]

Independent Variable	Uncorrected		Corrected[b/]	
	Coefficient	t-Ratio	Coefficient	t-Ratio
Const.	7.48148	2.27	8.14212	3.42
Jan.	-.02650	.19	-.01318	.08
Feb.	-.04431	.26	-.06271	.43
Mar.	.12419	.67	.10733	.65
Apr.	-.10601	.52	-.12546	.74
May	-.20501	1.22	-.22210	1.41
Jun.	-.54931	3.34	-.54616	3.55
Jul.	-1.04348	7.11	-1.05050	7.16
Aug.	-.94344	6.71	-.93911	6.87
Sep.	-.36993	2.70	-.35714	2.46
Oct.	-.14430	.98	-.14811	1.14
Nov.	-.20603	1.33	-.21093	1.20
I_{t-1}	.00023	.37	.00014	.35
P_t^c	.01435	1.58	.01814	2.85
P_{t-1}^m	-6.15211	.62	-8.58690	1.12
A_t	15.43	1.07	15.21	1.35
A_{t-1}	22.17	1.68	19.99	2.18
A_{t-2}	24.00	1.67	20.86	2.14
A_{t-3}	20.91	1.56	17.82	1.95
A_{t-4}	12.91	1.48	10.87	1.80
A_{t-5}	0	0	0	0
$\Sigma_{i=0}^{5} A_{t-i}$	95.42	1.71	84.76	2.23
R^2	.955		.964	
ρ[c/]	-.50		-.50	2.91
DW.	2.89		2.14	

[a/] This dependent variable is the per capita daily adjusted Class I milk sales in ounces. See text for specific definition of the independent variable.

[b/] Corrected for first-order serial correlation.

[c/] Rho (ρ) is the first-order autocorrelation parameter, i.e., $e_t = \rho e_{t-1} + W_t$.

a one cent per quart increase in the real price of milk would be expected to decrease per capita milk sales by .086 ounce per day ceteris paribus. The estimated price elasticity of demand is -0.26 calculated at the mean price and quantity of the sample period. This indicates that if milk prices were increased by 10 percent, the consumption of milk would be expected to decrease by 2.6 percent. A $100 increase in real annual income is estimated to increase per capita fluid milk sales by 0.014 ounce per day ceteris paribus. The estimated income elasticity is 0.07 when calculated at their mean values.

A 10 cent increase in the price of a 72 ounce carton of colas can yield an expected increase per capita fluid milk sales by 0.18 ounce per day. The cross elasticity of demand is estimated to be 0.23 when calculated at the means. The elasticities estimated here are all reasonable and are consistent with those obtained in other studies.[8]

The estimated long-run effect of advertising shows that a 0.1 cent increase in current capita monthly advertising yields a total increase in milk sales of 1.27 ounces per capita ceteris paribus.[9] The advertising elasticity of demand was estimated to be 0.047.

---

[8]Bullion, George W.M., "Estimation of Regional Retail Demand Elasticities for Whole Milk, United States, 1962-63, 1966, 1961-68," unpublished Ph.D. dissertation, Purdue University, June 1970.

[9]Assuming: (1) that advertising is increased in a single month by $0.001, (2) that the appropriate cost-of-media-deflation index is 2.0, (3) the long-run advertising coefficient is 84.76, and that a month equals 30 days, then $0.001/2.00 = .0005 real increase in advertising expenditure, (0.0005) x (84.76) = 0.0424 real long-run per capita daily sales increase, and (0.0424) x (30) = 1.27 ounces total long-run per capita sales increase.

III. PROFITABILITY OF THE ADVERTISING PROGRAM

The returns to the advertising effort can be estimated by comparing the value of the estimated increase in milk sales due to advertising to the cost of the advertising effort. Since the data over which the response function in Table 1 was estimated contains several observations when no advertising expenditures were made, it is reasonable to compare estimated milk sales at a given level of expenditure to those that could be expected at zero advertising. In Figure 2, the actual per capita daily milk sales in 1976 are plotted against those sales estimated assuming no advertising. In the latter case, all of the remaining regressors were held at their actual 1976 values.

For the calendar year 1976, the estimated fluid milk sales at the average 1976 expenditure level are compared to expected sales without advertising (see Table 2). Assuming that the effect of the advertising program is to increase the utilization of total milk in the fluid Class I market, the farm value of the per capita sales increase can be calculated. This farm value, however, is quite sensitive to the magnitude of the Class I-Class II price differential.[10] The greater the differential, of course, the greater the value of the increased sales. For instance, if the Class I-Class II price differential is $2.40 per hundredweight, after subtracting average per capita advertising cost, the producer's net return per capita from the advertising program in 1976 was 15.0 cents (Table 2). Even when

---

[10]The importance of the Class I-Class II price differential is explored in greater detail in: Thompson, S.R. and D.A. Eiler, "Determinants of Milk Advertising Effectiveness," Am. J. Agric. Econ., 59(1977):330-335.

Figure 2. Actual and Estimated (at Zero Advertising) Per Capita Daily Fluid Milk Consumption NY-Metro SMSA, 1976

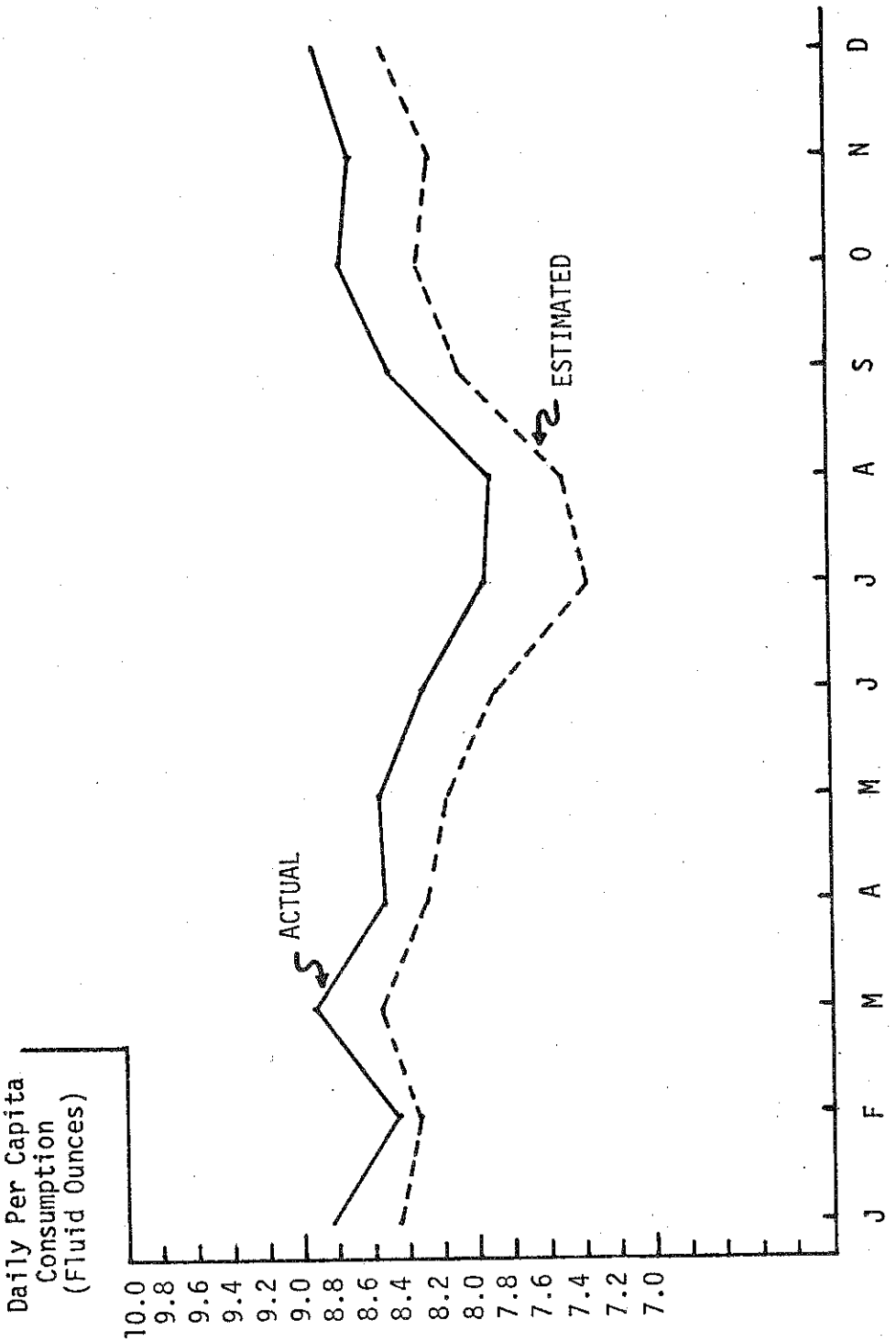


Table 2. Estimated 1976 Producer Returns to Fluid Milk Advertising for New York City SMSA

Average per capita consumption	
Estimated per capita sales of fluid milk:[a/]	
With advertising at 1976 level	3,120
With zero advertising ceteris paribus	2,962
Per capita sales gain attributed to advertising	158 oz.
Farm value of per capita sales increase[b/]	25.2
Per capita advertising expenditure in 1976	10.2
Producer's net return per capita from advertising	15.0¢

[a/] Sales were estimated using the actual 1976: average monthly advertising expenditure, monthly milk price, monthly income, monthly cola price, and the coefficients reported in Table 1.

[b/] Assuming no supply response and a Class I-Class II price differential of $2.40 per hundredweight, each additional ounce of fluid milk sales has an estimated farm value of $0.0016. Note, there are 14.88372 fluid ounces per pound of fluid milk.

extremely small price differentials are used, say $1.50 per hundredweight, the value of the advertising effort seems to exceed the cost.[11]

IV. SUMMARY AND CONCLUSIONS

The purpose of this report was to update previous findings by re-estimating the response of fluid milk sales to generic advertising and the corresponding returns to producers in the New York City market.

Data from January 1975 to March 1977 were used to econometrically estimate the response model. A statistical test showed that a significant change in the model's structure had taken place since 1974. Hence, a polynomial distributed lag response function was specified and estimation was restricted to the most recent 27 month period. All of the estimated parameters had the correct expected direction of influence and were of reasonable magnitude. The estimated long-run effect of advertising on sales (i.e., 84.6) was found to be statistically significant and of roughly the same magnitude as that previously estimated by Thompson and Eiler (i.e., 86.3). The advertising lag structure of the more recent estimate, however, was one period shorter. Moreover, the estimated advertising elasticity in this report was 0.047 vis-a-vis 0.038 estimated previously.

When fluid milk sales at 1976 advertising levels are compared to expected sales without advertising, the estimated net producer's return per capita from advertising was 15.0 cents. This return figure is comparable to the previously estimated return when pre- and post-Order sales were compared by Thompson and Eiler of 10.7 cents.

---

[11] See Appendix Table 2 for a listing of the monthly Class I-Class II price differentials in Federal Order No. 2 from 1971-77.

Although the results of this study may differ slightly from those found previously, the findings here are convincing enough to conclude that fluid milk advertising in the New York City market continues to be a profitable activity.

Appendix Table 1. Milk Sales, Generic Advertising Expenditures, and Other Data for New York City SMSA (January 1975 to March 1977)

		Adjusted Per Capita Sales[a] (Ounces)	Per Capita Monthly Advertising (Dollars)[b]	Per Capita Personal Income[c] (Dollars)	Retail Milk Price Quart[d] (Dollars)	Population SMSA (000)[e]	Population MCA (000)[f]	Consumer Price[g] Index	Cost of Advertising Index[h]	Retail[i] Cola Price 72 oz. Carton (Dollars)
1975	Jan.	9.15	---	6,929.8	.433	12,082.8	18,595.5	153.2	140.0	1.985
	Feb.	9.30	.01742	6,930.5	.430	12,152.6	18,574.8	154.8	140.0	1.970
	Mar.	9.18	.00430	6,931.3	.431	12,222.4	18,554.1	155.3	140.0	1.995
	Apr.	9.03	.00404	6,932.0	.423	12,292.2	18,533.4	155.6	154.0	1.999
	May	8.86	.00610	6,932.8	.436	12,362.0	18,512.7	156.3	154.0	1.921
	Jun.	8.55	.01686	6,933.5	.423	12,432.8	18,492.0	156.4	154.0	1.894
	Jul.	7.95	.00898	6,934.3	.415	12,501.5	18,471.3	157.0	139.0	1.894
	Aug.	8.19	.00427	6,979.2	.424	12,502.5	18,472.0	158.5	139.0	1.821
	Sep.	8.73	.00925	7,024.0	.421	12,503.4	18,472.7	162.4	139.0	1.811
	Oct.	8.93	.00958	7,068.9	.415	12,504.4	18,473.4	163.1	159.0	1.805
	Nov.	8.85	.01288	7,113.7	.430	12,505.3	18,474.1	164.6	159.0	1.805
	Dec.	8.96	---	7,158.6	.436	12,506.2	18,474.8	165.2	159.0	1.804
1976	Jan.	8.82	.00128	7,203.5	.445	12,507.2	18,475.5	165.2	175.0	1.801
	Feb.	8.46	.00700	7,248.3	.443	12,508.1	18,476.2	166.5	175.0	1.811
	Mar.	8.94	.00702	7,293.1	.450	12,509.0	18,476.9	167.7	175.0	1.810
	Apr.	8.53	.01128	7,337.9	.449	12,510.0	18,477.6	168.1	191.0	1.810
	May	8.57	.01394	7,382.8	.446	12,510.9	18,478.3	168.7	191.0	1.813
	Jun.	8.31	.01059	7,427.5	.448	12,511.8	18,479.0	170.0	191.0	1.815
	Jul.	7.95	.00579	7,472.4	.446	12,512.8	18,479.6	170.3	175.0	1.815
	Aug.	7.93	.01451	7,536.4	.444	12,481.9	18,448.2	171.9	175.0	1.811
	Sep.	8.46	.00475	7,600.6	.450	12,451.0	18,416.8	173.6	175.0	1.812
	Oct.	8.73	.01592	7,665.3	.459	12,420.0	18,385.4	173.9	205.0	1.830
	Nov.	8.68	.01041	7,730.2	.450	12,389.1	18,354.0	174.4	205.0	1.851
	Dec.	8.85	---	7,795.5	.449	12,358.2	18,322.5	174.7	205.0	1.863
1977	Jan.	8.75	---	7,861.0	.453	12,327.3	18,291.1	174.7	202.0	1.872
	Feb.	8.68	.00391	7,926.9	.455	12,296.4	18,259.7	175.5	202.0	1.863
	Mar.	8.70	.00840	7,993.1	.455	12,265.5	18,228.3	176.4	202.0	1.864

Footnotes for Appendix Table 1

a/ The net sales within the Standard Metropolitan Statistical Area (SMSA) were adjusted for the type of days in the month, i.e., number of Sundays, Mondays, etc. The sales were also placed on a per capita basis according to the population in the SMSA. Source for adjusting data for calendar composition: John P. Rourke, Adjusting In-Area Sales Data for Calendar Composition, USDA, Agr. Mktg. Ser. Fed. Milk Order Mktg. Stat., FMOMS, No. 196, April 1976 and FMOMS No. 210, June 1977.

b/ Includes media advertising expenditures for television, radio, and newspaper. Advertising expenditures were placed on a per capita basis according to the populating in the media coverage area (MCA). Source: Advertising invoices of American Dairy Association and Dairy Council of Syracuse, New York.

c/ Personal income within SMSA before taxes. Personal income was placed on a per capita basis according to the population of the SMSA. Source: New York State Department of Commerce, Personal Income, New York State By County, 1974 and 1975, July 11, 1977. Historical growth rates were used to estimate 1976 and the first three months of 1977.

d/ Prevailing food store Metro Area fluid whole milk price in dollars per quart. Source: Survey of Prices Charged for Milk on Retail Routes, Food Stores and Dairy Stores 25 Upstate Markets, various monthly issues.

e/ SMSA counties for NYC Metro are: Nassau, New York City--five boroughs, Rockland, Suffolk, Westchester, and Bergen, New Jersey. Population Source: New York State Statistical Yearbook, various issues.

f/ Media Coverage Area (MCA) population. Estimated population viewing television stations of a given market. Source: New York State Statistical Yearbook and Federal Population Series, P-26, various issues. Nonlinear population estimates were made for 1976 and 1977.

g/ Consumer Price Index (CPI) for all items less food in New York, 1967=100. Source: United States Department of Labor, The Consumer Price Index: U.S. City Average and Selected Areas, various monthly issues.

h/ Cost of Advertising Index (composite of all time periods) where first quarter 1971=100. This index reflects variations in the cost of prime time spot television. Source: United Dairy Industry Association, correspondence, Barbara J. Deering, January 7, 1976. Estimates for 1976 and 1977 were made in consultation with personnel from D'Aray-MacManus & Masius, Inc.

i/ Retail price of cola drink (throwaway, 72 oz. carton) in the New York-Northeastern, New Jersey area. Source: United States Department of Labor, Bureau of Labor Statistics, Estimated Retail Food Prices by City, various monthly issues.

Appendix Table 2. Class I-Class II Price Differentials in the New York-New Jersey Federal Milk Marketing Order

	Year						
	1971	1972	1973	1974	1975	1976	1977
	Dollars Per Hundredweight						
Jan.	$2.54	$2.37	$2.26	$3.09	$2.33	$2.31	$2.44
Feb.	2.50	2.37	2.34	3.37	2.33	3.21	2.47
Mar.	2.60	2.48	2.33	3.13	2.44	2.75	2.33
Apr.	2.54	2.52	2.31	2.90	2.20	2.30	2.05
May	2.58	2.62	2.41	3.74	2.36	2.82	2.21
Jun.	2.54	2.53	2.41	3.93	2.34	2.63	2.51
Jul.	2.36	2.36	2.25	3.01	2.03	1.96	2.34
Aug.	2.30	2.21	1.65	2.22	1.71	1.63	2.26
Sep.	2.28	2.27	1.65	1.94	1.42	2.59	2.25
Oct.	2.35	2.23	1.70	1.91	1.94	3.07	2.24
Nov.	2.32	2.14	2.39	2.27	1.77	2.54	2.14
Dec.	2.25	2.11	3.11	2.75	1.96	2.35	n/a
Annual Average:	2.43	2.35	2.23	2.86	2.02	2.51	2.29

Source: Market Administrator, Uniform Price Announcement--NY-NJ Milk Mktg. Area, various monthly issues.