Development and Measurement of Farm-to-Retail Price Linkage for Evaluating Dairy Advertising Effectiveness

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Abstract *A conceptual and empirical framework for estimating the effects of dairy advertising on farm prices and producer returns is developed The model consists of an industry-derived demand equation for milk linking advertising and government purchases to farm price, and a government purchases equation linking advertising and support prices to government purchases The econometric model is a mixed continuous/discrete system, estimated by the Amenyia Principle The two-equation system is estimated for both aggregated manufactured advertising and disaggregated manufactured advertising The results are consistent with theory and show significant effects of advertising, particularly for fluid advertising*

Keywords. *Dairy advertising, demand, government purchases, price linkage, Tobit*

Retail-to-farm demand linkage of advertising is affected by dairy policy at the manufacturing and farm levels as are the physical and economic relationships between retail products and the raw farm product While previous studies have focused on the impact of dairy product advertising expenditures on consumer demand for the products, this article is the first study of its type to focus on estimating the transmission of dairy product advertising back to the farm level

The Dairy and Tobacco Adjustment Act of 1983 (DTAA) requires farmers in the 48 contiguous States to pay a 15-cents-per-hundredweight (cwt) assessment on all commercially marketed milk Up to 10 cents per cwt can be allocated by farmers to regional, State, or local dairy product promotion The remaining funds are managed by the National Dairy Promotion and Research Board Over $800 million has been spent on generic dairy advertising and promotion since the implementation of the DTAA Economic studies (Ward and Dixon, 1989, Kinnucan and Forker, 1986, Thompson and Eiler, 1977, Liu and Forker, 1990)[1] provide evidence of a positive relationship between generic dairy advertising and retail dairy sales However, only a few studies have examined the impact of advertising on farm-level returns (Liu and others, 1990, Thompson and Eiler, 1977) One reason for this is the complexity of modeling the U S dairy industry where raw milk is used in both fluid and manufactured milk products The farm-level fluid milk price includes a market-determined component, the Minnesota-Wisconsin (MW) price of Grade B milk, and a regulated component (the Class I differential) In general the farm-level manufactured milk price is a market-determined price The "blend price" that a farmer receives for his milk is a weighted average of the fluid and manufactured milk prices The farmer's final receipts are adjusted for miscellaneous costs and payments, such as cooperative expenses, quality and volume premiums, and seasonal incentive payments

Government intervention, in the form of price support through government purchases of manufactured dairy products, takes place at the wholesale level of the manufactured milk market Many previous dairy industry studies assume government price supports always hold (Liu and Forker, 1990, Thompson and Eiler, 1977) The application of ordinary least squares (OLS) to these models results in estimates that may be biased and inconsistent (Kmenta 1986) The study by Liu and others (hereafter referred to as the Cornell study) is the first attempt at explicitly modeling government price support while simultaneously examining the issue of generic advertising effectiveness In their study, behavioral equations are estimated for retail fluid and manufactured demand, retail fluid and manufactured supply wholesale fluid and manufactured supply, and farm-level supply The Cornell model is estimated using a switching regression technique (applying the Heckman procedure for Tobit estimation) that accounts for both free market and price support regimes Simulation results suggest that fluid milk advertising is more effective in increasing retail demand for milk and its products than is manufactured milk advertising In addition, farm-level returns are higher when there is advertising only on fluid products ($7 04 per $1 spent) than when there is advertising on both fluid and manufactured products ($4 77 per $1 spent)

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[1]Sources are listed in the references section at the end of this article

One problem with the Cornell model is that it assumes product quantities at different market levels are the same. This assumption occurs because actual quantities consumed at the retail level are not observable but instead are measured on a milk-equivalent basis. In econometric analysis of eight disaggregated food commodities (including dairy products as a composite commodity), Wohlgenant (1989) found that the assumption of a fixed-proportions technology between the raw food product and marketing inputs in producing retail products is inconsistent with actual market behavior, producing biased farm-level demand elasticities. In theoretical analysis of distribution of gains from promotion, Wohlgenant (1993) also shows that retail-to-farm linkages of promotional activities are extremely sensitive to the assumption of fixed input proportions.

In view of the limitations of the Cornell model, the modeling approach for this study is based on a partially reduced-form inverse demand formulation of milk prices at the farm level. The conceptual model underlying the derived demand specification includes retail, wholesale, and farm-level supply and demand equations for fluid milk and manufactured milk products. The inverse demand specification for the blend price received by farmers is derived assuming both a competitive regime and a price support regime. The variables that influence the blend price depend on the market regime. For the competitive regime, variables include predetermined market supply of milk, class I price differential, retail demand and supply shifters, wholesale demand and supply shifters, and farm-level demand shifters for the fluid and manufactured market. In the price support regime, support prices for manufactured products would substitute for demand and supply shifters in the manufacturing sector. For this specification, both fluid and manufactured product advertising expenditures affect the blend price under the competitive regime but only fluid advertising affects the blend price under the support price regime.

In the following sections we present a conceptual framework for modeling effects of dairy products advertising on farm-level demand for milk, quarterly demand relationships which link advertising on fluid and manufactured products with farm-level milk prices, and simulations of the impact of assumed shifts in retail demand from advertising on farm-level milk prices and total revenue of milk producers.

Conceptual Framework

Farm-level demand for milk is viewed conceptually as industry-derived demand for milk as a factor of production in fluid and manufactured dairy products. The conceptual model for industry-derived demand is the reduced-form equation for the farm price of milk, holding the quantity of milk marketed constant (Wohlgenant and Haidacher, 1989, p. 41). In the context of the Cornell model, the equation for derived demand for milk would be derived from the following set of behavioral equations:

$Q_1^d = D_1(P_1, Z_1)$ (wholesale-derived demand for fluid milk) (1)

$Q_2^d = D_2(P_2, Z_2)$ (wholesale-derived demand for manufactured products) (2)

$Q_1^s = S_1(P_1, W_1, V_1)$ (wholesale supply of fluid milk) (3)

$Q_2^s = S_2(P_2, W_2, V_2)$ (wholesale supply of manufactured products) (4)

$X_1 = D_1^x(P_1, W_1, V_1)$ (farm-level demand for fluid milk) (5)

$X_2 = D_2^x(P_2, W_2, V_2)$ (farm-level demand for manufactured products) (6)

$W = (X_1/X)W_1 + (X_2/X)W_2$ (farm-level blend price for milk) (7)

$P_2 \geqslant P_g$ (manufactured price support constraint) (8)

$W_1 = W_2 + DIFF$ (farm-level fluid price) (9)

$Q_1^d = Q_1^s$ (wholesale fluid milk market clearing) (10)

$Q_2^d = Q_2^s - CINV$ (wholesale manufactured market clearing) (11)

$X = X_1 + X_2$ (farm-level market clearing) (12)

In this specification, Q_i^d denotes quantity demanded of the i^{th} wholesale product (i=1 (fluid), 2 (manufactured)), P_i is the market price of the i^{th} wholesale product, Q_i^s denotes quantity supplied of the i^{th} wholesale product, Z_i represents the impact of shifts in wholesale-derived demand, W_i is market price of the i^{th} farm product, V_i represents the impact of shifts in wholesale supply and farm-level demand, X_i is quantity demanded (and supplied) of the i^{th} farm product, X is total quantity of milk marketed (assumed to be predetermined), P_g is the government support price for manufactured dairy products, DIFF is the government-determined price differential between fluid and manufactured milk at the farm level, and

CINV represents government purchases of manufactured products In this specification, it should be noted that the wholesale demand equations are partially reduced-form derived demand equations, which include the effects of demand and supply shifts at the retail level These effects are subsumed in Z_1 and Z_2

The above system of equations can be reduced to four equations in the four prices P_1, P_2, W, and W_1, given the level of government purchases

$$S_1(P_1, W_1, V_1) = D_1(P_1, Z_1) \quad (13)$$

$$S_2(P_2, W_1\text{-DIFF}, V_2) = D_2(P_2, Z_2) + CINV \quad (14)$$

$$X = D_1^x(P_1, W_1, V_1) + D_2^x(P_2, W_1\text{-DIFF}, V_2) \quad (15)$$

$$W = W_1 - (DIFF/X)^* D_2^x(P_2, W_1\text{-DIFF } V_2), \quad (16)$$

subject to $P_2 \geqslant P_g$ The form of the reduced-form solution for the farm price variable, W, depends on whether the market is operating under the competitive regime or the price support regime Under the competitive regime, the industry (inverse)-derived demand equation for milk at the farm level has the form,

$$W = f(X, Z_1, Z_2, V_1, V_2, DIFF) \quad (17)$$

Alternatively, if the price support regime holds, then derived demand has the form,

$$W = g(X, Z_1, P_g, V_1, V_2, DIFF) \quad (18)$$

Thus, two different specifications for derived demand follow from the operational regime

An alternative specification for derived demand is obtained by viewing CINV as a latent variable, which theoretically takes on positive, zero, and negative values This would occur, for example, if CINV was defined as net government purchases, with negative values representing a reduction in government inventory of manufactured dairy products In this case, we could replace equations 17 and 18 by the following two-equation system

$$W = W(X, Z_1, Z_2, V_1, V_2, DIFF, CINV) \quad (19)$$

$$CINV = CINV(X, Z_1, Z_2, V_1, V_2, DIFF, P_g) \quad (20)$$

These equations are obtained by first solving equations 13-16 for W, given CINV, and then solving equations 13-16 for CINV, given that $P_2 = P_g$

The comparative statics of equations 19 and 20 are relatively straightforward, given equations 13-16 In particular, it seems reasonable to expect the blend price, W, to increase when farm supply (X) decreases, when wholesale demand for either product Z_1 or Z_2 increases, when marketing costs (V_1 or V_2) decrease, when the Class I differential (DIFF) decreases, and when net government purchases (CINV) increase We would expect net government purchases to increase when farm supply (X) increases, when wholesale demand (Z_1 or Z_2) decreases, when marketing costs (V_1 or V_2) increase, when the government support price (P_g) increases, and when the differential (DIFF) increases

Empirical Specification of Demand for Milk

Assume equations 19 and 20 can be represented by equations that are linear in the parameters Then, in matrix notation, the statistical model can be represented as

$$Y_1 = a_1 Y_2^* + X_1 B_1 + U_1 \quad (21)$$

$$Y_2^* = X_2 B_2 + U_2, \quad (22)$$

where $Y_2 = Y_2^*$ if $Y_2^* > 0$, but $Y_2 = 0$ otherwise These equations are the statistical counterparts to equations 19 and 20 Y_1 is the vector of observations on the blend price, Y_2^* is the latent variable corresponding to net government purchases, X_1 is the matrix of observations on the demand and supply shifters in the price equation, X_2 is the matrix of observations on the demand and supply shifters in the net government purchases equation and U_i (i=1,2) is a nonautocorrelated random disturbance term with zero mean and constant variance

Equations 21 and 22 represent a simultaneous equations model with one limited endogenous variable, Y_2 These equations are estimated using Amemiya's principle (Judge and others, 1985 pp 785-89), which is asymptotically more efficient than traditional two-stage estimation methods In this case, the procedure is implemented through estimating equation 22 by Tobit analysis, and estimating the reduced-form equation for Y_1 by least-squares The reduced-form parameter estimates corresponding to Y_1 are then regressed on the parameter estimates of the Tobit equation corresponding to Y_2^* and on an appropriately constructed matrix of ones and zeros, showing the relationship between the reduced form and structure associated with equations 21 and 22 (Judge and others, 1985, p 787)

Equations 21 and 22 are estimated subject to a set of cross-equation restrictions, specifically,

$$B_{1i} = -a_1 B_{2i}, \qquad (23)$$

where B_{1i} and B_{2i} are coefficients associated with the variables X_{1i} and X_{2i}, when $X_{1i} = X_{2i}$ and when X_{1i} represents a shift in wholesale-derived demand for manufactured dairy products In this way, generic advertising for manufactured products is restricted to have zero impact on farm price when the support price for manufactured products is binding In general, the effect of imposing these cross-equation restrictions is to produce two estimated derived demand structures, one consistent with the competitive regime and the other with the price support regime When the competitive regime holds, $Y_2^* = 0$ and X_1 represents all demand and supply shifters However, when the price support regime holds, $Y_2^* > 0$ and equation 21 has support prices for manufactured products instead of wholesale-derived demand shifters for the manufactured products Thus, by alternatively selecting $Y_2^* = 0$ or $Y_2^* > 0$, we can isolate the demand structure corresponding to the competitive regime (equation 17) or the price support regime (equation 18)

Econometric Results

Quarterly data for 1975 are used in the estimation of equations 21 and 22 Definitions of the variables and data sources are shown in table 1 Advertising data, which are the sum of generic and branded advertising by product class, come from *Leading National Advertisers* (1975-90) These data are real advertising quantities made available by Blaylock through ERS All variables other than for government purchases are in natural logs All nominal

Table 1—Variable definitions and sources

Variable	Definition	Source
BCINV	Beginning commercial inventory, billion lbs milk equivalent	Cornick et al
CPI	Consumer Price Index, all items, 1982-84 = 100	Cornick et al
DIFF1	Class 1 differential, $/cwt	Cornick et al
FARMPR	Farm milk price, cents/lb	Cornick et al
FMSUP	Farm milk production, billion lbs	Cornick et al
FUEL	Producer price index for fuel related products and power 1982-84 = 100	Cornick et al
FUSE	Onfarm use of milk, billion lbs	Cornick et al
GOVQ	Net government removals, billion lbs	Cornick et al
INC	Pesonal consumption expenditures	Cornick et al
NONALC	Nonalcoholic beverages, retail price index, 1982-84 = 100	Cornick et al
POLICY	Dummy variable for the dairy termination	
POP	U S population	Cornick et al
PPBNF	Government support price for butter, nonfat, cents/lb	Cornick et al
PPC	Government support price for cheese, cents/lb	Cornick et al
Q2, Q3, Q4	Dummy variables for quarters 2, 3, 4	
RADFL	Total fluid milk advertising expenditures, $1,000	Leading National Advertisers
RADMN	Total manufactured milk advertising expenditures, $1,000	Leading National Advertisers
RBUT	Total butter advertising	Leading National Advertisers
RCHS	Total cheese advertising expenditures, $1,000	Leading National Advertisers
RFDAWAY	Food consumed away from home, retail price index, 1982-84 = 100	Cornick et al
RFRZ	Total frozen dairy advertising expenditures, $1,000	Leading National Advertisers
ROTHER	Total other dairy advertising expenditures, $1,000	Leading National Advertisers
TIME	Linear time trend (first quarter of 1976 = 1)	
WAGEMAN	Wholesale trade average hourly earnings index, 1982-84 = 100	Cornick et al

variables are deflated by the Consumer Price Index for all items Quarterly dummy variables and a linear time trend are included in each regression

In previous studies, the switching points from the competitive to the price support regimes were identified by comparing a weighted average wholesale price for manufactured products with a weighted average government purchase price If the average purchase price was less than the average wholesale price, government purchases were set to zero, otherwise, government purchases were equal to observed purchases The problem with this approach is that identification of particular regimes is sensitive to the weights chosen in constructing the average wholesale and purchase prices Also, conceptually, government purchases occur whenever the support price for an individual commodity is greater than its wholesale price Thus, in the current study, competitive and price support regimes are identified by examining the relationship between the wholesale and the purchase price for butter, nonfat dry milk, and cheese, the major products purchased by the Government If in any quarter the purchase price for any product exceeds its wholesale price, the price support regime is assumed to be in effect, otherwise, the competitive regime is assumed to hold

By this procedure, we identify that the price support regime was in effect 68 percent of the time Liu and others (1990) use average purchase and wholesale prices over all manufactured products and find the price support regime was in effect 58 percent of the time from 1975 (Q1) through 1987 (Q4) While purchase prices for three products (butter, nonfat dry milk, and cheese) are used to identify regimes, butter and nonfat dry milk are aggregated for the estimation because of multicollinearity and a wrong sign obtained on the nonfat dry milk price variable in initial estimations

Consistent with the Cornell model and previous work by Ward and Dixon (1989), we assume advertising affects behavior in the current and subsequent four quarters, and we restrict the coefficients of the lag distribution by specifying a second-order polynomial lag with endpoint restrictions With this specification, we lose the initial 4 observations, leaving a total of 60 observations 1976 (Q1) to 1990 (Q4)

Econometric results are presented for two sets of advertising variables In the first set, we aggregated all manufacturing advertising into a single variable, one representing the effects of fluid advertising and the other, manufactured advertising (table 2) In the second set, manufactured advertising is disaggregated (butter, cheese, frozen, and other products), and these advertising variables are added to the fluid milk variable (table 3) In tables 2 and 3, the first column lists the variables (defined in table 1) the second column shows the coefficient estimates of the government purchase equation 22 estimated by Tobit, and the third column shows the coefficient estimates of the farm price equation 21 estimated by the Amemiya procedure [2] Values in parentheses are asymptotic t-values [3] All computations were performed using version 6 2 of SHAZAM (White and others 1990)

In table 2, we see general conformity between theory and estimation In the equation predicting net government purchases, the farm supply variable and support prices have positive signs The key demand shift variables, current and lagged fluid and manufacturer advertising, are negatively related to government purchases, as expected Some other variables in the equation may have incorrect signs, but theory is not precise on what sign to expect [4] Three of the most significant variables are income, time, and the effect of the dairy termination buyout programs The squared correlation between observed and expected values of this equation (not reported in table 2) is 0 88

Estimates of derived demand for raw milk at the farm level are reported in the last column of table 2 The elasticity of farm price with respect to the quantity of milk supplied (own-price flexibility) is less than one in absolute value, suggesting an elastic own-price elasticity of demand This is not

[2] In the first stage of the Amemiya estimation procedure, correction was made for fourth-order autocorrelation in the residuals of the unrestricted reduced-form price equation

[3] The t-statistics for the coefficients in the farm price equations were computed from standard errors using White's heteroskedastic-consistent covariance estimation method to correct for a general, unknown form of heteroskedasticity The reason the standard errors were corrected for heteroskedasticity is that the error term in the second stage of the Amemiya procedure is heteroskedastic The correct, but computationally more complex, formulas for the asymptotic coefficient standard errors are provided by Amemiya Thus, the standard errors (and hence, t-statistics) computed using White's method must be viewed as approximations to the true values

[4] Specifically, depending upon whether the goods are substitutes or complements, we would expect different signs on the price variables in the reduced-form rice equation This is true both for retail prices of related goods and for marketing input prices The variables NONALC, RFDAWAY, and RMEAT are included to represent the impact of retail prices of related goods on retail demand for fluid and manufactured dairy products FUEL and WAGEMAN are included to account for changes in costs of manufacturing and marketing dairy products The variable BCINV is included to represent the effects of commercial inventory holdings of dairy products

Table 2—Econometric results for total advertising model with disaggregate support prices

Variable	Government purchases		Farm price	
FMSUP	17 575	(1 6317)	–0 7247	(–4 5058)
RADFL	–0 1228	(–0 9177)	0 0120	(10 658)
RADFL1	–0 1965	(–0 9177)	0 0192	(10 658)
RADFL2	–0 2211	(–0 9177)	0 0216	(10 658)
RADFL3	–0 1965	(–0 9177)	0 0192	(10 658)
RADFL4	–0 1228	(–0 9177)	0 0120	(10 658)
RADMN	–0 1514	(–0 5110)	0 0019	
RADMN1	–0 2422	(–0 5110)	0 0030	
RADMN2	–0 2725	(–0 5110)	0 0034	
RADMN3	–0 2422	(–0 5110)	0 0030	
RADMN4	–0 1514	(–0 5110)	0 0019	
PPBNF	5 2220	(1 6496)		
PPC	19 634	(2 8569)		
DIFF1	7 8761	(1 0910)	–0 5660	(–7 8526)
FUSE	0 4841	(0 1607)	–0 2941	(–66 384)
FUEL	–0 1447	(–0 0389)	–0 0352	(–26 595)
NONALC	–1 9605	(–0 8414)	0 0716	(3 9884)
RFDAWAY	9 0292	(0 6670)	–0 1122	
RMEAT	–5 9507	(–1 2550)	0 0740	
INC	–26 219	(–2 7833)	–0 7764	(–3 2355)
WAGEMAN	23 204	(1 1037)	1 4150	(6 6635)
TIME	0 5833	(2 6613)	0 0048	(0 8984)
BCINV	5 6539	(2 6423)	–0 0823	(–1 5907)
POP	–39 921	(–0 9625)	–3 0111	(–8 2418)
Q2	–0 4866	(–0 4869)	0 0413	
Q3	–2 6720	(–3 6995)	0 0614	
Q4	–0 3523	(–0 3903)	0 1090	
POLICY	–1 5294	(–2 6974)	0 0236	(1 6858)
GOVQ			0 0124	(1 3584)
CONSTANT	707 21	(0 8851)	56 869	
LOG LIKELIHOOD VALUE	–60 728508			

Note All variables except GOVQ and the dummy variables are in natural logarithms The variable definitions are given in table 1 The advertising variables (for example, RADFL, RADFL1, RADFL2, RADFL3, RADFL4) represent effects in the curren quarter and the previous four quarters Values in parentheses represent asymptotic t-values

consistent with previous work suggesting inelastic demand (for example, Wohlgenant and Haidacher, 1989) However, with quarterly data, greater possibilities for storage by the commercial sector can lead to a more elastic demand response (Pasour and Schrimper, 1965) A comparison with the results in table 3, which shows that demand is less elastic when manufactured advertising is disaggregated, suggests that the estimate of own-price flexibility of milk is sensitive to aggregation of the manufactured advertising variables

Both fluid and manufactured advertising have the correct signs [5] Except for population, which we would expect to be positive, it is hard to predict the signs of the other variables in this equation [6]

The advertising elasticities in the farm price equation appear to be reasonable, especially the fluid advertising elasticities The sum of the fluid advertising effects is 0 084, indicating that over the period of a year, a sustained increase of 10 percent in fluid advertising would increase farm price 0 84 percent If manufactured advertising is added to fluid advertising, the elasticity becomes 0 097 Both of these estimates are near the elasticity of 0 05 computed by Wohlgenant (1991) The larger relative magnitude of the fluid (vs manufactured) advertising variable, is consistent with the relative effects on retail demand estimated by Liu and others (1990)

[5] In the price equation, the coefficients on the manufacturing advertising variables (as well as the support price variables and the two retail price indices, RFDAWAY and RMEAT) are constrained to equal the coefficient on the government purchase variable (0 012432) multiplied by the negative of the respective coefficient in the government purchase equation (see equation 23)

[6] Includes income, which has been found to be negative in many studies

Table 3—Econometric results for disaggregate advertising model with disaggregate support prices

Variable	Government purchases		Farm price	
FMSUP	25 640	(2 2518)	-0 9625	(-11 422)
RADFL	-0 2700	(-1 7403)	0 0185	(20 804)
RADFL1	-0 4320	(-1 7403)	0 0295	(20 804)
RADFL2	-0 4860	(-1 7403)	0 0332	(20 804)
RADFL3	-0 4320	(-1 7403)	0 0295	(20 804)
RADFL4	-0 2700	(-1 7403)	0 0185	(20 804)
RBUT	0 1202	(0 8185)	-0 0008	
RBUT1	0 1923	(0 8185)	-0 0013	
RBUT2	0 2164	(0 8185)	-0 0014	
RBUT3	0 1923	(0 8185)	-0 0013	
RBUT4	0 1202	(0 8185)	-0 0008	
RCHS	-0 4768	(-1 5407)	0 0031	
RCHS1	-0 7628	(-1 5407)	0 0050	
RCHS2	-0 8582	(-1 5407)	0 0056	
RCHS3	-0 7628	(-1 5407)	0 0050	
RCHS4	-0 4768	(-1 5407)	0'0031	
RFRZ	0 1041	(0 4526)	-0 0007	
RFRZ1	0 1665	(0 4526)	-0 0011	
RFRZ2	0 1873	(0 4526)	-0 0012	
RFRZ3	0 1665	(0 4526)	-0 0011	
RFRZ4	0 1041	(0 4526)	-0 0007	
ROTHER	0 1307	(0 5036)	-0 0009	
ROTHER1	0 2091	(0 5036)	-0 0014	
ROTHER2	0 2352	(0 5036)	-0 0015	
ROTHER3	0 2091	(0 5036)	-0 0014	
ROTHER4	0 1307	(0 5036)	-0 0009	
PPBNF	6 9175	(1 8554)		
PPC	14 131	(1 9349)		
DIFF1	4 3491	(0 5290)	-0 1922	(-13 445)
FUSE	-2 2957	(-0 6618)	-0 0839	(-11 122)
FUEL	1 8406	(0 4270)	-0 0054	(-0 8850)
NONALC	-2 4285	(-1 0634)	0 0995	(12 472)
RFDAWAY	13 906	(0 9842)	-0 0914	
RMEAT	0 1730	(0 0270)	-0 0011	
INC	-32 886	(-3 3186)	-0 7972	(-7 3765)
WAGEMAN	22 561	(0 8535)	2 4016	(32 391)
TIME	0 6146	(2 6292)	0 0063	(3 0948)
BCINV	6 9407	(2 9380)	-0 0037	(-0 1608)
POP	-62 466	(-1 4551)	-1 0189	(-4 9631)
Q2	-0 7859	(-0 7699)	0 0579	
Q3	-2 7068	(-3 6020)	0 0419	
Q4	0 4641	(0 4780)	0 0816	
POLICY	-0 8954	(-1 4226)	- 0008	(-0 2628)
GOVQ			0 0066	(1 994)
CONSTANT	1128 4	1 3748	20 299	
LOG LIKELIHOOD VALUE	-58 684650			

Note All variables except GOVQ and the dummy variables are in natural logarithms The variable definitions are given in table 1 The advetising variables (for example, RADFL, RADFL1, RADFL2, RADFL3, RADFL4) represent effects in the current quarter and the previous four quarters Values in parentheses represent asymptotic t-values

These advertising elasticities are for the dairy sector under a competitive regime Under the price support regime, the effect of manufactured advertising is constrained to be zero (When a change in manufactured advertising induces a change in government purchases, this effect cancels out the direct effect of a change in manufactured advertising) The effect of fluid advertising (over four quarters) is now 0 073 compared with 0 084 when the competitive regime holds [7]

[7]The own-price flexibility of milk would be smaller (-0 51 compared with -0 72) when the competitive price regime holds

The results in table 3 are very similar in sign and magnitude to those in table 2 except for some disaggregated advertising effects For example, butter, frozen, and other products have incorrect signs in both equations, but their effects are insignificant in the government purchase equation Own-price flexibility is larger in absolute value in

This is consistent with Marshall's rule that derived demand for a factor will be more elastic (smaller price flexibility) the more elastic demand is for the product Since demand for all milk products is more elastic (at the wholesale level) when the price support scheme is operational, demand for milk at the farm level is more elastic, which is what we observe this specification compared with the one in table 2 The effects of fluid advertising are also slightly larger in this specification

To discriminate between the disaggregated and aggregate advertising models, we employ the Akaike Information Criteria (AIC) (Harvey, 1990, pp 177-78) This criteria was applied to the unrestricted reduced-form price equations for each model and a smaller AIC was obtained for the second model, indicating the model with disaggregated variables is preferred [8]

Model Validation

To determine the validity of the estimated econometric structure (equations 21 and 22) for simulating the effects of changes in advertising, static simulations were conducted with the reduced form to see how well the model replicated historical values of the endogenous variables Because the Tobit model is used to predict the (unobserved) latent variable net government purchases, the validity of the model is solely assessed in terms of predicting the farm price of milk

Initial efforts to generate historical forecasts of the farm price variable were unsuccessful, with the predicted price consistently exceeding the actual price by a large, relatively fixed amount This suggests that the estimated intercept values obtained by the Amemiya procedure are badly biased Although the Amemiya procedure, which is a quasi-maximum likelihood procedure, yields econometric estimates that are consistent, there is no assurance that the historically predicted residuals should have a zero mean as would be the case with any least-squares procedure At the same time, it is not necessary to restrict the intercept of the reduced-form price equation Thus, to ensure that the historically predicted residuals have a zero mean, only the nonintercept coefficients (which exclude the constant plus the quarterly dummies) were estimated by the Amemiya procedure

Given estimated values for the nonintercept coefficients, the residuals, formed by subtracting the sum of the variables multiplied by these coefficient estimates, were regressed on the constant and three dummy variables to obtain predicted residuals for the reduced-form price equation that have a zero mean As there was evidence of serial correlation when estimating the unrestricted reduced-form price equation in stage 1 of the Amemiya procedure, the estimates were also corrected for fourth-order autocorrelation The constant and quarterly dummy variable estimates of the farm price equation (reported in tables 2 and 3) produce zero means for the historically predicted residuals

Using parameters estimated by the above procedure, historical simulations were conducted for both the aggregate manufactured advertising model and the disaggregate manufactured advertising model The root-mean squared errors of the forecasts are 1 11 cents per pound (aggregate) and 1 09 cents per pound (disaggregate) With a sample mean real milk price of 13 35 cents per pound, the coefficients of variation are 0 083 (aggregate) and 0 082 (dissaggregate)

Impact of Advertising

Both models were also used to simulate the effects of increased advertising over time on the farm price of milk and on total revenue of milk producers To determine the impact of advertising on farm revenue since 1983, historical forecasts of the real farm price were compared with forecasts holding advertising constant in real terms from 1983 (Q4) through 1990 (Q4) Since advertising affects price with a time lag, comparisons began with the fourth quarter of 1984

The effect of increased advertising on farm revenue was calculated by dividing the change in total revenue by the change in advertising [9] (Since the quantity of farm production of milk is taken as fixed, the change in total revenue is simply the sum of the changes in price weighted by the actual quantities) By this procedure, we obtain farm-level rates of return to advertising of 2 56 1 and 6 00 1 for the aggregated and disaggregated models These estimates are in the range of the estimate of 4 77 1 obtained by Liu and others (1990)

Summary and Conclusions

To estimate the effects of changes in dairy product advertising on farm prices, we constructed a model

[8] Use of a conventional F-statistic to test whether aggregating all manufactured advertising variables together is too restrictive is inappropriate because the two models are non-nested Use of a non-nested hypothesis test leads to four possible outcomes, including acceptance and rejection of both models Indeed, application of Davidson and MacKinnon's J-test, while indicating rejection of the aggregate manufactured advertising specification when that model is the null hypothesis, also indicates rejection of the disaggregated advertising specification when that model is assumed to be the null hypothesis

[9] To facilitate a comparison with other studies, the change in advertising was calculated as the change in aggregate advertising expenditures deflated by the CPI In 1982 84 dollars, the change from 1983 (Q4) through 1990 (Q4) was $517,651,337

with an industry-derived demand equation for milk at the farm level linking advertising and government purchases to farm price, and a government purchases equation linking advertising and support prices to government purchases

The two-equation model was estimated for both aggregate and disaggregated manufactured advertising Estimation was performed using quasi-maximum likelihood procedures on the mixed/continuous equation system The econometric results were generally consistent with theory, indicating significant effects of both fluid and manufactured advertising on farm price In terms of predictive performance, the model with the disaggregate manufactured advertising variables was preferred

Both estimated econometric models were used to simulate the impact of increased advertising since 1984 The return on investment to advertising was estimated to be between 2 56 1 and 6 00 1, between $2 56 and $6 00 on each additional dollar spent on advertising 1984 (Q4) to 1990 (Q4) Estimates do not take into account milk supply response, the effects of advertising would likely be different if supply response was included in the simulations

A model specification for supply response of raw milk at the farm level is needed to calculate more accurately returns on advertising investment Also, joint estimation of supply response would permit relaxing the assumption that the quantity of milk marketed is predetermined with respect to price in the same quarter Disaggregation of the advertising variables into generic and branded advertising would permit direct estimation of the effects of generic advertising on milk prices Finally, more work on specification of variables to represent demand and supply determinants (including alternative distributed lag formulations for the advertising variables) is needed

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