July 1993

A.E. Res. 93-8

EVALUATING U.S. GENERIC MILK ADVERTISING EFFECTIVENESS USING AN IMPERFECT COMPETITION MODEL

by
Nobuhiro Suzuki
Harry M. Kaiser
John E. Lenz
Olan D. Forker

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
Cornell University, Ithaca, NY 14853

Table of Contents

List of Tables

List of Figures

Acknowledgements

Nobuhiro Suzuki is a senior researcher in the National Research Institute of Agricultural Economics, Japanese Ministry of Agriculture, Forestry and Fisheries, and a Visiting Fellow at Cornell University, 1991-1993. Harry M. Kaiser is an associate professor, John E. Lenz is a research associate, and Olan D. Forker is a professor, all in the Department of Agricultural Economics, Cornell University.

The research is supported in part by funds provided by the dairy farmers of New York state under authority of the New York State Milk Promotion Order and the New York State Department of Agriculture and Markets. Partial funding was also provided for a component of the study by the Commodity Economics Division, Economic Research Service of the U.S. Department of Agriculture. The authors thank Donald J. Liu of Iowa State University, Garth J. Holloway and Richard J. Sexton of University of California, Davis, and Bernard F. Stanton of Cornell University for their useful comments.

Abstract

An analytical model to evaluate the effectiveness of U.S. generic milk advertising which incorporates the degree of market competition is presented. Unlike traditional perfect competition models, the imperfect competition model allows for simultaneous movement of both price and quantity with an endogenous fluid (Class I) price differential. The simulation results of the imperfect competition model are compared with the conventional exogenous fluid price differential model. It is shown that the conventional fixed fluid price differential model may under-state the effectiveness of U.S. generic milk advertising in terms of returns to producers.

Key words: generic milk advertising, imperfect competition, fluid differential.

Evaluating U.S. Generic Milk Advertising Effectiveness Using an Imperfect Competition Model

Nobuhiro Suzuki, Harry M. Kaiser, John E. Lenz,
and Olan D. Forker

Introduction

Although raw milk is essentially a homogeneous input in the production of fluid milk and manufactured dairy products, in many countries the price received for fluid milk usage is higher than the price received for manufactured product usage. Such differences indicate that the prices are not competitively determined. This is also the case in the U.S. because a federal or state milk marketing order programs establish minimum Class I price differentials (premiums) for most of the milk that is marketed, and in addition over-order fluid premium payments exist in many markets as a result of negotiations between cooperatives and fluid processors.

Changes in milk advertising expenditures, in theory, will bring about changes in milk prices as well as in milk demand. Thus, the effectiveness of an advertising program should be measured to account for both changes in price and quantity; price and quantity should each be treated as endogenous. In most studies of U.S. dairy markets, an exogenous fluid milk price (Thompson, Eiler, and Forker; Liu and Forker 1989, 1990; Ward and Dixon; Blisard, Sun, and Blaylock), or an exogenous fluid (Class I) price differential (Kaiser, Streeter, and Liu; Kaiser et al.; Liu et al.) is assumed. No models known to the authors have incorporated a degree of competition measure in models of the

U.S. dairy industry, nor has an endogenously determined fluid price differential been introduced (except for Suzuki et al).

In this paper, a model to measure the effectiveness of U.S. generic milk advertising is developed which incorporates the degree of market competition. The usefulness of the model is then demonstrated by illustrating the relative differences of simulation results between the model which has an endogenously determined fluid price differential reflecting the current degree of market competition and a conventional model that utilizes an exogenous fluid price differential. We hypothesize that the former model will provide better estimates of the effects of generic milk advertising than the latter.

Although there are several criticisms of an approach that identifies the degree of market competitiveness, especially regarding a dynamic feedback game, its usefulness in empirical studies has been widely accepted in the literature (Appelbaum; Azzam; Azzam and Pagoulatos; Azzam and Schroeter; Bresnahan 1982, 1989; Chen and Lent; Dixit; Durham and Sexton; Holloway; Iwata; Karp and Perloff; Maier; Schroeter; Schroeter and Azzam; Sullivan; Suzuki, Lenz and Forker; Wann and Sexton; Wilson and Casavant).

Imperfect Competition, Milk Marketing Orders and Dairy Cooperatives

At the turn of the century, about 40 years before federal milk marketing orders were instituted, dairy cooperatives introduced the use of classified pricing and pooling of funds to generate greater returns to dairy farmers (Cassels). However, they were not completely successful due to their lack of complete control over the milk supply since not all farmers were cooperative members. An independent (non-cooperative) farmer had an economic incentive to sell his milk to a proprietary fluid dealer rather than a cooperative because the fluid dealer could pay slightly more than the cooperative's pooled return or blend price, but still lower than the cooperative's Class I price. Due to the independent-producer problem the cooperatives lobbied for and eventually obtained government regulation to enforce classified pricing market-wide in the form of marketing orders (Novakovic and Pratt).

Under the marketing order system, the minimum Class I differential (the difference between the price received for milk used for fluid products and that for manufacturing) is fixed by the authority of the federal government, or in some cases state government. In many markets, the effective price for fluid milk use is higher than the minimum Class I price as a result of cooperatives' bargaining for over-order fluid payments (Fallert, p. 154). Consequently, the effective fluid milk price differential is the minimum Class I differential plus any over-order payment.

The ability of producers to negotiate over-order payments for fluid milk depends on the producer organization's share of the total supply. If milk handlers can buy milk from non-cooperative producers, it will be difficult for a cooperative group to obtain premiums above the minimum Class I price (Robinson, p. 115). Therefore, the effective fluid milk price differential reflects the degree of imperfection in U.S. milk market created mainly by the federal orders and dairy cooperatives. Although the countervailing power of processors may reduce cooperative market power, this paper concentrates on cooperative market power and does not explicitly consider processors' oligopsonistic power.

Theoretical Model

To measure the degree of imperfection, a perfectly competitive market is defined as a basis of comparison. In a perfectly competitive market, cooperatives are without market power. One would expect a relatively uniform manufacturing milk price nationwide. According to Robinson,

> "Class II or manufacturing milk prices are approximately the same in all markets and are linked to the M-W (Minnesota-Wisconsin) price. Uniform pricing of manufacturing milk is necessary because products derived from surplus milk are easily transported between regions. Cheese, butter, and skim-milk powder produced in federal-order markets must compete with similar products manufactured from grade B milk in Minnesota and Wisconsin. Handlers operating in federal-order markets will not purchase surplus milk if it is priced higher than what unregulated plants pay for manufacturing milk in the Midwest." (Robinson, p. 116)

Individual farmers, without cooperative market power and any revenue pooling, would directly compete with each other until the price difference between fluid and manufacturing milk would disappear except for modest locational differences. If a market did not have enough milk to meet local fluid uses, there would be some locational or transportation differentials paid for fluid milk even without marketing orders and cooperatives because fluid plants would have to transport milk from further distances. Fluid plants tend to be located near population centers, while manufacturing plants tend to be located near farms because dairy products are less bulky to ship than raw or fluid milk. For simplicity, we ignore such possibilities because the number of deficit areas and the magnitude of fluid differentials in a perfectly competitive market is difficult to predict. Several previous studies, which tried to estimate welfare losses caused by marketing orders, also assumed no differentials as a benchmark for comparison (Buxton; Dahlgran; Ippolito and Masson; Masson and Eisenstat).

If one specifies that, under imperfect competition, the role of dairy cooperatives is to allocate their raw milk supply to fluid and manufacturing markets so as to maximize total milk sales revenues, the first order condition is to equate marginal revenues from fluid and manufacturing milk. If the cooperatives undertake processing themselves, manufacturing costs should be taken into account. For simplicity, our model does not incorporate them. Under perfect competition, the first order condition is simply expressed as:

(1) $P_f = P_m$,

where P_f is fluid milk price, P_m is manufacturing milk price.

At the opposite extreme, the first order condition for monopoly or collusion is:

(2) $P_f(1 - 1/\epsilon) = P_m(1 - 1/\eta)$,

where $\epsilon = |(\partial Q_f/\partial P_f)\cdot(P_f/Q_f)|$ and $\eta = |(\partial Q_m/\partial P_m)\cdot(P_m/Q_m)|$ are price elasticities of fluid and manufacturing milk demand in absolute terms, respectively; Q_f is aggregate quantity of fluid milk demand; and Q_m is aggregate quantity of manufacturing milk demand.

To express an intermediate degree of imperfect competition, a "market power" parameter, θ, is introduced. Then, equality across markets of "perceived" marginal revenue is expressed as:

(3) $$P_f(1 - \theta_f/\epsilon) = P_m(1 - \theta_m/\eta),$$

or (4) $$P_f + \theta_f \cdot Q_f/(\partial Q_f/\partial P_f) = P_m + \theta_m \cdot Q_m/(\partial Q_m/\partial P_m).$$

θ ($0 \leq \theta \leq 1$) is considered an aggregate indicator of cooperatives' market power under the federal order system. Marginal milk production cost does not enter equation (3) because milk production is almost never controlled by cooperatives, but rather it is determined by individual farmers' response to blend prices they receive.

If θ can be assumed to be the same for both fluid and manufacturing markets, one can identify a value of θ which satisfies equation (3) or (4), with values of milk price elasticities estimated by demand functions and observations of P_f, P_m, Q_f, and Q_m. However, θ_m will probably be lower than θ_f because fluid milk is costlier to transport than manufactured milk, and, therefore, the geographical scope of markets for manufactured milk products in general will exceed that for fluid milk. This means that a given milk marketer will face more competition in the manufactured milk market.

Instead of deriving θ ($\theta_f = \theta_m$) by estimating both fluid and manufacturing demand equations, one could estimate the fluid (or manufacturing) demand equation and equation (3) or (4) into which the manufacturing (or fluid) demand equation is substituted. θ is directly estimated as a coefficient of (3) or (4) using this method (Bresnahan 1982), and θ_f and θ_m can be separately identified. However, the coefficients for the manufacturing (or fluid) demand equation cannot be identified (See Appendix). Consequently, there is not a perfect method for identifying θ_f and θ_m.

The solution to this problem adopted here is to assume that $\theta_m = 0$ and then solve for θ_f. The assumption that $\theta_m = 0$ is fairly realistic because the manufacturing milk price for each market is given as the M-W price, and the M-W price is indirectly supported by government purchases of dairy products. We use the assumption ($\theta_m = 0$) and identify a value of θ_f which satisfies (3) or (4), assuming that θ_f is constant in each time period and that cooperatives approximately realize the condition expressed by (3) or (4). To check differences of simulation results caused by differences of θ estimates, we also use a derived value of θ assuming $\theta_f = \theta_m$.

The full dairy sector imperfect competition model is expressed as:

Milk production:

(5) $Q = f(BP)$

Fluid milk demand:

(6) $Q_f = g(P_f, A_f)$

Manufacturing milk demand:

(7) $Q_m = h(P_m, A_m)$

Milk sales maximizing allocation:

(8) $P_f + \theta_f \cdot Q_f/(\partial Q_f/\partial P_f) = P_m + \theta_m \cdot Q_m/(\partial Q_m/\partial P_m)$

Milk uses identity:

(9) $Q \equiv Q_f + Q_m + FUSE$

Blend price:

(10) $BP = (P_f \cdot Q_f + P_m \cdot Q_m)/(Q - FUSE)$,

where Q is aggregate milk production, BP is blend price[1], A_f is fluid milk advertising expenditures, A_m is manufacturing milk advertising expenditures, and FUSE is on-farm use of milk produced (assumed to be exogenous), with all other variables as previously defined. The other exogenous variables such as feed price, income, and trend, are not included in the above simplified expressions. With the six endogenous variables (Q, Q_f, Q_m, P_f, P_m, BP) and six equations, the model is complete. Because this model expresses farmers' supply and processors' demand for raw milk, government purchases of dairy products and changes in commercial inventories are not treated separately, i.e., manufacturing milk demand (Q_m) includes commercial manufacturing demand, government purchases of dairy products, and changes in commercial inventories on a milk-equivalent basis.

The imperfect competition model expressed by equations (5) through (10) is transformed to a conventional exogenous fluid (Class I) price differential model when equation (8) is replaced with:

(11) $P_f = P_m + DIFF$,

where DIFF is the exogenous fluid (Class I) price differential.

---

[1]The blend price is a uniform price received by all farmers in the market and is equal to the average of the Class I and Class II prices, weighted by utilization rates of how the milk is used between fluid and manufacturing purposes.

Empirical Model Estimation[2]

Over-Order Payment Data

The effective fluid milk price is equal to the M-W price (the manufacturing class price in most federal orders) plus the minimum Class I differential plus any over-order payment. Since the only available data on over-order payments pertain to "announced" over-order payments in 35 markets by the USDA, it is difficult to collect the over-order payment data for all cooperatives over time and to make a national average time-series data set. Instead, we estimate the effective fluid milk price (P_f) by solving the blend price equation for P_f:

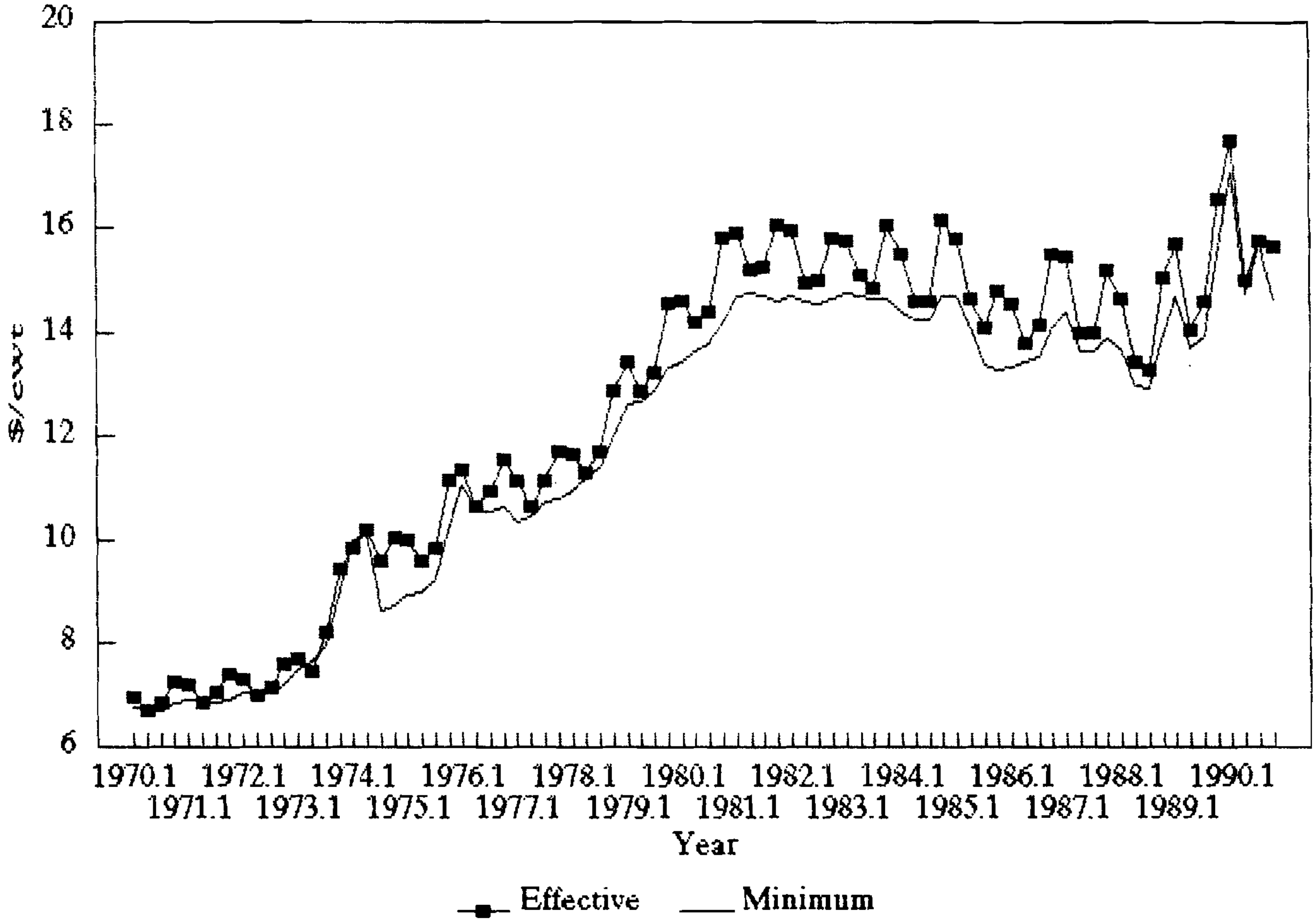
(12) $$P_f = [BP\cdot(Q-FUSE)-P_m\cdot Q_m)]/Q_f$$

The difference between the Class II and III prices is minor and neglected. The blend price (BP) is the all milk price reported by the USDA which includes over-order payments. The differences between the estimated effective fluid milk price and the minimum Class I price are shown in Figure 1. The effective prices are higher than the minimum prices in almost all years, indicating the existence of over-order payments. Figure 1 implies that many previous models had internal data inconsistency because they used the minimum Class I price and the all milk price.

---

[2]The data and its sources are listed in Kaiser et al.

Figure 1. Fluid Milk Prices



Supply Function

Milk supply (Q) is estimated using quarterly data from 1975 to 1990 as a function of the current and lagged milk-feed price ratio (MF = blend price / feed price), time trend (TREND) representing technical progress, intercept dummy variables for the Milk Diversion Program (MDP) and the Dairy Termination Program (DTP), and harmonic seasonality variables (SIN1, COS1, and COS2). The econometric results are presented in Table 1, along with the rest of the estimated equations. All variables are defined in Table 2. A polynomial distributed lag is imposed to account for lagged effects of the milk-feed price ratio.[3] The second degree polynomial distributed lag with both endpoints constrained to lie close to zero, with the six quarter lag length, provides the most significant results. This lag length seems reasonable considering the biological reproduction cycle. The long run price elasticity of milk supply is 0.224, which is similar to Chavas and Klemme's estimated two-year price elasticity of 0.20, and Weersink's estimate of 0.29. To overcome significant first-order autocorrelation in the disturbance term, the Cochrance-Orcutt procedure is employed. Two-Stage-Least-Squares (TSLS) estimation is used because both milk production and the blend price are endogenous in the model.

---

[3]Because long run milk-feed price effects are considered by imposing a polynomial distributed lag, cow numbers are not included in explanatory variables.

Table 1. Estimated Equations for U.S. Milk Supply, Fluid Demand, and Manufacturing Demand

Dependent Variables	Milk Supply $\ln(Q)$	Fluid Demand Q_f/N	Manufacturing Demand Q_m/N
Estimation Periods	1975.2 - 90.4	76.3 - 90.4	76.3 - 90.4
Independent Variables			
Intercept	3.899(24.75)[a]	-0.077(-2.49)	0.378(4.66)
ln(MF)	0.019(3.86)		
$\ln(MF)_{-1}$	0.032(3.86)		
$\ln(MF)_{-2}$	0.040(3.86)		
$\ln(MF)_{-3}$	0.043(3.86)		
$\ln(MF)_{-4}$	0.040(3.86)		
$\ln(MF)_{-5}$	0.032(3.86)		
$\ln(MF)_{-6}$	0.019(3.86)		
TREND	0.0039(8.17)		
MDP	-0.024(-1.67)		
DTP	-0.041(-2.94)		-0.0059(-1.71)
SIN1	-0.0053(-1.94)	0.0016(8.28)	-0.0013(-1.98)
COS1	-0.052(-19.57)	0.0023(10.15)	-0.0074(-9.08)
COS2	0.071(5.40)	0.00018(3.70)	0.00074(2.12)
$(U^{Q})_{-1}$	0.734(7.57)		
P_f/CPI		-0.105(-3.16)	
INC/CPI		0.0011(2.70	-0.0069(-3.55)
(GA_f)		1.0×10^{-7}(3.10)	
$(GA_f)_{-1}$		1.7×10^{-7}(3.10)	
$(GA_f)_{-2}$		2.0×10^{-7}(3.10)	
$(GA_f)_{-3}$		2.0×10^{-7}(3.10)	
$(GA_f)_{-4}$		1.7×10^{-7}(3.10)	
$(GA_f)_{-5}$		1.0×10^{-7}(3.10)	
BA_f		6.8×10^{-7}(2.60)	
AU19		0.387(4.85)	
$(U^{Qf/N})_{-1}$		0.788(4.94)	
P_m/CPI			-1.113(-3.96)
(BA_m)			3.6×10^{-7}(2.34)
$(BA_m)_{-1}$			5.4×10^{-7}(2.34)
$(BA_m)_{-2}$			5.4×10^{-7}(2.34)
$(BA_m)_{-3}$			3.6×10^{-7}(2.34)
D89.4			0.018(2.80)
D90.4			-0.022(-3.16)
$(U^{Qm/N})_{-1}$			0.670(3.78)
Adj. R^2	0.95	0.92	0.78
D.W.	1.79	2.02	1.74

[a]Figures in parentheses are t-values.

Table 2. Definitions for the Variables Used in the Equations Presented in Table 1

Q = milk production (billion pounds),

MF = (blend price)/(feed price), where blend price is all milk price ($/cwt) and feed price is U.S. average price of 16% protein dairy feed ($/ton),

TREND = time trend variable equal to 1 for 1970, quarter 1,..., MDP = intercept dummy variable for the Milk Diversion Program equal to 1 for 1984, quarter 1 through 1985, quarter 2, equal to 0 otherwise,

DTP = intercept dummy variable for the Dairy Termination Program equal to 1 for 1986, quarter 2 through 1987, quarter 3, equal to 0 otherwise,

SIN1, COS1, and COS2 = harmonic seasonality variables representing the first wave of the sine function (1,0,-1,0), the first wave of the cosine function (0,-1,0,1), and the second wave of the cosine function (-1,1,-1,1), respectively. (1,0,-1,0) etc. are values for each quarter, where the first quarter means $\pi/2$, second π, third $3\pi/2$, and fourth 2π,

U_{-1} = lagged residual,

Q_f = fluid milk marketed (billion pounds),

N = U.S. population (million persons),

P_f = effective Class I price estimated using equation (12) ($/cwt),

CPI = consumer price index for all items (1982-84 = 100),

INC = disposable personal income per capita ($1,000),

GA_f and BA_f = generic and branded fluid advertising expenditures deflated by the media price index ($1,000), respectively

AU19 = ratio of persons under 19 years old to the total population (total=1),

Q_m = manufacturing milk marketed (billion pounds),

P_m = M-W price ($/cwt),

BA_m = branded manufacturing advertising expenditures (including branded butter advertising, branded ice cream advertising, and branded cheese advertising) deflated by the media price index ($1,000),

D89.4 = intercept dummy variable equal to 1 for 1989, quarter 4, equal to 0 otherwise,

D90.4 = intercept dummy variable equal to 1 for 1990, quarter 4, equal to 0 otherwise.

Fluid Milk Demand Function

The fluid milk demand function is the processors' demand for raw milk. To insure that all identities are meaningful, all quantities in the model are measured on a milk-fat equivalent basis. Per capita fluid milk demand (Q_f/N) is explained by the effective fluid milk price (P_f), per capita income (INC), the ratio of persons under 19 years old to the total population (AU19), current and lagged fluid advertising expenditures (branded BA_f, and generic GA_f), and harmonic seasonality variables (SIN1, COS1, and COS2). The variables P_f and INC are deflated by the consumer price index, and BA_f and GA_f are by the media price index. A polynomial distributed lag is imposed to account for lagged generic fluid advertising effects. The second degree polynomial distributed lag with both endpoints constrained to lie close to zero, with the five quarter lag length, provides the most significant results. The effects are the largest four to six months later, and erode in about a year. No lagged effects of branded fluid advertising are found to be significant, but the current effect is significant. Calculated at mean data points, the elasticities of fluid demand with respect to price, income, and branded fluid advertising are -0.293, 0.483, and 0.0089, respectively. Liu et al.'s estimated elasticities of retail fluid demand with respect to price and income were -0.282 and 0.154, respectively. The long run generic advertising elasticity is 0.054, which is similar to Kinnucan and Forker's estimate of 0.051 in New York City, but larger than Liu et al.'s estimate of 0.0175 for retail-level national fluid demand. The fluid demand function is estimated using a linear form because other functional forms (double-log, semi-log, log-inverse, and inverse) resulted in negative marginal revenue estimates and are thus rejected because negative fluid milk marginal revenue precludes discussion of the collusion case expressed by equation (2).[4] TSLS is used to estimate this equation because both quantity and price are endogenous in the model.

Manufacturing Milk Demand Function

Because this is processors' demand for raw milk, government purchases of dairy products and changes in commercial inventories are not treated separately. Per capita manufacturing milk demand (Q_m/N) is estimated as a function of the manufacturing milk price (P_m) deflated by the CPI, per capita income (INC) deflated by the CPI, the ratio of persons under 19 years old to the total population (AU19), current and lagged manufacturing milk advertising expenditures (branded BA_m, and generic GA_m), an intercept dummy variable for the DTP, and harmonic seasonality variables (SIN1, COS1, and COS2). The federal dairy price support program is considered in this equation in that the manufacturing milk price (P_m = M-W price) is indirectly supported through government purchases of dairy products. Intercept dummy variables are also included for the fourth quarters of 1989 and 1990 because regression residuals for both periods are very large. The outlier for the fourth quarter of 1989 is likely due to the unusually strong demand for nonfat dry milk during that quarter, but we have no explanation for the fourth quarter 1990

---

[4]The manufacturing demand function is also estimated using a linear form to be consistent with the fluid demand function.

outlier. A polynomial distributed lag is imposed to account for lagged branded manufacturing advertising effects. The second degree polynomial distributed lag with both endpoints constrained to lie close to zero, with three quarter lag length, provides the most significant results. On the other hand, we could not estimate any significant effects of generic manufacturing advertising (a negative coefficient with very small t-value is found). The variable, AU19, is also not significant. Consequently, these variables are dropped from the model. The estimated coefficient on the income variable is negative and significant, which is not consistent with what one would expect. Because each dairy product has a very different demand trend and structure, disaggregated estimation would likely produce better results, however, this is beyond the scope of our present analysis. Calculated at mean data points, the elasticities of manufacturing demand with respect to price and long run branded advertising are -1.575 and 0.234, respectively. The estimated price elasticity is relatively large compared to previous studies such as -0.928 by Liu et al. Again, TSLS was used to estimate this equation because both manufacturing demand and price are endogenous in the model.

"Market Power" Parameter

The "market power" parameter equals one, under monopoly or collusion and zero under perfect competition or price-taking behavior. Two different values of annual average θ's derived from equation (3) or (4) with estimates of fluid and manufacturing demand equations are reported in table 3. $\theta_m = 0$

is assumed in case 1, and $\theta_f = \theta_m$ in case 2. θ values are larger when $\theta_f = \theta_m$ is assumed, but the differences are relatively small. The results for both cases indicate that the U.S. milk market is neither perfectly competitive nor purely monopolistic. On a scale from 0 to 1, the data imply some "market power" that has been declining over time.

Table 3. Estimated "Market Power" Parameters (Annual Average)

Year	Case 1 θ_f when $\theta_m = 0$	Case 2 $\theta_f = \theta_m$
1977	0.077(0.024)[a]	0.089[b]
1978	0.065(0.021)	0.075
1979	0.066(0.021)	0.076
1980	0.066(0.021)	0.076
1981	0.065(0.020)	0.076
1982	0.061(0.019)	0.072
1983	0.059(0.019)	0.071
1984	0.056(0.018)	0.066
1985	0.061(0.019)	0.073
1986	0.057(0.018)	0.067
1987	0.058(0.018)	0.069
1988	0.050(0.016)	0.059
1989	0.044(0.014)	0.052
1990	0.055(0.017)	0.065

[a]Figures in parentheses are standard errors defined by: $(P_f - P_m) \cdot N/(Q_f \cdot CPI) \cdot$[standard error of the fluid demand function's estimated slope].

[b]Standard errors cannot be computed in this case because of the nonlinear relationship.

Simulations

To determine the validity of the estimated model, values for the endogenous variables, given the values for the exogenous variables, are determined in a dynamic simulation by the Gauss-Seidel technique for the historical period 1980-90. As illustrated by the mean absolute percent errors shown in Table 4, the largest error is less than 4%, which is small for dynamic simulation.

Table 4. Mean Absolute Percent Errors[a] (1980.1-90.4)

Endogenous Variables	Mean Absolute Percent Error Case 1	Case 2
	%	%
Fluid Milk Price (P_f)	3.10	3.16
Manufacturing Milk Price (P_m)	3.70	3.69
Blend Price (BP)	3.54	3.56
Fluid Milk Demand (Q_f)	1.60	1.59
Manufacturing Milk Demand (Q_m)	2.91	2.88
Milk Production (Q)	1.67	1.66

[a]The formula is: $(1/n)\sum|(P-A)/A|\times 100$, where P is the predicted value and A is the actual value.

To estimate the effectiveness of generic milk advertising, we simulate scenarios with 1% increases in generic fluid advertising expenditures in every period from the first quarter of 1980 until the fourth quarter of 1990. Because we could not estimate any significant effectiveness of generic manufacturing advertising, only generic fluid advertising expenditures are considered. The effectiveness is shown by increases in producer surplus associated with 1% increases in the advertising expenditures. The change in producer surplus is approximated by the following trapezoid area:

$$(BP'-BP)\cdot(Q'+Q-2\cdot FUSE)/2,$$

where ' represents *ex post* value. *Ex ante* values are not observations but values solved by fully dynamic simulation.

The results of both imperfect competition models (case 1 and 2), as well as the exogenous fluid (Class I) price differential model are shown in Table 5. The results represent the average increase in producer surplus, prices, and quantities from 1980 through 1990 associated with a 1% increase in generic advertising expenditures.

It is clear from the simulation results that producers benefit from increased generic advertising expenditures. The 1% increase in generic milk advertising expenditures causes fluid milk quantity and price to increase by 0.0484% and 0.0222%, respectively, under case 1, and 0.0478% and 0.0243%, respectively, under case 2. There is a larger increase in fluid milk price, and a smaller increase in fluid quantity under case 2 than under case 1. Consequently, the 1% increase in generic fluid milk advertising results in a smaller decrease in manufacturing milk quantity and a smaller increase in manufacturing milk price under case 2 than under case 1. The derived "market power" parameters are larger in case 2 than in case 1. The results show that with greater market power, generic fluid milk advertising causes a larger increase in fluid milk price and a smaller increase in fluid quantity. Hence, greater market power results in larger returns to producers with fluid demand more price-inelastic than manufacturing demand. Producer surplus increases by $1.017 million for case 1, and $1.044 million for case 2.

Table 5. Estimated Average Increases in Producer Surplus Associated with 1% Increases in Advertising Expenditures (1980-90)

	Imperfect Competition Model		Exogenous Fluid Price Differential Model
	Case 1 $\theta_m = 0$	Case 2 $\theta_f = \theta_m$	
Increases in Producer Surplus (1000$)	1,017	1,044	902
Percent changes in:			
Fluid Milk Price (%)	0.0222	0.0243	0.0135
Fluid Milk Quantity (%)	0.0484	0.0478	0.0508
Manufacturing Milk Price (%)	0.0154	0.0150	0.0171
Manufacturing Milk Quantity (%)	-0.0214	-0.0208	-0.0237

The simulation also reveals that the conventional Class I price differential model under-states the benefits of generic fluid milk advertising. For example, the increase in fluid milk price is 0.0087 points larger, and the increase in fluid quantity is 0.0024 points smaller under case 1 than under the conventional model. Consequently, there is a smaller decrease in manufacturing milk quantity and a smaller increase in manufacturing price under case 1 than under the conventional model. In terms of producer welfare, the increase in producer surplus due to a 1% increase in generic milk advertising is 13% (case 1) and 16% (case 2) larger with the imperfect competition model than with the exogenous fluid differential model. Because greater market power results in larger returns to producers, the exogenous fluid differential model that ignores the degree of imperfect competition underestimates the effectiveness of the U.S. generic milk advertising.

Conclusions

In this paper we developed a framework to evaluate U.S. generic milk advertising effectiveness accounting for the degree of competition. The effective fluid milk price differential is endogenously explained by the degree of market power in the model. The traditional model with an exogenous fluid price differential does not account for the degree of imperfect competition. The estimated "market power" parameters indicate that there is some market power in the U.S. milk market. The model with an endogenously determined fluid differential provides simulation results that indicate that greater market power results in larger returns from generic milk advertising, and, therefore, the traditional model with an exogenous fluid price differential may underestimate the magnitude of impacts of the U.S. generic milk advertising.

References

Appelbaum, E. "The Estimation on the Degree of Oligopoly Power." J. Econometrics 19(1982):287-99.

Azzam, A. M., and E. Pagoulatos. "Testing Oligopolistic and Oligopsonistic Behavior: An Application to the U.S. Meat-Packing Industry." J. Agr. Econ. 41(1990):362-70.

Azzam, A. M., and J. R. Schroeter. "Implications of Increased Regional Concentration and Oligopsonistic Coordination in the Beef Packing Industry." West. J. Agr. Econ. 16(1991): 374-81.

Azzam, A. M. "Testing the Competitiveness of Food Price Spread." J. Agr. Econ. 43(1992):248-56.

Blisard, W. N., T. Sun, and J. M. Blaylock. "Effects of Advertising on the Demand for Cheese and Fluid Milk." Staff Report No. AGES 9154, U.S. Dept. of Agriculture, Economic Research Service, Washington DC, October 1991.

Bresnahan, T. B. "The Oligopoly Solution Concept is Identified." Economics Letters. 10(1982):87-92.

Bresnahan, T. B. "Empirical Studies of Industries with Market Power." In Handbook of Industrial Organization, Volume II, edited by R. Schmalensee and R. D. Willig, 1011-57. Amsterdam: Elsevier Science Publishers B. V., 1989.

Buxton, B. M. "Welfare Implications of Alternative Classified Pricing Policies for Milk." Amer. J. Agr. Econ. 59(1977): 525-29.

Cassels, J. M. A Study of Fluid Milk Prices. Cambridge: Harvard University Press, 1937.

Chavas, J-P., and R. M. Klemme. "Aggregate Milk Supply Response and Investment Behavior on U.S. Dairy Farms." Amer. J. Agr. Econ. 68(1986):55-66.

Chen, Z., and R. Lent. "Supply Analysis in an Oligopsony Model." Amer. J. Agr. Econ. 74(1992):973-79.

Dahlgran, R. A. "Welfare Costs and Interregional Income Transfers Due to Regulation of Dairy Markets." Amer. J. Agr. Econ. 62(1980):288-96.

Durham, C. A. and R. J. Sexton. "Oligopsony Potential in Agriculture: Residual Supply Estimation in California's Processing Tomato Market." Amer. J. Agr. Econ. 74(1992): 962-72.

Fallert, R. F. "Federal Milk Marketing Order Issues and Research Needs." In Dairy Models and Modeling for Policy Analysis: Concepts and Issues. Proceedings of a Seminar Sponsored by NC-176, NE-153, and S-166, 153-61, Ohio State University, October 1986.

Forker, O. D. and R. W. Ward. Commodity Advertising: The Economics and Measurement of Generic Programs. New York: Lexington Books, 1993.

Holloway, G. J. "The Farm-Retail Prices Spread in an Imperfectly Competitive Food Industry." Amer. J. Agr. Econ. 73(1991): 979-89.

Ippolito, R. A., and R. T. Masson. "The Social Cost of Government Regulation of Milk." J. Law and Econ. 21(1978): 33-65.

Iwata, G. "Measurement of Conjectural Variations in Oligopoly." Econometrica 42(1974):947-66.

Kaiser, H. M., O. D. Forker, J. E. Lenz, and C. Sun. "Evaluating Generic Dairy Advertising Impacts on Retail, Wholesale, and Farm Milk Markets." J. Agr. Econ. Research, 1993, forthcoming.

Kaiser, H. M., D. H. Streeter, and D. J. Liu. "Welfare Comparison of U.S. Dairy Policies with and without Mandatory Supply Control." Amer. J. Agr. Econ. 70(1988): 848-58.

Karp, L. S., and J. M. Perloff. "Dynamic Oligopoly in the Rice Export Market." Rev. Econ. and Statist. 71(1989):462-70.

Kinnucan, H. W., and O. D. Forker. "Allocation of Generic Advertising Funds Among Products: A Sales Maximization Approach." Northeast. J. Agr. and Resource Econ. 17(1988): 64-71.

Liu, D. J., and O. D. Forker. "Generic Fluid Milk Advertising, Demand Expansion, and Supply Response: The Case of New York City." Amer. J. Agr. Econ. 70(1988):229-36.

Liu, D. J., and O. D. Forker. "Optimal Control of Generic Fluid Milk Advertising Expenditures." Amer. J. Agr. Econ. 72(1990):1047-55.

Liu, D. J., H. M. Kaiser, O.D. Forker, and T. D. Mount. "An Economic Analysis of the U.S. Generic Dairy Advertising Program using an Industry Model." Northeast. J. Agr. and Resource Econ. 19(1990):37-48.

Maier, L. The Costs and Benefits of U. S. Agricultural Policies with Imperfect Competition in Food Manufacturing. Cornell University Ph.D. thesis, 1991.

Masson, R. T., and P. M. Eisenstat. "Welfare Impacts of Milk Orders and the Antitrust Immunities for Cooperatives." Amer. J. Agr. Econ. 62(1980):270-78.

Novakovic, A. M., and J. Pratt. Geographic Price Relationships Under Federal Milk Marketing Orders. A. E. Research 91-8, Dept. Agr. Econ., Cornell University, September 1991.

Robinson, K. L. Farm and Food Policies and Their Consequences. New Jersey: Prentice-Hall Inc., 1989.

Schroeter, J. R. "Estimating the Degree of Market Power in the Beef Packing Industry." Rev. Econ. and Statist. 70(1988): 158-62.

Schroeter, J. R., and A. M. Azzam. "Marketing Margins, Market Power, and Price Uncertainty." Amer. J. Agr. Econ. 73(1991):990-99.

Sullivan, D. "Testing Hypotheses about Firm Behavior in the Cigarette Industry." J. Polit. Econ. 93(1985):586-98.

Suzuki, N., H. M. Kaiser, J. E. Lenz, and O. D. Forker. Imperfect Competition Model and Deregulation: U.S. Dairy Policy. Working Paper 93-2, Dept. Agr. Econ., Cornell University, 1993.

Suzuki, N., J. E. Lenz, and O. D. Forker. "A Conjectural Variations Model of Reduced Japanese Milk Price Supports." Amer. J. Agr. Econ. 75(1993):210-18.

Thompson, S. R., D. A. Eiler, and O. D. Forker. "An Econometric Analysis of Sales Response to Generic Milk Advertising in New York State." Search Agriculture, Vol. 6, No. 3. Ithaca: New York State College of Agriculture and Life Sciences, Cornell University, July 1976.

Wann, J. J., and R. J. Sexton. "Imperfect Competition in Multiproduct Food Industries with Application to Pear Processing." Amer. J. Agr. Econ. 74(1992):980-90.

Ward, R. W., and B. L. Dixon. "Effectiveness of Fluid Milk Advertising Since the Dairy and Tobacco Adjustment Act of 1983." Amer. J. Agr. Econ. 71(1989):730-40.

Weersink, A. "Nonrobustness of Dynamic Dual Models of Northeastern and U.S. Dairy Industries." Northeast. J. Agr. and Resource Econ. 19(1990):12-16.

Wilson, W. W., and K. L. Casavant. "Some Market Power Implications of the Shipping Act of 1984: A Case Study of the U.S. to Pacific Rim Transportation Markets." West. J. Agr. Econ. 16(1991):427-34.

Appendix

An Alternative Solution

For simplicity, fluid and manufacturing demand equations are specified as follows:

(A1) $Q_f = a + bP_f$

(A2) $Q_m = c + dP_m$

Then, equality across markets of "perceived" marginal revenue is:

(A3) $P_f + \theta_f \cdot Q_f/b = P_m + \theta_m \cdot Q_m/d$

In this paper, we tried to estimate θ's from (A3) using estimates of (A1) and (A2).

Alternatively, substituting (A2) into (A3) yield:

(A4) $P_f = -\theta_f/b \cdot Q_f + (1 + \theta_m)P_m + \theta_m \cdot c/d$

If (A1) and (A4) are estimated without estimating (A2), both θ_f and θ_m are identified, but c and d cannot be identified separately.

OTHER AGRICULTURAL ECONOMICS RESEARCH PUBLICATIONS

No. 92-10	A Survey of Human Resource Management Practices in Florist Crop Production Firms	Thomas R. Maloney Robert A. Milligan
No. 92-11	International Monetary Issues and Agricultural Development	G. Edward Schuh
No. 92-12	New Product Procurement: A Summary of Buying Practices and Acceptance Criteria at U.S. Supermarket Chains	Peter J. Fredericks Edward W. McLaughlin
No. 93-01	Feed Grains and Meat Production in Venezuela	Fernando Marrero Steven Kyle
No. 93-02	A Survey of Economic Models of the Dairy Industry	Harry M. Kaiser Don P. Blayney
No. 93-03	Analysis of Generic Dairy Advertising Scenarios on Retail, Wholesale, and Farm Milk Markets	Harry M. Kaiser Olan D. Forker
No. 93-04	Price Transmission Processes: A Study of Price Lags and Asymmetric Price Response Behavior for New York Red Delicious and McIntosh Apples	Michelle R. Hansmire Lois Schertz Willett
No. 93-05	A Survey of Recruitment & Selection Practices in Florist Crop Production Firms	Thomas R. Maloney Robert A. Milligan Kristine T. Petracek
No. 93-06	Agricultural Diversity and Cash Receipt Variability for Individual States	Loren W.Tauer Tebogo Seleka
No. 93-07	Valuation of Plant Variety Protection Certificates	William Lesser