Price and Quantity Effects of Canada's Dairy Advertising Programs

Henry W. Kinnucan and Evelyn T. Belleza

An equilibrium-displacement model is combined with econometric estimates of key model parameters to identify the impacts of Canada's dairy advertising programs on prices and quantity. Results suggest increased advertising of fluid milk enhances the farm value of milk but has minimal effect on government costs of the dairy price-support program. Owing to government intervention in the butter market, increased butter advertising has no effect on the farm value of milk, at least in the short run, but is highly effective at reducing government costs. Advertising is most effective, *ceteris paribus*, in markets where retail demand and wholesale supply for the specific dairy product are relatively price inelastic.

Despite large increases in the amount of money spent on generic (non-brand) advertising of food products by agricultural groups over the past decade (e.g., see Forker and Ward), relatively little is known about the economic impacts of the programs. The few studies that have been done focus on U.S. programs (Liu *et al.*; Kaiser *et al.*; Zidack, Kinnucan and Hatch; Ward and Lambert) or address only the *quantity* impacts of isolated campaigns (Kinnucan; Goddard and Tielu; Goddard and Amuah; Chang and Kinnucan, 1990, 1991a). The overall impacts (quantity *and* price) of the Canadian dairy advertising program, which is one of the oldest and best funded programs of its kind in the world ($1.12 per capita compared to $0.70 in the United Kingdom, and $0.52 in the United States (Forker *et al.*, p. 4)), have not been addressed in the scholarly literature.

The objective of this research is to determine the price and quantity impacts of Canada's diary advertising programs. Knowledge of the price and quantity impacts of advertising is important because it serves as a basis for assessing the welfare effects, industry rates of return, and decisions concerning the efficient allocation of marketing resources. A secondary objective is to provide estimates of supply, demand, price transmission and advertising elasticities that may be useful for the analysis of government policies and other forces affecting the Canadian dairy industry.

The research objectives are accomplished by specifying an equilibrium-displacement model that takes into account the important policy interventions in the Canadian dairy markets. Based on econometric estimates of the structural parameters, the model's reduced form is simulated to determine the effects of increased fluid milk and butter advertising on prices and quantities. A major question is whether advertising increases the farm value of milk sufficiently to cover the cost of the programs.

Conceptual Framework

The conceptual framework consists of vertically linked markets for raw milk, processed milk at the wholesale level, and fluid milk and manufactured dairy products (e.g., butter and cheese) at the retail level. At the farm level, dairy farmers produce milk to sell to provincial milk marketing boards. The production decision is based on expected milk prices and marketing quotas for fluid and manufacturing milk. Actual milk prices are set by the government or marketing authority using target returns and cost-of-production formulas. Monies to fund the advertising programs are obtained through a mandatory per-unit levy on farm marketings. Increases in the levy, which typically equals about 1.2% of the farm price, shifts up the primary supply schedule for milk.

Kinnucan is professor and Belleza is post-doctoral research associate, Department of Agricultural Economics and Rural Sociology, Auburn University, Auburn, Alabama 36849-5604 USA.

We express appreciation to Ellen Goddard, Archie MacDonald and Elisha Kizito for providing data and background information on Canadian dairy markets and to Robert Nelson, Greg Traxler, and Hui Xiao for reviewing an earlier version of the manuscript. Two anonymous journal reviewers provided insightful comments that improved the quality of the manuscript. The usual disclaimers apply. Scientific journal paper no. 1-955072 of the Alabama Agricultural Experiment Station.

At the wholesale level, bottlers and manufacturers purchase the raw milk from the provincial milk marketing boards and convert it into fluid milk and manufactured products for sale to retailers. Wholesalers pay government-mandated higher prices for milk destined to fluid uses than for milk used in manufacturing. The prices they receive, in turn, are influenced by government policy through a system of wholesale price and processing margin guarantees and by advertising-induced shifts in retail demand.

At the retail level, consumers purchase milk and other dairy products from grocery stores, restaurants, and other retail establishments. Retail demand is influenced by consumer income, the prices charged for the various dairy products, and industry advertising. Based on demand and cost factors, retailers place orders with bottlers and manufacturers to maintain inventories at desired levels.

The price and quantity impacts of advertising in the vertical system depend on the magnitude of the advertising-induced shifts in the primary demand schedules, the slopes of the supply schedules at each level, the behavior of marketing margins, and cost pass-through, i.e., whether farmers absorb all, none, or a portion of the advertising levy. The cost pass-through, which in general depends on the relative slopes of the supply and demand schedules for milk at the farm level (Chang and Kinnucan, 1991b), appears at each stage as a leftward shift in the supply schedule. The behavior of the marketing margins depends, *inter alia*, on the degree of substitutability between the farm and non-farm inputs in the vertical system (Kinnucan and Forker, p. 290). If the substitution elasticities between farm and non-farm inputs are zero (fixed proportions), advertising-induced shifts in retail demand in general will have a greater effect on farm price than when the substitution elasticities are non-zero (variable proportions) (Wohlgenant, p. 646).

Model

The essence of the foregoing framework is the advertising-induced shifts in retail demand and the consequent effects on price at the farm level. The farm-level price effect depends on government intervention. The critical intervention for the purposes of this analysis is the government offer-to-purchase program. Two cases need to be distinguished: the case in which the offer-to-purchase program is *nonbinding* in the sense that the government price is below the market-clearing price and the case in which the offer-to-purchase program is *binding* in the sense that the government price is above the market-clearing price.

The critical difference between the binding and non-binding programs is that in the non-binding case no surpluses are generated, which means that advertising-induced increases in demand for the affected dairy product can still influence farm price. For a market with a binding offer-to-purchase program, a surplus is generated that must be purchased by the government. In this case, advertising affects government purchases and not price (unless the demand shift is large enough to render the offer-to-purchase program non-binding at the support price). Because the offer-to-purchase program affects only the manufactured markets, the fluid market is specified separately from the manufactured market.

Fluid Market

The behavioral equations defining the fluid market are:[1]

(1) $Q_1^d = D_1(P_1, A_1)$ (retail demand)

(2) $W_1 = F_1(P_1)$ (retail-wholesale price linkage)

(3) $Q_1^s = S_1(W_1)$ (wholesale supply)

(4) $Q_1^d = Q_1^s$ (retail/wholesale market-clearing)

where Q_1^d is retail demand for fluid milk, P_1 is retail price, A_1 is fluid milk advertising, W_1 is wholesale fluid price, and Q_1^s is wholesale fluid supply. In this formulation, the retail and wholesale markets are linked by a price-transmission equation (equation (2)), which may be interpreted as a quasi-reduced form of the implied retail supply and wholesale demand equations.

Comparative statics of the fluid milk model can be obtained by first expressing the model in log-differential form:

(5) $$\mathrm{dln}Q_1^d = N_1\mathrm{dln}P_1 + B_1\mathrm{dln}A_1$$

(6) $$\mathrm{dln}W_1 = T_1\mathrm{dln}P_1$$

(7) $$\mathrm{dln}Q_1^s = E_1\mathrm{dln}W_1$$

(8) $$\mathrm{dln}Q_1^d = \mathrm{dln}Q_1^s$$

[1] For brevity, exogenous variables other than advertising and policy variables (e.g., support prices) are not specified in the structural equations defining initial equilibrium as these variables are held constant in the simulations to be presented later. However, the omitted exogenous variables do appear in the econometric models used to estimate the structural model's parameters.

where $\text{dln}Z = \text{d}Z/Z$ refers to the percent change in Z divided by 100, N_1 is the retail-level demand elasticity for fluid milk, B_1 is the advertising elasticity, T_1 is the elasticity of retail-wholesale price transmission, and E_1 is the wholesale-level supply elasticity. The percent change in retail price is obtained by substituting (5)–(7) into (8), which yields:

$$\text{(9)} \qquad \text{dln}P_1 = [B_1/(E_1T_1 - N_1)]\text{dln}A_1$$

Equation (9) indicates that for normal sloping supply and demand curves, an increase in fluid milk advertising always increases retail price, as the price-transmission and advertising elasticities are positive.

The effect of an increase in fluid milk advertising on wholesale price is obtained by substituting (9) into (6), which yields

$$\text{(10)} \qquad \text{dln}W_1 = [T_1B_1/(E_1T_1 - N_1)]\text{dln}A_1.$$

Equation (10) indicates that wholesale price will increase in tandem with the retail price, with the transmission elasticity T_1 governing the extent to which advertising enhances wholesale price vis-a-vis the retail price.

The effect of an increase in fluid milk advertising on quantity is obtained by substituting (10) into (7), which yields

$$\text{(11)} \qquad \text{dln}Q_1 = [E_1T_1B_1/(E_1T_1 - N_1)]\text{dln}A_1,$$

Equation (11) indicates that the quantity effect of an increase in fluid milk advertising hinges on the supply elasticity. If $E_1 = 1$, equations (10) and (11) are equal and a given percentage increase in advertising will have identical effects on wholesale price and quantity. If the supply elasticity is greater than unity, the quantity effect will be larger than the price effect; if the supply elasticity is less than unity, the price effect will exceed the quantity effect.

Equations (9)–(11) constitute the reduced form of the structural fluid milk model. Given estimates of the requisite elasticities, the reduced form provides a basis for assessing the impact of a given increase in fluid milk advertising on consumers and middlemen.

Manufacturing Market

As mentioned previously, the market for manufactured dairy products is influenced by a government offer-to-purchase program, which is implemented at the wholesale level. This program is binding in some markets (e.g., butter), but not in others (e.g., cheese). Because butter and cheese are the primary markets affected by advertising, the model is specified with these two markets in mind. The structural equations are:

(12)	$Q_2^d = D_2(P_2,A_2)$	(retail demand)
(13a)	$W_2 = F_2(P_2)$	(price linkage if $P_g < W_2$)
(13b)	$P_2 = F_2'(P_g)$	(price linkage if $P_g \geq W_2$)
(14)	$Q_2^s = S_2[max(W_2,P_g)]$	(wholesale supply)
(15a)	$Q_2^d = Q_2^s$	(market-clearing if $P_g < W_2$)
(15b)	$Q_2^d = Q_2^s - GP$	(market-clearing if $P_g \geq W_2$)

where Q_2^d is retail demand for the manufactured dairy product; P_2 is retail price; A_2 is manufactured dairy product advertising; W_2 is wholesale price; P_g is the government offer-to-purchase price; Q_2^s is wholesale supply; and GP is government purchases. The model's structure is similar to the fluid market, with the important difference that an effective offer-to-program produces a surplus in the affected wholesale market (equation (15b)), which must be removed by the government to sustain the offer-to-purchase price.

Wholesale supplies are assumed to respond to the reigning price, the higher of the government price and the wholesale price. If the offer-to-purchase program is non-binding, the assumed direction of causation is from retail to wholesale price (equation (13a)), as in the fluid market. If the program is binding, the direction of causation is reversed, with the support price determining the retail price (equation (13b)).

The reduced-form for the manufacturing market model in the case of a non-binding program is derived in a parallel manner as was done for the fluid milk sub-model. In particular, expressing equations (12), (13a), (14) and (15a) in log-differential form and making appropriate algebraic substitutions, the following set of equations is obtained:

$$\text{(16)} \qquad \text{dln}P_2 = [B_2/(E_2T_2 - N_2)]\text{dln}A_2$$

$$\text{(17)} \qquad \text{dln}W_2 = [T_2B_2/(E_2T_2 - N_2)]\text{dln}A_2.$$

$$\text{(18)} \qquad \text{dln}Q_2 = [E_2T_2B_2/(E_2T_2 - N_2)]\text{dln}A_2.$$

where B_2, E_2, T_2, and N_2 are the manufactured dairy product advertising, wholesale supply, retail-wholesale price transmission, and retail demand elasticities, respectively. These equations are similar to (9)–(11) and thus have a similar interpretation.

A binding offer-to-purchase program implies that advertising affects government purchases (or inventory) and not price. The reduced form that expresses this fact is obtained by replacing (13a) with (13b) and (15a) with (15b) and repeating the steps indicated earlier for the non-binding case. This yields the alternative reduced form:

$$\text{(19)} \qquad \mathrm{dln}Q_2^d = [N_2/T_2]\mathrm{dln}P_g + B_2\mathrm{dln}A_2 \,.$$

$$\text{(20)} \qquad \mathrm{dln}GP = [E_2(Q_2^s/Q_2^d) - N_2/T_2)]\mathrm{dln}P_g - (Q_2^d/GP)B_2\mathrm{dln}A_2$$

Comparing (19) and (20) with (16)–(18), it is apparent that advertising no longer influences retail or wholesale price when a market is effectively supported by a government purchase scheme. This is because an advertising-induced increase in demand simply reduces the quantity that the government needs to purchase to maintain the support price. As long as the support price is too high for increases in advertising to eliminate the need for government removals, there is no need for production to increase to satisfy the additional demand and hence price remains constant. Equations (19) and (20) indicate that an increase in the support price always reduces retail demand and increases government purchases for normal-sloping supply and demand schedules. Under the same assumptions, and for a given support price level, an increase in advertising always increases retail demand and reduces government purchases in the supported market.

Farm-Level Market

The government's financial exposure under the offer-to-purchase program is reduced by placing a quota on milk production at the farm level. In addition, the government attempts to enhance farm income through a price-discrimination scheme whereby milk destined for the fluid market is priced higher than milk destined for the more price-elastic manufacturing market. The producer receives a "blend price," which is a weighted average of the fluid and industrial milk prices.

Accordingly, the farm market is represented by the following set of structural equations:

$$\text{(21)} \quad P_B = (X_1/X)P_I + (X_2/X)P_{II} \qquad \text{(blend price)}$$

$$\text{(22)} \quad P_I = M_1(W_1) \qquad \text{(price linkage to fluid market)}$$

$$\text{(23)} \quad P_{II} = M_2[(max(W_2,P_g)] \qquad \text{(price linkage to mfg. market)}$$

$$\text{(24)} \quad X = X_1 + X_2 \qquad \text{(farm-level market clearing)}$$

where P_B is the blend price of milk, P_{II} is the industrial milk price, P_I is the fluid milk price (equal to P_{II} plus a government-determined premium), X_1 is the quantity of milk used for fluid purposes (equal to Q_1), X_2 is the quantity of milk used for manufacturing purposes (equal to λQ_2, where λ is a fixed conversion factor that indicates the quantity of X_2 required to produce one unit of Q_2), and X is the total quantity of milk produced, which is assumed to be predetermined by the government quota system.

The reduced form for blend price is obtained by first substituting equations (22)–(24) into (21), and taking the logarithmic differential of the resulting equation, which, after some manipulation, yields (bearing in mind that $\mathrm{dln}X = 0$):

$$\text{(25)} \qquad \begin{aligned} \mathrm{dln}P_B = {} & [(P_I - P_{II})X_1/P_BX]\mathrm{dln}X_1 \\ & + (P_IX_1/P_BX)L_1\mathrm{dln}W_1 \\ & + (P_{II}X_2/P_BX)L_2\mathrm{dln}W_2. \end{aligned}$$

where L_1 and L_2 are elasticities of wholesale-farm price transmission for fluid and industrial milk, respectively. Recognizing that changes in retail demand translate into equivalent changes in farm-level demand, i.e., $\mathrm{dln}X_1 = \mathrm{dln}Q_1$, equations (10), (11) and (17) are now substituted into (25) to obtain the reduced-form equation for blend price in terms of advertising:

$$\text{(26)} \qquad \mathrm{dln}P_B = \frac{[(P_I - P_{II})(E_1/P_IL_1) + 1]P_IX_1L_1T_1B_1}{P_BX(E_1T_1 - N_1)} \mathrm{dln}A_1 + \frac{P_{II}X_2L_2T_2B_2}{P_BX(E_2T_2 - N_2)}\mathrm{dln}A_2$$

Equation (26) indicates how an increase in retail-level advertising is translated into changes in the farm price given fixed supply and advertising in the fluid market or a manufactured market with a non-binding offer-to-purchase program. Given historical dairy price-support policies, equation (26) is appropriate for fluid milk and cheese advertising. For butter advertising, equations (19) and (20) are used in place of (26) to reflect the fact that due to a binding offer-to-purchase program in the butter market, advertising-induced increases in retail demand for butter affect government purchases and not price.

Equation (26) provides an *a priori* basis for assessing the relative impacts of fluid milk and (non-binding) manufactured dairy product advertising. For example, advertising in the manufactured market becomes more effective vis-a-vis the fluid market as the supply and demand elasticities in the manufactured market become less elastic, *ceteris paribus*. If supply, demand, price-transmission and advertising elasticities in each market are equal, the relative effectiveness of advertising in the two markets will depend on market shares and the magnitude of the price differential between fluid and industrial milk. With equal elasticities, for example, manufactured dairy product advertising (in a non-binding market) becomes more effective vis-a-vis fluid advertising as the price differential diminishes, i.e., $(P_I - P_{II}) \rightarrow 0$, and as the industrial-milk market share gets larger, i.e., $P_{II}X_2/P_BX \rightarrow 1$.

Estimation

To determine the actual relative impacts of fluid milk and manufactured dairy product advertising, the structural parameters (elasticities) in the foregoing model have to be estimated. Estimation was accomplished by specifying separate blocks of equations for the fluid milk, cheese, and butter markets, the markets directly affected by industry advertising. Within each block, a retail demand, wholesale supply, and price-linkage equations were specified in a manner consistent with the structural model.

The equations were estimated in double-log form using quarterly data for the period 1973.I through 1988.IV. To minimize simultaneous-equation bias and take into account cross-equation correlation in the disturbance terms, each block was estimated by three-stage least squares (3SLS) or seemingly-unrelated instrumental variables (SURIV).[2] Variable definitions are provided in Table 1 and the regression results are presented in Tables 2–5. Unless otherwise indicated, statistical inference is based on a one-tail t-test at the 5% level.

An important element in the estimation of advertising effects is the time pattern of the sales response to increased advertising expenditures (e.g., Venkateswaran, Kinnucan, and Chang). In an extensive review of the econometric literature, Clarke (p. 355) found that ". . . 90 per cent of the cumulative effect of advertising on sales of mature, frequently purchased, low-priced products occurs within 3 to 9 months of the advertisement." For dairy markets, studies suggest that market responses to advertising linger for months rather than years (e.g., Ward and Dixon; Kaiser *et al.*) and may be sluggish, i.e., require up to four months for an increase in advertising to register as an increase in sales (e.g., Capps and Schmitz). Accordingly, in specifying the empirical models, we

Table 1. Definition of Variables

Variable Name	Definition
Endogenous:	
Q_f^r	Commercial disappearance of fluid milk and creams
Q_f^w	Total domestic production of bottled milk
Q_c^r	Commercial disappearance of cheese
Q_c^w	Total domestic production of cheese
Q_b^r	Commercial disappearance of creamery butter
Q_b^w	Total domestic production of butter
P_f^r	Retail price index of fluid milk
P_f^w	Wholesale price of fluid milk
P_I	Average farm price of milk in Ontario and Quebec
P_c^r	Retail price index of cheddar cheese
P_c^w	Wholesale price of cheddar cheese (Belleville)
P_{II}	Net target return for industrial milk
P_b^r	Retail price index of butter
P_B	Blend price of milk, weighted average of P_I and P_{II}
Exogenous:	
SP_b^w	Wholesale support price of butter
CINV	Beginning commercial inventory of cheese
BINV	Beginning commercial and government inventory of butter
QRT_j	Dummy variable to indicate calendar quarter, j = 1 for Jan–Mar; j = 2 for Apr–June; and j = 3 for July–Sept.
D5	Dummy variable to indicate the presence of generic cheese advertising (*D5* = 1 if 1977–88; *D5* = 0 otherwise)
TREND	Linear time trend
CPI	Consumer Price Index for all items
N	Canadian population
INC	Disposable personal income
WAGE	Average weekly earnings of manufacturing workers (including overtime)
AD_F	Generic advertising and sales promotion expenditures for fluid milk
ADG_C	Generic advertising expenditures for cheese
ADB_C	Brand advertising expenditures for cheese
AD_B	Generic advertising expenditures for butter
POJ	Retail price index for orange juice
PODP	Retail price index of dairy products excluding cheese
PM	Retail price of margarine
PCI	Index of total food processing cost in Canada
MCI	Index of food marketing cost in Canada
DCI	Dairy cash cost index in Eastern Canada
DPPM	Dairy processing plant margins

[2] For a more complete discussion of the empirical estimates, including results for the skim milk market and a data appendix, see Belleza.

Table 2. Fluid Milk Market Estimates, Canada, 1973–88 Quarterly Data

Variable	Retail Demand (Q_f^r/N)	Whole Supply (Q_f^w)	Retail-Wholesale Price Linkage (P_f^r/CPI)	Wholesale-Farm Price Linkage (P_f^w/CPI)
Intercept	0.896 (4.14)[a]	0.570 (4.60)	−0.087 (−0.56)	0.131 (2.72)
QRT_1	−0.030 (−6.48)	−0.040 (−5.44)	—	—
QRT_2	−0.010 (−2.33)	−0.040 (−6.02)	—	—
QRT_3	0.004 (0.66)	0.004 (0.46)	—	—
TREND	—	0.001 (3.55)	—	—
Lag. Dep. Variable	0.672 (7.60)	0.520 (5.60)	0.793 (10.96)	0.657 (9.72)
P_f^r/CPI	−0.050 (−1.30)	—	—	—
P_f^w/CPI[b]	—	−0.019 (−0.19)	0.110 (2.73)	—
P_I/CPI[c]	—	—	—	0.258 (5.13)
$(AD_F/CPI*N)_{-3}$	0.010 (2.76)	—	—	—
$INC/CPI*N$	0.052 (1.25)	—	—	—
POJ/CPI	0.012 (0.95)	—	—	—
$WAGE/CPI$	—	—	0.151 (1.13)	—
NTR/CPI	—	−0.184 (−2.03)	—	—
System $R^2 = 0.99$			Chi-square = 404.19 with 20 df	

[a]Numbers in parentheses are asymptotic t-statistics.
[b]Lagged farm price $(P_F^f/CPI)_{-1}$ used as in instrument in the supply equation.
[c]Lagged dairy cost index $(DCI/CPI)_{-1}$ used as an instrument.

tested for delays in market response to advertising and experimented with alternative lag specifications. Carryover effects, where significant, were modeled using a lagged dependent variable specification. Cumulative advertising effects are accounted for in the simulation model via the long-run advertising elasticity, which is obtained by dividing the short-run advertising elasticity by one minus the estimated coefficient of the lagged dependent variable in the respective double-log model.

Fluid Milk Estimates

Coefficient estimates for the most part agree with *a priori* expectations (Table 2). Fluid milk demand is price and income inelastic, seasonal, and is subject to habit formation as indicated by the highly significant lagged dependent variable. Advertising is significant in the third quarter following the initial expenditure, and exhibits a long-run elasticity of 0.030. The response delay, although lengthy, is not inconsistent with other findings (e.g., Capps and Schmitz). The elasticity estimate compares favorably to Venkateswaren and Kinnucan's estimates of 0.043–0.060 for fluid milk advertising in the Ontario market for a similar time period.

Wholesale supply exhibits a seasonal pattern that mimics demand and shows an increasing trend over time. Increases in the price of industrial milk reduces the supply of fluid milk. The estimated own-price effect, however, is not significant. One interpretation of this result is that wholesale supply is perfectly elastic, reflecting the hypothesis that the fluid market is supplied on demand because milk used for fluid purposes is priced higher than milk used for industrial purposes. This interpretation, however, is inconsistent with the results obtained by Kaiser *et al.* for the U.S. market, which operates under a similar price-support structure. Kaiser *et al.* (p. 8) found wholesale supply to be price inelastic, with a long-run elasticity estimate of 0.38. Apparently, collinearity or perhaps weaknesses in model specification precludes obtaining a reliable estimate of the supply elasticity.

The price-linkage equations indicate stickiness

Table 3. Cheese Market Estimates, Canada, 1973–88 Quarterly Data

Variable	Retail Demand (Q_c^r/N)	Wholesale Supply (Q_c^w/N)	Retail-Wholesale Price Linkage (P_c^r/CPI)	Wholesale-Farm Price Linkage (P_c^w/CPI)
Intercept	−1.273 (−2.18)[a]	2.864 (3.00)	0.495 (3.63)	−0.797 (−4.69)
QRT_1	—	0.070 (3.39)	—	—
QRT_2	—	0.190 (9.71)	—	—
QRT_3	—	0.070 (3.82)	—	—
TREND	0.008 (6.53)	—	—	—
Lag. Dep. Variable	—	0.770 (13.12)	0.838 (21.17)	0.756 (14.61)
P_c^r/CPI	−0.362 (−1.13)	—	—	—
P_c^w/CPI	—	1.093 (3.46)	0.158 (3.67)	—
P_{II}/CPI	—	−0.900 (−5.20)	—	0.357[b] (2.12)
$ADG_C/CPI*N$	0.086 (1.13)	—	—	—
$(ADG_C + ADB_C)/CPI*N$	−0.155 (−2.03)	—	—	—
D5	−0.547 (−1.07)	—	—	—
*INC/CPI*N*	0.696 (5.90)	—	—	—
PODP/CPI	0.314 (1.06)	—	—	—
CINV/N	—	−0.316 (−3.07)	—	—
FPC/CPI	—	−2.676 (−3.02)	—	—
System R^2 = 0.99			Chi-square = 447.37 with 20 df	

[a]Numbers in parentheses are asymptotic *t*-statistics.
[b]Index of real food marketing cost (*MCI/CPI*) used as in instrument.

in the transmission of price changes between market levels as evidenced by coefficients near unity for the lagged dependent variables. This is consistent with a market structure dominated by large dairy cooperatives that exercise government-sanctioned monopoly power in fluid milk pricing.

Cheese Market Estimates

Retail cheese demand is price and income inelastic, exhibits no seasonality or habit formation, and shows a positive trend over time (Table 3). Estimated generic advertising effects, whether considered alone or in combination with brand advertising, are either insignificant or exhibit a perverse, i.e., negative effects. Similar results were obtained by Kaiser *et al.* (p. 7) with respect to brand and generic advertising of cheese in the United States.[3]

The wholesale supply of cheese is positively related to the wholesale price and negatively related to the price of industrial milk. The estimated own-price coefficient is 1.09, which suggests that wholesale supply is price elastic. The lagged dependent variable is significant and has a coefficient close to unity, indicating relatively long lags in adjustment of supply to price. This is consistent with the oligopolistic market structure of cheese production in which a few dominant firms (e.g., Kraft) set the pattern for retail pricing and promotion.[4] This interpretation is consistent with the es-

[3] Experimentation with alternative lags produced no better results.

The inability to identify significant (and satisfactory) advertising effects for cheese is not peculiar to the Canadian market; USDA researchers responsible for the annual report to Congress on the effectiveness of the U.S. dairy promotion program express similar frustration with the U.S. market (Blisard).

[4] A reviewer suggested that given oligopolistic firms and other monopoly elements (e.g., cooperatives and marketing boards) in dairy markets, a model that allows for imperfect competition (e.g., Suzuki *et al.*) may be more appropriate than the competitive market-clearing model

Table 4. Butter Market Estimates, Canada, 1973–88 Quarterly Data

Variable	Retail Demand (Q_b^r/N)	Wholesale Supply (Q_b^w/N)	Retail-Wholesale Price Linkage (P_b^r/CPI)	Wholesale-Farm Price Linkage (P_{II}/CPI)
Intercept	2.573 (2.56)[a]	−0.467 (−0.16)	0.781 (7.50)	0.412 (2.47)
QRT_1	−0.136 (−5.10)	0.170 (2.58)	—	—
QRT_2	−0.098 (−4.60)	0.512 (8.31)	—	—
QRT_3	−0.004 (−0.12)	0.292 (4.90)	—	—
TREND	−0.004 (−2.48)	—	—	—
Lag. Dep. Variable	0.084 (0.67)	0.148 (1.17)	0.681 (15.55)	0.824 (15.56)
P_b^r/CPI	−0.546 (−2.66)	—	—	—
SP_b^w/CPI	—	1.500[b] (1.67)	0.412 (7.27)	0.239[c] (4.19)
P_{II}/CPI	—	1.124[d] (3.67)	—	—
P_c^w	—	−1.627 (−1.77)	—	—
$(AD_b/\text{CPI*N})_{-2}$	0.0002 (3.16) [0.06][e]	—	—	—
*INC/CPI*N*	−0.677 (−1.98)	—	—	—
PM/CPI	0.059 (0.70)	—	—	—
WAGE/CPI	—	−0.929 (−0.70)	—	—
BINV	—	—	−0.015 (−3.35)	−0.007 (−1.03)
System R^2 = 0.09			Chi-square = 350.49 with 23 df	

[a]Numbers in parentheses are asymptotic t-statistics.
[b]Lagged value used in estimation.
[c]Dairy processing plant margins (*DPPM/CPI*) used as a proxy.
[d]Lagged value used as an instrument.
[e]Number in brackets is the elasticity evaluated at data means.

timated coefficients in the price linkage equations, which show significant lags in price transmission throughout the marketing channel.

Butter Market Estimates

Butter demand is price inelastic and seasonal, exhibits a negative trend and income elasticity, and shows no habit formation. Generic advertising lagged two periods is significant, and shows an elasticity of 0.060 evaluated at mean data points. (Due to the existence of zero values, the advertising variable is specified in natural numbers rather than logarithms.) That the butter market in Canada is sluggish to respond to increases in butter advertising is consistent with Chang and Kinnucan's (1990) study based on an earlier time period, which showed a six-quarter lag. Chang and Kinnucan's (1990) estimate of the butter advertising elasticity is 0.023.

Wholesale supply shows a significant positive relationship with the support price of butter. The estimated own-price coefficient is 1.50, suggesting an elastic supply, a result consistent with the corresponding estimate for cheese. The lagged dependent variable is insignificant, which suggests butter producers respond rapidly to price changes. This may reflect the fact that the wholesale price is set by the government, so changes in price are correctly anticipated and are regarded as permanent. As with the case for the fluid and cheese markets, the price-linkage equations indicate sig-

used in this study. While we agree with this criticism, there is a tradeoff between model complexity and reproducability, especially when the number of markets and products is relatively large, as in this study. Moreover, if Suzuki *et al.*'s findings are any indication, assuming competitive market clearing is innocuous for the purposes of this study in that returns to advertising are likely to be understated rather than overstated.

Table 5. Parameters and Baseline (1988) Values for the Canadian Dairy Industry

Item	Definition	Value Fluid	Cheese	Butter
Parameters:				
N_i	Retail demand elasticity	−0.15	−0.36	−0.60
B_i	Generic advertising elasticity	0.030	0.000	0.060
E_i	Wholesale supply elasticity	0.380[a], 1.00	1.09[b], 4.75	1.50
T_i	Retail-wholesale price transmission elasticity	1.91	1.03	0.78
L_i	Wholesale-farm price transmission elasticity	1.32	0.68	1.33
Baseline Values:				
A_i	Advertising expenditures (mil. $)	11.4	3.00	6.18
P_I	Farm price of milk used for fluid purposes ($/hectoliter)	53.74	—	—
P_{II}	Farm price of milk used for cheese and butter ($/hl)	—	44.06	44.06
X_I	Quantity of milk used for fluid purposes (million hl.)	30.01	—	—
X_2	Quantity of milk used for industrial purposes (mil. hl)	49.57[c]	24.78	22.31
X	Total shipment of milk off farms (mil. hl)	79.58	—	—
P_B	Average price received by farmer ($P_B = (P_I X_I + P_{II} X_2)/X$)	49.21	—	—
SP_b	Support price of butter ($/kg)	—	—	5.10
GP_b	Government net purchases of butter (mil. kg)	—	—	7.55
Q_b^d	Quantity consumed of butter (mil. kg)	—	—	97.40
λ_b	Liters of milk required to produce one kg of butter	—	—	22.73

[a]Estimate taken from Kaiser *et al.*, 1993, p. 8.
[b]Short-run elasticity.
[c]Total quantity used for all industrial purposes; the cheese and butter shares are 0.50 and 0.45, respectively.

nificant lags in price adjustments throughout the marketing channel.

Simulation

Given the insignificance of cheese advertising, simulations of the structural model are restricted to the fluid milk and butter markets. Specifically, the estimated elasticities are inserted into the reduced form (equations (9)–(11) and (26) for fluid milk and equations (16)–(18) and (26) (non-binding support price) or (19)–(20) (binding support price) for butter) and the model is simulated to determine the effects of isolated 10% increases in fluid milk and butter advertising on equilibrium prices, quantity, government purchases, and farm revenues (producer surplus).

Parameterization

The parameters used in the simulation exercise are given in Table 5. (Although the cheese market is not considered in the simulations, parameter values are given for completeness and comparative purposes.) Parameters include the initial (1988) equilibrium values of relevant variables. The elasticities are the long-run elasticities from the Tables 2–5 with the exception of the wholesale supply elasticity for fluid milk. The fluid milk supply elasticity, owing to the insignificant estimate obtained in our econometric model, was set equal to 0.38 and, alternatively, 1.00. The former value is based on Kaiser *et al.*'s estimate for the U.S. market; the latter value was selected to more nearly match the supply elasticity estimates obtained for the cheese and butter markets. In cases where price-transmission elasticities from the estimated equations represent wholesale-retail or farm-wholesale linkages, the elasticities were inverted to obtain the requisite retail-wholesale or wholesale-farm elasticities.

Simulations for the butter market were conducted under two alternative scenarios: (i) the offer-to-purchase program is binding ($SP_b > P_b^w$ and (ii) the offer-to-purchase program is non-binding ($SP_b \leq P_b^w$). The latter assumption reflects the more recent experience with respect to price-support policy in the Canadian dairy industry (Canadian Milk Supply Management Committee). In addition, the simulations for fluid milk advertising include the indirect effects of increases in fluid milk demand on government costs of the price-support program.[5]

[5] With fixed-supply, an increase in fluid milk demand implies a reduction in milk that must be purchased by the government to maintain the support price. The equation to measure the associated government cost reduction is derived from the farm level market-clearing condition (equation (24)):

$$X^s = X_1^d + X_2^d. \tag{A1}$$

Table 6. Simulated Effects of a 10% Increase in Fluid Milk Advertising vs. a 10% Increase in Butter Advertising on Equilibrium Prices, Quantity, Producer Surplus, and Government Costs

	Fluid Market		Butter Market	
Variable	$E_1 = 0.38$	$E_1 = 1.00$	$SP_b > P_b^w$	$SP_b \leq P_b^w$
Percent Changes:				
$d\ln P^r$	0.34	0.15	—	0.33
$d\ln P^w$	0.65	0.28	—	0.26
$d\ln Q^r$	0.25	0.28	0.60	0.40
$d\ln P_B$	0.37	0.17	—	0.088
$d\ln GP$	−0.044	−0.049	−7.73	—
Absolute Changes:[a]				
dPS	14.65	6.73	—	3.46
dGC	−0.017	−0.019	−2.98	—
dA	1.14	1.14	0.62	0.62
dPS/dA	12.65	5.90	—	5.59
$\|dGC/dA\|$	0.015	0.016	4.82	—

[a]Changes in producer surplus (dPS), government costs (dGC), and advertising (dA) are in million dollars.

Results

Results indicate that the relative impacts of increased fluid milk and butter advertising depend critically on the supply elasticities in the two markets and whether the offer-to-purchase program is binding or non-binding (Table 6). If the offer-to-purchase program is non-binding and the wholesale-level supply elasticity for fluid milk is unitary, fluid milk advertising has smaller effects on retail price and quantity than butter advertising and larger effects on the blend price and producer surplus. (With fixed supply at the farm level, farm revenue and producer surplus (quasi-rent) are identical.) However, owing to the larger baseline investment in fluid milk advertising (\$11.4 million) vis-a-vis butter advertising (\$6.2 million), the *marginal* effect of an increase in fluid milk advertising on producer surplus is only slightly larger than the marginal effect of an increase in butter advertising (\$5.90 for fluid milk vs. \$5.59 for butter).

If the supply elasticity for fluid milk is inelastic (0.38) and the offer-to-purchase program for butter is non-binding, the quantity impacts of increased milk advertising are still smaller than for increased butter advertising, but the price impacts are magnified by a factor of two or more. In this case, increases in fluid milk advertising are much more profitable *at the margin* than equivalent percent increases in butter advertising (the simulated marginal rates of return are \$12.65 for fluid milk vs. \$5.59 for butter).

If the offer-to-purchase program is binding, increased fluid milk advertising always dominates increased butter advertising in terms of the *direct* effects on producer surplus. That is, owing to the absence of price effects in the butter market when the offer-to-purchase program is binding, increases in butter advertising does not effect the blend price and therefore has no direct effect on producer surplus. However, increased butter advertising may still have an *indirect* effect on producer surplus in that the reduced government purchases associated with an increase in butter advertising may alleviate pressure to reduce the support price in a later period. In particular, our model suggests that a 10% increase in butter advertising results in a 7.7% decrease in government purchases of surplus butter, which translates into an incremental reduction in government costs of \$4.82 for each additional dollar spent on butter advertising. (In the absence of price effects, increases in butter advertising trans-

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First, define

$$X_2^d = \lambda(Q_2^d + GP) \quad \text{(A2)}$$

where λ is a conversion factor that indicates the number of units of industrial milk required to produce one unit of the manufactured product. Equation (A.2) states that the demand for industrial milk in equilibrium equals commercial demand for the manufactured dairy product (Q_2^d) plus government demand (GP), both expressed in milk-equivalent units. Substituting (A.2) into (A.1) and taking total derivatives yields:

$$dX = dQ_1^d + \lambda\,(dGP + dQ_2^d) \quad \text{(A.3)}$$

The relationship between changes in government purchases and changes in fluid milk demand is obtained from (A.3) by setting $dX = dQ_2^d = 0$ and solving for dGP, which yields

$$dGP = -\lambda^{-1}\, dQ_1^d.$$

This relationship can be re-expressed in percent changes as:

$$d\ln GP = -\lambda^{-1}\,(Q_1^d/GP)\, d\ln Q_1^d \quad \text{(A.4)}$$

Equation (A.4) serves as the basis for calculating the indirect effects of advertising-induced increases in fluid milk demand ($Q_1{}^d$) on government costs of the offer-to-purchase program. The calculations assume that the butter market absorbs all the surpluses.

late into relatively large increases in butter demand — see Table 6.) An increase in fluid milk advertising, by comparison, has a negligible effect on government purchases and costs (less than a 0.05% reduction per 10% increase in advertising expenditures according to our simulation results).

Concluding Comments

Results based on an equilibrium-displacement model suggests the Canadian dairy advertising program has had a significant impact on producer returns, at least with respect to the fluid milk and butter advertising programs. The estimated marginal returns from increases in either fluid milk or butter advertising are significantly greater than one, which suggests that the industry may be underinvesting in generic advertising at the national level. Increases in butter advertising have especially large effects on the government costs of the offer-to-purchase program, reducing government outlays an estimated $4.82 per additional dollar spent on advertising, Fluid milk advertising, in contrast, had negligible impacts on government outlays for price support, although fluid milk advertising in general was more effective than butter advertising at increasing the blend price and producer surplus.

The insignificance of cheese advertising in the econometric results raises questions about the effectiveness of the cheese advertising program. One interpretation is that brand advertising of cheese is so dominant that generic advertising has little scope for contributing new information (expenditures by Kraft and other major brands over the sample period exceed generic expenditures by a factor of four). Alternatively, and perhaps more plausibly, statistical problems such as measurement error in the data series for brand advertising (e.g., see Kinnucan and Belleza) may be biasing the estimated coefficient for generic advertising toward zero. In any case, further research, perhaps using cross-section data, is needed to sort out these issues before it can be determined that the cheese advertising program was in fact ineffective.[6]

A caveat in interpreting the results is that the wholesale-level supply elasticity for the fluid milk market could not be estimated with any degree of precision and therefore had to be approximated using extraneous estimates. Given the importance of the supply elasticities in determining advertising effectiveness, more attention needs to be paid to estimating supply response at intermediate market levels. Then, too, the assumption of fixed supply at the farm level, although justifiable given government controls on milk production, implies that the results may overstate the longer-run returns to the dairy advertising programs. Still, results based on this study suggest that the industry advertising programs have been effective at increasing producer returns and reducing public expenditures for dairy price supports.

[6] A recent study examining the effects of brand and generic cheese advertising on Canadian attitudes and consumption found that generic advertising had a direct impact on *processed* cheese consumption. The effect of generic advertising on *natural* cheese consumption, however, was found to be indirect, operating through an attitude variable, which was affected by generic advertising. (For more details, see Kinnucan and Clary).

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