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Imperfect Competition Models and Commodity Promotion Evaluation: The Case of U.S. Generic Milk Advertising

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ABSTRACT

This article examines whether the assumption of perfect competition in the U.S. dairy industry biases the findings of economic impacts of generic dairy advertising. An imperfect competition model based on an approach similar to that of Appelbaum is developed and used to evaluate generic milk advertising. The results are compared with a perfect competition model. The findings indicate positive price and quantity impacts due to generic advertising. The differences in magnitude of impacts between the two models are small, suggesting that the assumption of perfect competition for U.S. dairy models is plausible.

Key Words: evaluation, generic milk advertising, imperfect competition model.

Almost all previous models used to evaluate the economic impacts of commodity promotion programs have assumed perfect competition in the market. However, this may not be a realistic assumption for many commodities. Market power likely exists both on the buying and selling sides of the market. For example, farmers, through their cooperatives, may exert a degree of selling power over processors buying agricultural commodities. Alternatively, processors may have some buying power relative to farmers or cooperatives, and/or may have some selling power over buyers of the processed products.

The existence of market power may give biased results if traditional perfect competition models are used to evaluate economic impacts of promotion programs. This is an important issue because nearly all previous studies have assumed perfect competition. Two exceptions include a study of generic milk promotion in Japan (Suzuki et al.) and an analysis of generic beef advertising in Canada and the United States (Cranfield and Goddard).

The purpose of the current research is to determine whether the assumption of perfect competition in the U.S. dairy industry biases the findings of economic impacts of generic dairy advertising in the United States. A secondary objective is to measure the impact of generic milk advertising on dairy markets at the national level. Two models of the U.S. dairy industry are used to simulate the impacts of generic dairy advertising: (*a*) an imperfect competition model, and (*b*) a perfect compe-

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tition model. The imperfect competition model endogenizes the degree of market competition using an approach similar to that of Appelbaum, which is based on the assumption that dairy cooperatives maximize total revenue by equating "perceived" marginal revenue from fluid and manufacturing milk markets. Using quarterly data from 1975 through 1995, an econometric model of milk supply with fluid and manufacturing milk demand was estimated and used to simulate the impacts of milk advertising on prices and quantities. The perfect competition model treats the price premiums obtained by cooperatives through bargaining power as exogenous. A comparison of simulation results of the two models based on alternative advertising scenarios provides information on the potential magnitude of bias from the exogenous Class I premium model.

Conceptual Model

The underlying assumption of the imperfect competition model stipulates that the role of dairy cooperatives, acting as consignment milk sellers, is to allocate their members' raw milk supply to fluid (or Class I, as it will be referred to here) and manufacturing markets[1] to maximize total milk sales revenue. For most dairy farmers in the United States, the manufacturing milk price is equal to the Basic Formula Price (or the Minnesota-Wisconsin price before 1995). Therefore, the manufacturing milk price is assumed to be exogenous for dairy cooperatives' decisions on milk allocation. With this assumption, the ith cooperative's sales-maximizing problem can be expressed as:

$$(1) \qquad \text{Max } R^i = P_f q_f^i + P_m(q^i - q_f^i),$$

s.t.:

$$(2) \qquad Q_f = f(P_f),$$

$$(3) \qquad \sum_{j \neq i} q_f^j = g(q_f^i),$$

and

$$(4) \qquad Q_f = q_f^i + \sum_{j \neq i} q_f^j,$$

where R^i is the ith cooperative's milk sales revenue, P_f is Class I milk price, P_m is manufacturing milk price, q_f^i *is the* ith cooperative's Class I milk marketings, q^i is milk quantity sent from member farmers, and $\{\Sigma_{j \neq i} q_f^j\}$ is the sum of all other fluid milk marketings by cooperatives. Equation (3) indicates the ith cooperative's conjecture of the other cooperatives' aggregate reaction function, i.e., how the cooperative believes rivals will respond to a change in Class I milk supply level.

The Lagrangian function for this problem is specified as:

$$(5) \qquad L = P_f q_f^i + P_m(q^i - q_f^i) + \alpha[Q_f - f(P_f)] + \beta\left[\sum_{j \neq i} q_f^j - g(q_f^i)\right] + \gamma\left[Q_f - q_f^i - \sum_{j \neq i} q_f^j\right].$$

The first-order conditions are:

$$(6) \qquad \partial L/\partial P_f = q_f^i - \alpha(\partial Q_f/\partial P_f) = 0,$$

$$(7) \qquad \partial L/\partial Q_f = \alpha + \gamma = 0,$$

$$(8) \qquad \partial L/\partial q_f^i = P_f - P_m - \beta\left(\partial \sum_{j \neq i} q_f^j/\partial q_f^i\right) - \gamma = 0,$$

and

$$(9) \qquad \partial L \Big/ \partial \sum_{j \neq i} q_f^j = \beta - \gamma = 0.$$

[1] Federal and state milk marketing orders use a system of classified pricing to price raw milk according to how it is utilized. Milk used in the most price-elastic products (e.g., butter) receives the Class III price, which is equal to the Basic Formula Price determined through market conditions in the surplus manufacturing (Grade B) milk area of the U.S. (Wisconsin and Minnesota). Milk used in the most price-inelastic fluid products receives the Class I price, which is equal to the Class III price plus a fixed fluid differential, and varies with distance from the Upper Midwest. Most federal milk marketing orders now utilize four product classes, with Class I being fluid products, Class II being soft dairy products, Class III being mostly hard dairy products, and Class IIIa being nonfat, dry milk. For simplicity, a two-class system was used in this study, with Classes II, III, and IIIa considered a single manufacturing milk class paid the Basic Formula Price.

Taking P_m and q^i as given, equations (6), (7), and (9) can be solved for α, resulting in:

$$(10) \quad \alpha = -\gamma = -\beta = q_f^i/(\partial Q_f/\partial P_f).$$

Substituting (10) into (8) yields:

$$(11) \quad P_f + q_f^i/(\partial Q_f/\partial P_f)\left[1 + \left(\partial \sum_{j\neq i} q_f^j/\partial q_f^i\right)\right] = P_m.$$

The term $\{\partial \Sigma_{j\neq i} q_f^j/\partial q_f^i \equiv r^i\}$ (conjectural variation) is the derivative of equation (3), and the term $\{1 + \partial \Sigma_{j\neq i} q_f^j/\partial q_f^i = \partial Q_f/\partial q_f^i \equiv k^i\}$ (1 + conjectural variation) is Varian's k (Varian). The first-order condition implies that the milk sales revenue is maximized by equating "perceived" marginal revenues from Class I and manufacturing milk.

Using the conjectural elasticity, $\theta = (\partial Q_f/\partial q_f^i)(q_f^i/Q_f)$ (i.e., Varian's k expressed in the elasticity term), equation (11) can be expressed as:

$$(12) \quad P_f + \theta \times Q_f/(\partial Q_f/\partial P_f) = P_m,$$

or

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

where ϵ is the price elasticity of Class I demand in absolute value. Although P_f and θ are not the same for all cooperatives, equation (12) is assumed to be valid for the national market level if P_f and θ are translated into national average values.

Equation (12) can be rearranged as:

$$(13) \quad \theta = \epsilon(P_f - P_m)/P_f.$$

Values for θ can be estimated by substituting estimated values for ϵ, and observations for P_m and P_f, into equation (13).

Although it is assumed that manufacturing milk demand (Q_m) and q^i are given for each cooperative's decision on milk allocation between markets in the short term, they are not exogenous at the market level. Using the relationship in (12), the imperfect competition model of the U.S. dairy industry is represented by the following six equations which contain six endogenous variables:

$$(14) \quad Q = f(BP, P_{feed}, T, D1, D2, D3, BST);$$

$$(15) \quad Q_f = g(P_f, INC, GA_f, BA_f, T, D1, D2, D3, BST);$$

$$(16) \quad Q_m = h(P_m, INC, T, D1, D2, D3, BST);$$

$$(17) \quad P_f(1 - \theta/\epsilon) = P_m;$$

$$(18) \quad Q = Q_f + Q_m + FUSE;$$

and

$$(19) \quad BP = (P_fQ_f + P_mQ_m)/(Q - FUSE),$$

where the endogenous variables are aggregate milk production (Q), farm blend price (BP), Class I and manufacturing milk demand (Q_f and Q_m), and Class I and manufacturing milk prices (P_f and P_m). The exogenous variables include feed price (P_{feed}); time trend (T); intercept dummy variables for seasonality and for bovine somatotropin (bST) utilization ($D1$, $D2$, $D3$, and BST); disposable per capita income (INC); generic and branded milk advertising expenditures (GA_f and BA_f); and on-farm use of milk produced ($FUSE$). Equation (14) is the farm milk supply function, and equations (15) and (16) are the Class I and manufacturing milk demand functions, respectively. Equation (17) is the first-order condition for optimal milk allocation between Class I and manufacturing markets to maximize milk sales. Equation (18) is an equilibrium condition requiring farm milk supply to be equal to Class I and manufacturing processors' milk demand plus on-farm use of milk. Finally, equation (19) is the formula for the blend price, which is a weighted average price received by farmers based on the class prices and utilization of the milk supply.

The above model was compared to a conventional perfect competition model where the Class I price premium was treated as an exogenous variable. The conventional model was the same as the above model, except that equation (17) was replaced with the following:

$$(20) \quad P_f = P_m + DIFF,$$

where $DIFF$ is the exogenous Class I price differential.

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

	Dependent Variables		
Independent Variables	Milk Supply $\ln(Q)$	Fluid Demand $\ln(Q_f/N)$	Mfg. Demand $\ln(Q_m/N)$
Intercept	4.906 (15.87)	−4.281 (−22.80)	−3.412 (−13.97)
$\ln(MF)$	0.049 (4.99)		
$\ln(MF)_{-1}$	0.084 (4.99)		
$\ln(MF)_{-2}$	0.106 (4.99)		
$\ln(MF)_{-3}$	0.113 (4.99)		
$\ln(MF)_{-4}$	0.106 (4.99)		
$\ln(MF)_{-5}$	0.084 (4.99)		
$\ln(MF)_{-6}$	0.049 (4.99)		
T	0.003 (13.34)	−0.0042 (−7.45)	
$D1$	0.027 (5.18)	−0.016 (−3.71)	0.055 (3.96)
$D2$	0.086 (14.58)	−0.071 (−12.41)	0.185 (13.26)
$D3$	0.036 (6.95)	−0.063 (−11.35)	0.093 (6.80)
$\ln(P_f/CPI)$		−0.158 (−3.24)	
$\ln(INC/CPI)$		0.258 (3.54)	0.119 (0.99)
$\ln(GA_f)$		0.0051 (8.22)	
$\ln(GA_f)_{-1}$		0.0086 (8.22)	
$\ln(GA_f)_{-2}$		0.0103 (8.22)	
$\ln(GA_f)_{-3}$		0.0103 (8.22)	
$\ln(GA_f)_{-4}$		0.0086 (8.22)	
$\ln(GA_f)_{-5}$		0.0051 (8.22)	

Table 1. (Continued)

Independent Variables	Milk Supply $\ln(Q)$	Fluid Demand $\ln(Q_f/N)$	Mfg. Demand $\ln(Q_m/N)$
	Dependent Variables		
$\ln(BA_f)$		0.0071	
		(2.28)	
BST		−0.032	−0.026
		(−4.14)	(−1.36)
$\ln(P_m/CPI)$			−0.217
			(−2.80)
$AR(1)$	0.567		
	(4.65)		
$MA(1)$	0.428	0.482	0.872
	(2.90)	(3.86)	(7.88)
Adjusted R^2	0.94	0.90	0.86
D.W.	2.01	1.90	1.55

Note: Numbers in parentheses are *t*-values.

Estimated Model

The effective Class I price used in the estimation is defined as the manufacturing milk price (the Minnesota-Wisconsin price or the Basic Formula Price), plus the minimum Class I differential, plus any over-order payment. There were no data for national over-order payments for Class I milk, but the effective Class I milk price (P_f) could be estimated by solving the blend price equation for P_f:

$$(21) \quad P_f = [BP(Q - FUSE) - P_m Q_m)]/Q_f.$$

The term BP in equation (21) refers to the all-milk price, which is a measure of the national blend price including over-order payments. Based on equation (21), the effective Class I price was 5% higher than the actual Class I price, on average, between 1975 and 1995. The effective Class I price computed by equation (21) may be somewhat higher than the true effective Class I price because the all-milk price includes over-order payments for Class II and Class III milk, as well as Class I milk. However, over-order premiums for Class II and Class III milk are usually much smaller on a national basis than Class I premiums, and therefore the potential upward bias in P_f from equation (21) is likely small.

To check for potential bias, the effective Class I price estimated from equation (21) was compared with the "announced cooperative Class I price," which includes over-order Class I premiums, over the period 1976–90 (Suzuki et al.). The average effective Class I price computed using equation (21) from 1976–95 was $14.32, while the average announced cooperative Class I price was $14.29. The 3¢ difference, which represents 0.2% of the effective Class I price, implies that the over-order premiums for Class II and Class III milk at the national level are not large on average, and consequently there is probably little bias caused by using the computed effective Class I price from the blend price equation.

The estimated farm milk supply, Class I demand, and manufacturing demand equations—corresponding to equations (14) through (16)—are presented in table 1, while all variable definitions and data sources are listed in table 2. These equations were estimated using two-stage least squares to correct for potential simultaneity bias due to both price and quantity being endogenous variables. Quarterly national data from 1975–95 were used to estimate the model.

The milk supply equation (Q) was estimat-

Table 2. Definitions of Variables and Identification of Data Sources

Variable	Definition
T	Time trend variable, equal to 1 for 1975.1.
$D1$, $D2$, $D3$	Intercept dummy variables for 1st, 2nd, and 3rd quarters of year.
P_f	Effective Class I price per cwt estimated using equation (21).
BST	Intercept dummy variable for bST utilization; equal to 1 for 1994.1–1995.3, equal to 0 otherwise.
Q_m	Manufacturing milk marketed (bil. lbs.), computed as the milk production minus on-farm use minus fluid milk marketings.
$AR(1)$	First-order autoregressive error term.
$MA(1)$	First-order moving average error specification.
Q	Milk production, bil. lbs.[a]
MF	All-milk price per cwt divided by the 16% protein feed price per ton.[a]
Q_f	Fluid milk marketed, bil. lbs.[a]
P_m	Minnesota-Wisconsin price per cwt.[a]
N	U.S. population, million persons.[b]
CPI	Consumer price index for all items, 1982–84 = 100.[c]
INC	Disposable personal income per capita, in $1,000s.[d]
GA_f, BA_f	Generic and branded fluid advertising expenditures, deflated by the media cost index, in $1,000s.[e]

[a] USDA/Economic Research Service, *Dairy Situation and Outlook Report.*

[b] Bureau of Economic Statistics, Inc., *Handbook of Basic Economic Statistics.*

[c] USDL/Bureau of Labor Statistics, Consumer Price Index database.

[d] USDL/Bureau of Labor Statistics, *Employment and Earnings.*

[e] Leading National Advertisers, Inc., *Leading National Advertisers* and *Class/Brand QTR $.*

ed as a function of the milk-feed price ratio (MF or BP/P_{feed}), a time trend (T), and intercept dummy variables for seasonality ($D1$, $D2$, and $D3$). It was assumed that farmers formulate price expectations based on past price observations; accordingly, a polynomial distributed lag was specified for the milk-feed price ratio.[2] Several specifications for the lag structure were estimated, and the one that yielded the best statistical fit in terms of the adjusted coefficient of variation was selected. The second-degree polynomial distributed lag imposed with both endpoints constrained to lie close to zero and a six-quarter lag length fit the data best. The time trend variable was included as a proxy for improvements in technology over time. The intercept dummy variable for bST utilization (BST) was dropped from the model because it was not significant. The Cochrane-Orcutt procedure and the moving average error specification were employed to overcome significant first-order autocorrelation in the disturbance term. The computed long-run price elasticity of milk supply was 0.591.

Per capita Class I milk demand[3] (Q_f/N) was estimated as a function of the effective Class I price (P_f), per capita income (INC), a time trend as a proxy for preference changes (T), current and lagged fluid advertising expenditures (branded BA_f and generic GA_f), and intercept dummy variables for bST utilization and seasonality (BST, and $D1$, $D2$, and $D3$). All prices and income variables were deflated by the consumer price index, and advertising expenditures were deflated by the media price index. A polynomial distributed lag was imposed to account for lagged generic fluid advertising effects, which is one of the most common methods of modeling advertising impacts (Forker and Ward). As with the previous case, several lag specifications were estimated, and the one that resulted in the best statistical

[2] The number of cows was not included as an explanatory variable because long-run milk-feed price effects were incorporated by imposing a polynomial distributed lag.

[3] All quantities in the model were measured on a milk-fat equivalent basis to satisfy the equilibrium conditions.

fit in terms of the adjusted coefficient of variation was selected. The second-degree polynomial distributed lag with both endpoints constrained to lie close to zero and a five-quarter lag length fit the data best.

Similar specifications for fluid milk advertising have been used by many researchers (e.g., Liu et al.; Suzuki et al.; Kaiser et al.). Current branded fluid advertising expenditures were found to be significant, but lagged expenditures were not. The elasticities of Class I demand with respect to price, income, and branded fluid advertising were −0.158, 0.258, and 0.0071, respectively. The estimated long-run generic advertising elasticity was 0.048, which was 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. It is of interest that the results show a negative and statistically significant impact of bST on Class I milk demand.

Per capita manufacturing milk demand (Q_m/N) was estimated as a function of the manufacturing milk price (P_m), per capita income (INC), and intercept dummy variables for bST utilization and seasonality (BST, and $D1$, $D2$, and $D3$).[4] Again, all prices and income were deflated by the consumer price index. A time trend as a proxy for preference changes (T) was dropped from the model because it was not significant. Advertising variables were not included in this aggregate equation because of aggregation bias due to summing up advertising expenditures for many different dairy products. The estimated elasticities of manufacturing demand with respect to price and income were −0.217 and 0.119, respectively.

Using equations (9) and (13), along with the estimated price elasticity of Class I demand, quarterly values for θ were derived and are reported in table 3. While the estimated elasticities are all statistically significant at the

Table 3. Estimated Quarterly Values for θ

	Quarter				Annual Aver-
Year	1	2	3	4	age
1976	NA	NA	0.032 (0.010)	0.045 (0.014)	NA
1977	0.042 (0.013)	0.030 (0.009)	0.035 (0.011)	0.039 (0.012)	0.037
1978	0.036 (0.011)	0.029 (0.009)	0.028 (0.009)	0.030 (0.009)	0.031
1979	0.034 (0.010)	0.027 (0.008)	0.026 (0.008)	0.035 (0.011)	0.030
1980	0.034 (0.011)	0.028 (0.009)	0.027 (0.008)	0.033 (0.010)	0.031
1981	0.032 (0.010)	0.027 (0.008)	0.029 (0.009)	0.035 (0.011)	0.031
1982	0.034 (0.011)	0.027 (0.008)	0.027 (0.008)	0.032 (0.010)	0.030
1983	0.032 (0.010)	0.027 (0.008)	0.025 (0.008)	0.036 (0.011)	0.030
1984	0.035 (0.011)	0.027 (0.008)	0.024 (0.007)	0.035 (0.011)	0.030
1985	0.036 (0.011)	0.035 (0.011)	0.034 (0.010)	0.039 (0.012)	0.036
1986	0.038 (0.012)	0.032 (0.010)	0.032 (0.010)	0.037 (0.012)	0.035
1987	0.042 (0.013)	0.033 (0.010)	0.031 (0.009)	0.041 (0.013)	0.037
1988	0.043 (0.013)	0.036 (0.011)	0.027 (0.008)	0.030 (0.009)	0.034
1989	0.043 (0.013)	0.032 (0.010)	0.024 (0.007)	0.020 (0.006)	0.030
1990	0.044 (0.014)	0.023 (0.007)	0.027 (0.008)	0.054 (0.017)	0.037
1991	0.044 (0.014)	0.035 (0.011)	0.024 (0.008)	0.034 (0.010)	0.034
1992	0.043 (0.013)	0.027 (0.008)	0.028 (0.009)	0.036 (0.011)	0.034
1993	0.040 (0.012)	0.020 (0.006)	0.034 (0.010)	0.022 (0.007)	0.029
1994	0.027 (0.008)	0.031 (0.010)	0.023 (0.007)	0.032 (0.010)	0.028
1995	0.029 (0.009)	0.035 (0.011)	0.026 (0.008)	NA	NA

Note: Numbers in parentheses are standard errors, defined by: Standard Error of the Estimated Price Elasticity of Fluid Demand × $(P_f - P_m)/P_f$.

[4] Government purchases of dairy products and changes in commercial inventories were included with commercial demand in the manufacturing milk demand function because such purchases were counted as demand for raw milk.

99% confidence level, they are close to zero, with the average value for all years equaling 0.032. This result is lower than, but similar to, findings of two other studies that have estimated conjectural elasticities. Suzuki et al. estimated an average conjectural elasticity for the U.S. dairy industry of 0.06 for the period 1977–90. Liu, Sun, and Kaiser estimated average fluid milk and manufactured product conjectural elasticities for the U.S. dairy industry of 0.176 and 0.10, respectively, for the period 1976–92. The magnitude of the conjectural elasticities over this period suggests that the U.S. dairy industry is relatively competitive. Furthermore, the results indicate a slight trend toward greater competition over time. This trend is interesting since there have been significant mergers and growth among major dairy cooperatives in recent years. However, as Suzuki et al. point out, increases in transportation technology and in reserves of milk outside the Upper Midwest have resulted in a more competitive milk market nationally.

Model Validation and Advertising Scenarios

The imperfect competition model, presented by equations (14)–(19), was completed by introducing the estimated farm milk supply with Class I and manufacturing demand equations into equations (14)–(16), and estimating values for θ and ϵ into equation (17). When equation (20), $P_f = P_m + DIFF$, was used instead of equation (17), the perfect competition model was created. Again, the purpose of creating the exogenous perfect competition model was to compare the results of the two models in terms of price and quantity impacts of generic milk advertising. First, the validity of both models was determined by dynamically simulating values for the endogenous variables over a historical period (1976–95), given the values for the exogenous variables using the Gauss-Seidel technique. The mean absolute percent errors[5] were calculated for each model and were quite similar. Since the largest error was roughly 6% (relatively small for a dynamic simulation), both models were deemed reasonable for this purpose.

To estimate the effectiveness of generic milk advertising, four scenarios were simulated based on 10% and 50% increases, and 50% and 95% decreases in generic fluid advertising expenditures in every period from the third quarter of 1976 through the third quarter of 1995. A fifth scenario was run with advertising levels set equal to historical levels in order to provide a baseline for comparison to the other four scenarios. The effectiveness of advertising was measured in terms of changes (from the baseline scenario) in Class I and manufacturing milk prices, and Class I and manufacturing milk quantities associated with the respective change in generic milk advertising expenditures.

Results

The simulation results for the various scenarios are summarized in table 4. The first column of numbers for each scenario gives the percentage change in prices and quantities due to a change in milk advertising expenditures, averaged over the period 1976.3–1995.3, generated by the imperfect competition model. The second column of numbers for each scenario provides identical information, except it corresponds to the perfect competition model.

Not surprisingly, the largest discrepancy between models was the predicted impact of advertising on the Class I price. For example, in the 50% increase in milk advertising scenario, the imperfect competition model predicted an increase in the Class I price of 12.5¢ per cwt, while the perfect competition model predicted an increase of 10.8¢. In fact, for all four scenarios, the imperfect competition model consistently predicted a larger change in the Class I price due to changes in advertising. Therefore, the claim that the conventional perfect competition model understates the impact of advertising on the Class I price appears to be confirmed in this empirical simulation. However, the difference in magnitudes between models was small, indicating the bias

[5] The formula used to calculate the mean absolute percent error is: $(1/n)\ \Sigma|(P - A)/A| \times 100$, where P is the predicted value, and A is the actual value.

Table 4. Estimated Quarterly Average Changes in Milk Prices and Quantities Associated with Changes in Advertising Expenditures (1976.3–1995.3)

	Changes from Baseline Level			
Item	Imperfect Competition	Perfect Competition	Imperfect Competition	Perfect Competition
	--- 50% Increase Scenario ---		--- 50% Decrease Scenario ---	
Fluid Milk Price ($/cwt)	0.125 (0.87)	0.108 (0.75)	−0.207 (−1.44)	−0.179 (−1.25)
Fluid Milk Quantity (bil. lbs.)	0.233 (1.76)	0.235 (1.78)	−0.389 (−2.94)	−0.395 (−2.97)
Manufacturing Milk Price ($/cwt)	0.099 (0.87)	0.108 (0.95)	−0.164 (−1.44)	−0.178 (−1.58)
Manufacturing Milk Quantity (bil. lbs.)	−0.039 (−0.19)	−0.042 (−0.21)	0.065 (0.32)	0.071 (0.35)
	--- 10% Increase Scenario ---		--- 95% Decrease Scenario ---	
Fluid Milk Price ($/cwt)	0.029 (0.20)	0.025 (0.18)	−0.839 (−5.86)	−0.720 (−5.03)
Fluid Milk Quantity (bil. lbs.)	0.054 (0.41)	0.055 (0.42)	−1.604 (−12.11)	−1.620 (−12.23)
Manufacturing Milk Price ($/cwt)	0.023 (0.20)	0.025 (0.22)	−0.664 (−5.86)	−0.720 (−6.37)
Manufacturing Milk Quantity (bil. lbs.)	−0.009 (−0.04)	−0.010 (−0.05)	0.271 (1.33)	0.296 (1.45)

Note: Numbers in parentheses are percentage changes.

in previous models was likely small as well. The two models do indicate roughly the same level of advertising impact on Class I quantities. The imperfect competition model predicted a slightly lower advertising impact on Class I quantities than the perfect competition model.

The two models also generated differences in terms of milk advertising impacts on the manufacturing milk market. In the 50% increase in milk advertising scenario, the imperfect competition model predicted a 9.9¢ per cwt increase in the manufacturing price due to changes in milk advertising, while the conventional perfect competition model predicted a 10.8¢ increase. Similarly, the imperfect competition model predicted a 0.19% decrease in manufacturing milk quantities due to increased milk advertising, compared with a 0.21% decrease projected by the conventional model. Similar to the Class I market results, the actual magnitude of differences between models was relatively small.

The main methodological implication of this study is that the extent of possible bias caused by assuming perfect competition in the dairy markets is rather small. The simulated values of market variables from both models were quite similar between the two models. Moreover, since the conjectural elasticity has been generally falling over time, indicating increasing competition in the market, it appears that the use of perfect competition models in future analyses of the U.S. dairy industry may be appropriate.

Clearly, from the results of both models, generic milk advertising has had an impact on the markets for both fluid and manufacturing milk. For example, the imperfect competition model predicted that a 50% decrease in generic fluid milk advertising over the period 1976–95 would have resulted in an average decrease in the Class I price of 1.44% and an average decrease in Class I volume of almost 3%. This means that reducing milk advertising by 50% over this period would have resulted in an average reduction in total Class I milk revenue to farmers of 4.3%. This translates into an annual loss in revenue of $322 million, on average, from 1976–95, which is significant considering the amount of the total checkoff program (including advertising for all products, research and development, nutrition education, and overhead) over this period averaged just $206 million per year.

The model also indicated cross-commodity impacts of fluid milk advertising on the manufactured products market. For instance, a 50% decrease in fluid milk advertising would have resulted in an average decrease of 1.4% in the manufacturing milk price and a 0.3% increase in manufacturing sales, because a decrease in Class I sales made more milk available for the manufacturing milk market. This translated into a decrease in total manufacturing milk revenue of 1.1%, on average, over 1976–95. Therefore, generic fluid milk advertising over this period had positive impacts for dairy farmers in both fluid and manufactured product markets.

Conclusion

The purpose of this study was to determine whether the assumption of perfect competition in the U.S. dairy industry biases the findings of economic impacts of generic dairy advertising in the United States. Two models of the U.S. dairy industry were developed and used to simulate the impacts of generic dairy advertising: (*a*) an imperfect competition model, and (*b*) a perfect competition model. The imperfect competition model endogenized the degree of market competition using an approach similar to that of Appelbaum. The perfect competition model treated the price premiums obtained by cooperatives through bargaining power as exogenous.

The results indicate the perfect competition model understated the impact of generic milk advertising on the Class I price, and overstated the advertising impacts on Class I quantity, and on manufacturing milk price and quantity. However, the differences in magnitude of impacts between the two models were small. Therefore, the empirical results suggest the extent of bias in previous exogenous Class I premium models was likely small as well. Like virtually all previous studies, this research also confirmed that generic fluid milk advertising has had a positive impact on fluid and manufactured milk markets in the United States in terms of increasing producer prices and Class I volume.

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