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The Economic Implications of the U.S. Generic Dairy Advertising Program:

An Industry Model Approach

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Abstract

The purpose of this paper was to examine the impact of U.S. generic dairy advertising on milk price and milk volume at the retail, wholesale and farm level in the dairy sector. To improve on earlier studies, the analysis was based on a dairy industry model encompassing supply and demand conditions in various markets within the dairy sector and government intervention of the dairy price support program. Consequently, additional insights concerning the impact of generic dairy advertising were realized. The model were recursive in that the farm milk supply is predetermined in each period. The retail-wholesale subsystem was estimated simultaneously while the farm milk supply equation was estimated separately. The estimated model was used to simulate price and quantity values under four advertising scenarios: (1) no advertising, (2) historical fluid advertising, (3) historical manufactured advertising, and (4) historical fluid and manufactured advertising.

Compared to no advertising, the fluid-only scenario increased retail fluid sales by 2.74% while the manufactured-only scenario increased retail manufactured sales by 0.99%. The scenario of allowing for both fluid and manufactured advertising resulted in the market becoming competitive during some periods. In this latter scenario, due to the price effect of the added competition, the sales increase was reduced slightly to 2.67% for fluid milk and 0.85% for manufactured dairy products.

The farm level rate of return was estimated at $7.04 for every dollar spent in fluid-only advertising. The rate of return for

manufactured-only advertising was zero because the strategy results in only a replacement of government purchases by the increased commercial consumption. With the scenario of both fluid and manufactured advertising, the overall farm level rate of return was $4.77. The fluid-only advertising reduced government purchases by 16.2%, which amounts to an average saving in government costs of about $390,900 per quarter in 1987 dollars. Manufactured-only advertising reduced government purchases by 9.63% with a saving of $234,432 per quarter. The actual scenario of combining fluid and manufactured advertisings resulted in a reduction of government purchases by 18.7% with a saving of $531,830 per quarter.

Compared to the previous studies, the dairy industry model provided additional insights into the way generic dairy advertising influences prices and quantities at the retail, wholesale, and farm level. To further the usefulness of the model, it is essential to improve the existing data base for advertising expenditure variables. The current advertising data are at best proxies. It is also useful to refine the model to include regional disaggregation. A national industry model with regional characteristics would enable researchers and program managers to assess the differential impact of the national and regional programs and determine the optimal expenditure pattern across regions.

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The U.S. dairy industry of the 1980's has been characterized by chronic excess milk production relative to commercial market needs. These surpluses of milk have caused government costs of the dairy price support program to soar above previous levels, and have depressed dairy farm prices for much of the 1980's.

The federal government has enacted various supply and demand management programs aimed at curbing this milk surplus problem. Supply management policies have been enacted in order to reduce, or slow the rate of growth in milk production. Two examples include the 1984-85 Milk Diversion Program, and the 1986-87 Dairy Termination Program. A demand management program was authorized under the Dairy and Tobacco Adjustment Act of 1983. This Act established the National Dairy Research and Promotion program with an objective of increasing dairy product consumption. Since then, generic dairy advertising has been funded by a mandatory $0.15 per cwt. assessment on all milk marketings, generating over $200 million per year for promotion purposes.

Given the magnitude of money involved in promoting dairy products, there is an obvious need for objective evaluation of the program impact on various markets within the dairy sector. At the national level, both fluid and manufactured dairy products advertising activities have been partially evaluated. Ward and Dixon estimate a retail fluid milk demand equation covering twelve major milk market regions which represent 40% of the U.S. population. On the manufactured side, Blaylock and Blisard estimate retail natural and processed cheese demand equations for the U.S. at home market. These studies have contributed to an understanding of the impact of U.S. generic dairy advertising. However, several important issues still need to be addressed.

First, the previous studies have estimated retail demand equations, but have ignored retail supply. Hence, the retail price is treated as exogenous and is not affected by the increased demand due to advertising. Accordingly, such models may overpredict the impact of advertising on retail demand. Second, the previous studies ignore markets other than that at the retail level. Since the link between the impact of advertising on the retail market and the subsequent impacts on the wholesale and farm markets has not been explicitly modeled, the effect of advertising on the wholesale and farm markets cannot be appropriately analyzed. Third, the implications of government price intervention have not been explicitly modeled. It will become clear that the advertising program has different effects depending on whether the market is competitive or government supported.[1] Finally, the previous studies have not taken into account the farm supply response to advertising. If the advertising program indeed increases the demand for milk and, hence, farm revenue, producers will likely increase supplies which might eventually wipe out any short-term gains.

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1 Due to recent large amounts of annual government purchases, it is tempting to describe the dairy sector exclusively as government supported. However, this observation is not appropriate when examining the market on a quarterly or monthly basis. Moreover, using government purchases for regime identification is flawed due to the existence of specialized manufacturing plants who package their product according to government standards and are not equipped to sell in commercial markets even when the competitive price exceeds the government price. Using the relationship between the government price and the market price as a criterion to identify regimes, our data indicate that the competitive regime held for 42% of the quarters during the period 1975-87.

Additional insight into the impact of U.S. generic dairy advertising program can be gained if the evaluation is based on a dairy industry model encompassing supply and demand conditions in various markets including government intervention.[2] The purpose of this paper is to assess the impact of U.S. generic dairy advertising program in a multiple market setting. Based on a quarterly econometric model of the U.S. dairy industry, the price and quantity effects of fluid and manufactured dairy products advertising are simulated for the retail, wholesale and farm level.

Conceptual Framework

The econometric model of the dairy industry consists of a retail, wholesale, and farm level. At the farm level, raw milk is produced and sold to wholesalers, who in turn process and sell it to retailers. Both wholesale and retail levels are divided into a fluid and a manufactured component. The construction is similar to a previous model by Kaiser, Streeter, and Liu in that milk products are divided into fluid and manufactured dairy products. However, the previous model only considered the retail and the farm levels. The extension to include a wholesale level in this study facilitates the incorporation of government intervention in the wholesale manufactured market. A schematic view of the various components of the dairy sector is in Figure 1.

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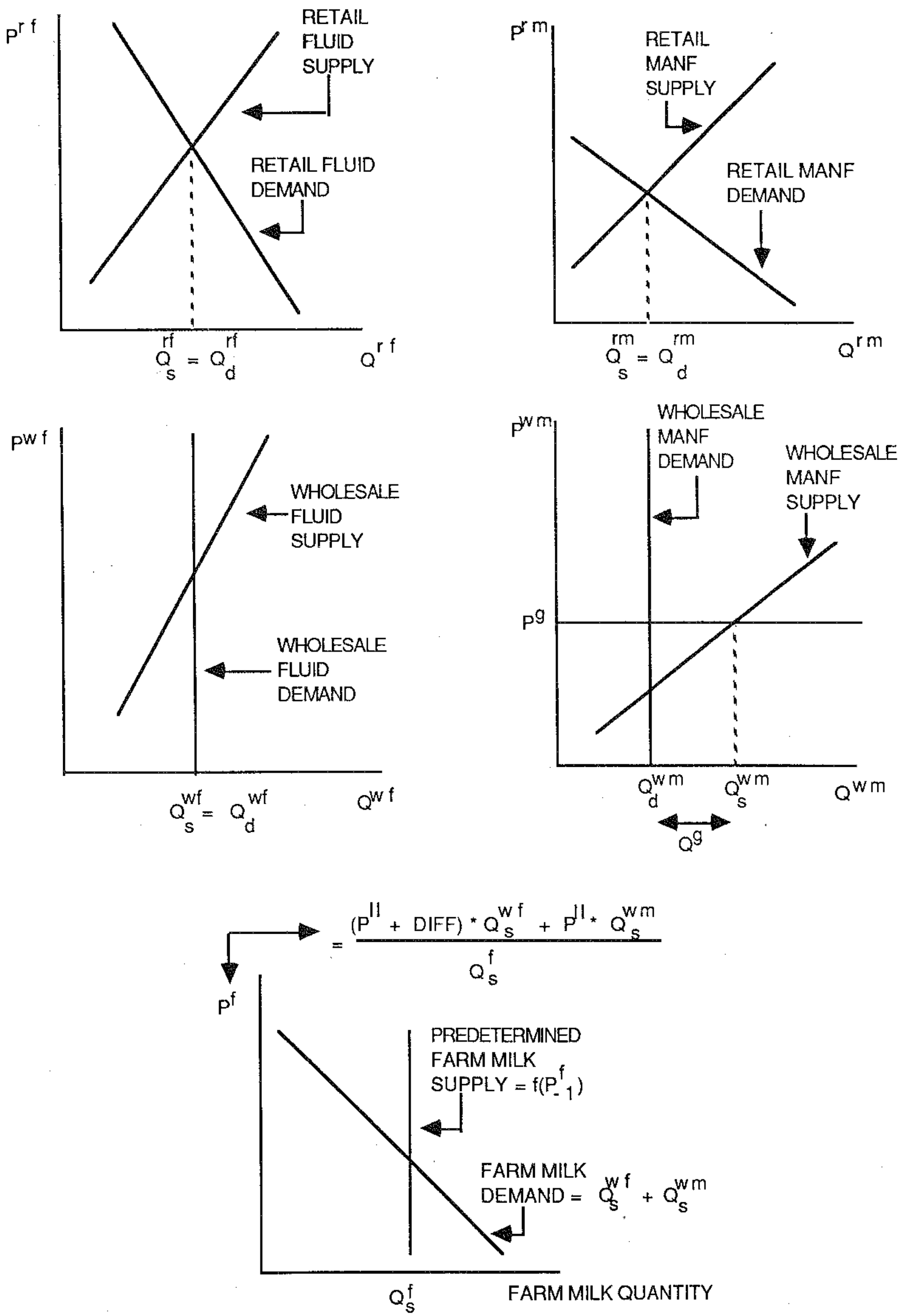
2 Numerous studies have investigated the impact of individual state dairy advertising program on the consumer and/or farm markets (e.g., Kinnucan and Forker; Liu and Forker; Thompson and Eiler). However, since the manufactured market is national rather than local in scope, reliable sales data for state level manufactured dairy products do not exist. Hence, an industry model approach to advertising at the state level is not possible.

Figure 1. Conceptual model of U.S. Dairy Market.*



* Ignores changes in commercial inventories, specialized plant quantity, and farm use, for simplicity. The wholesale fluid demand and wholesale manufactured demand curves are not drawn as downward sloping in this figure. Rather, they are "derived" from their respective retail quantities.

In the retail fluid market, a general specification for supply, demand and the equilibrium condition can be written as:

$$(1.1) \quad Q_s^{rf} = \alpha_s^{rf} P^{rf} + \beta_s^{rf} P^{wf} + \gamma_s^{rf} Z_s^{rf} + \mu_s^{rf}$$

$$(1.2) \quad Q_d^{rf} = \beta_d^{rf} P^{rf} + \gamma_d^{rf} Z_d^{rf} + \mu_d^{rf}$$

$$(1.3) \quad Q_s^{rf} = Q_d^{rf} \equiv Q^{rf}$$

where Q_s^{rf} and Q_d^{rf} are the retail fluid quantity supplied and demand; P^{rf} and P^{wf} are the equilibrium retail fluid price and wholesale fluid price; Z_s^{rf} and Z_d^{rf} are vectors of exogenous supply and demand shifters pertaining to the retail fluid market; and Q^{rf} denotes the equilibrium retail fluid quantity.

The retail manufactured supply, demand and equilibrium condition can be written following the form of the retail fluid market as follows:

$$(2.1) \quad Q_s^{rm} = \alpha_s^{rm} P^{rm} + \beta_s^{rm} P^{wm} + \gamma_s^{rm} Z_s^{rm} + \mu_s^{rm}$$

$$(2.2) \quad Q_d^{rm} = \beta_d^{rm} P^{rm} + \gamma_d^{rm} Z_d^{rm} + \mu_d^{rm}$$

$$(2.3) \quad Q_s^{rm} = Q_d^{rm} \equiv Q^{rm}$$

where superscripts rm's and wm's represent the retail and wholesale manufactured markets, respectively.

The wholesale fluid supply, demand and equilibrium condition are:

$$(3.1) \quad Q_s^{wf} = \alpha_s^{wf} P^{wf} + \beta_s^{wf} (P^{II} + \text{DIFF}) + \gamma_s^{wf} Z_s^{wf} + \mu_s^{wf}$$

$$(3.2) \quad Q_d^{wf} = Q^{rf}$$

$$(3.3) \quad Q_s^{wf} = Q_d^{wf} \equiv Q^{wf}$$

where P^{II} is the Class II price and Diff is the exogenous Class I differential.[3] All other variables are similarly defined with superscript wf's denoting variables pertaining to the wholesale fluid

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3 Under the rules of the federal milk marketing order program, processors buy raw milk from dairy farmers paying a base price called the Class II price for all the milk sold plus a fixed premium called the Class I differential for that milk sold to the fluid market.

market. Equation (3.2) specifies that the wholesale fluid demand should equal the equilibrium retail fluid quantity as all the quantity variables are expressed on a milk equivalent basis.

The wholesale manufactured supply, demand and equilibrium condition when the market is competitive are:

(4.1) $$Q_s^{wm} = \alpha_s^{wm} P^{wm} + \beta_s^{wm} P^{II} + \gamma_s^{wm} Z_s^{wm} + \mu_s^{wm}$$

(4.2) $$Q_d^{wm} = Q^{rm}$$

(4.3) $$Q_s^{wm} = Q_d^{wm} + QSP + \Delta INV \equiv Q^{wm}$$

where QSP is the quantity of milk sold to the government by specialized manufacturing plants, ΔINV is change in commercial inventories of manufactured products, and all other variables are similarly defined with superscript wm's denoting variables pertaining to the wholesale manufactured market. The variables QSP and ΔINV are treated as exogenous in this study because they comprise a very small and rather constant portion of manufactured quantity.[4]

The wholesale manufactured price appearing in (2.1) and (4.1) is constrained by the dairy price support program. That is, since the government sets a purchase price for storable manufactured dairy products and is willing to buy surplus quantities of the products at that price, the following constraints holds:

(5) $$P^{wm} \geq P^g$$

where P^g is the aggregate government purchase price for the manufactured products at the wholesale level.

When the government support regime holds, P^{wm} simply equals P^g which is exogenous. However, the quantity of government purchases

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4 Even though the magnitude of commercial inventory changes over time, its first difference (ΔINV) appears to be stationary with a strong seasonal pattern.

emerges as an additional endogenous variable. Accordingly, the equilibrium condition of (4.3) for the wholesale manufactured market becomes:

$$(4.3_{*}) \qquad Q_s^{wm} = Q_d^{wm} + QSP + \Delta INV + Q^g = Q^{wm}$$

where Q^g is government purchases measured on a milk equivalent basis.

Finally, the farm supply is treated as predetermined due to the standard assumption that dairy farmers' price expectations are based on lagged prices only (e.g., Chavas and Klemme; Kaiser, Streeter and Liu; LaFrance and de Gorter). As such, the farm supply equation is:

$$(6.1) \qquad Q_s^f = \alpha_s^f P^f + \gamma_s^f Z_s^f + \mu_s^f$$

where Q_s^f is the farm milk supply, P^f is the farm milk price, and the superscripts f's represent the farm market. Since milk used for fluid and manufactured purposes commands different prices, the farm milk price received by dairy farmers is the average of the Class I and Class II prices weighted by their respective quantities:

$$(6.2) \qquad P^f = \frac{(P^{II} + DIFF) * Q^{wf} + P^{II} * Q^{wm}}{(Q_s^f - FUSE)}$$

where FUSE is on-farm use of milk, which is assumed to be exogenous. The model is closed by the following farm level equilibrium condition:

$$(6.3) \qquad Q_s^f = Q^{wf} + Q^{wm} + FUSE$$

To summarize, since the farm milk supply is predetermined, the above dairy model is recursive in nature consisting of a retail-wholesale subsystem [equations (1) to (5)] and a farm market [equation (6)]. Given the predetermined farm milk supply, the retail-wholesale subsystem encompasses two possible regimes. In the case of competitive regime, the endogenous variables are: retail and wholesale fluid quantities ($Q_d^{rf} = Q_s^{rf} = Q_d^{wf} = Q_s^{wf}$), retail manufactured quantities and wholesale manufactured demand quantity ($Q_d^{rm} = Q_s^{rm} = Q_d^{wm}$), wholesale manufactured supply quantity (Q_s^{wm}), retail fluid price (P^{rf}), wholesale fluid price (P^{wf}), retail manufactured price (P^{rm}), wholesale manufactured price (P^{wm}), and Class II price (P^{II}). In the case of the government support regime, government quantity (Q^g) replaces P^{wm} as an endogenous variable.

Estimation Results

Since the underlying market structures are different depending on whether the market is competitive or government supported, an application of the conventional two stage least squares procedure to the retail-wholesale subsystem in (1) to (5) will result in selectivity bias (Maddala, 1983, pp. 326-35). Instead, the subsystem is estimated by a switching simultaneous system procedure. A detailed description of the procedure is in Appendix A. The six structural equations that need to be estimated simultaneously are: retail fluid demand, retail manufactured demand, retail fluid supply, wholesale fluid supply, retail manufactured supply, and wholesale manufactured supply. Quarterly data from 1975 through 1987 are used to estimate the equations. The farm supply equation in (6.1) is estimated by ordinary least squares as the supply is assumed to be predetermined. Due to the availability of data, a longer time series from 1970 through 1987 is used in this estimation. The quantity variables are taken from the USDA commercial disappearance table while other variables are from various public and private publications.[5] All data used in the estimation are in Appendix B.

Retail-Wholesale Subsystem

The retail fluid and manufactured demand equations are estimated on a per capita basis, while the retail and wholesale supply equations are estimated on a total quantity basis because population is not a supply determinant. Both demand equations are expressed as functions of own price, per capita income, price of substitutes, advertising, time trend, harmonic seasonal variables, and other shifters. The supply equations are expressed as functions of own price, input prices, lagged supply, harmonic seasonal variables, and other shifters. The estimation results are presented in Table 1. All the estimated coefficients have correct signs and are significant at conventional confidence levels (as indicated by the t-values in parentheses). The adjusted R-squared, Durbin-Watson statistics, and Durbin-h statistics suggest good fit of the data. A more specific explanation of the equations follows.

Per capita retail fluid demand (Q_d^{rf}/POP) is estimated as a function of the ratio of the fluid milk price index (P^{rf}) to per capita income (INC); the ratio of the retail non-alcoholic beverage price index (PBEV) to per capita income; deflated generic fluid advertising

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5 The generic advertising data are from various issues of *Leading National Advertisers*. Due to the survey techniques used, the expenditures reported in the publication are generally regarded as low compared to the true expenditures. However, alternative data sources for the U.S. market with the required extended time period are not available. Since the error in variable problem may result in downward bias advertising coefficients in the estimation (rather than upward bias as one might have intuitively thought, see Maddala, 1977, pp. 292-94), the result should be interpreted with care. An instrumental variable approach of regressing advertising on its own lags was initially tried to purge the correlation between the error term and the advertising variable. However, the resulting low R-squared in the instrumental equation indicates the poor performance of the procedure, which was subsequently abandoned.

Table 1: Estimated Retail-Wholesale Subsystem

Reta. Fluid Demand

$$\ln Q_d^{rf} = -2.236 - 0.282 \ln (P^{rf}/INC) + 0.154 \ln (PBEV/INC) + .0025 \ln DGFA$$
(-14.88) (-2.34) (2.31) (2.01)

$$+ 0.004 \ln DGFA_{-1} + 0.0045 \ln DGFA_{-2} + 0.004 \ln DGFA_{-3} + 0.0025 \ln DGFA_{-4}$$
(2.01) (2.01) (2.01) (2.01)

$$- 0.179 \ln TIME - 0.028\, SIN1 + 0.083\, COS1 + 0.517\, u^{rf}_{d_{-1}} + \ln POP$$
(-6.79) (-3.60) (10.70) (3.24)

Adj. $R^2 = 0.88$ Durbin-Watson = 1.84

Reta. Manu. Demand

$$\ln Q_d^{rm} = -2.467 - 0.928 \ln (P^{rm}/INC) + 0.645 \ln (PMEA/INC) + 0.0009 \ln DGMA$$
(-10.42) (-2.68) (2.29) (1.64)

$$+ 0.0014 \ln DGMA_{-1} + 0.0016 \ln DGMA_{-2} + 0.0014 \ln DGMA_{-3} + 0.0009 \ln DGMA_{-4}$$
(1.64) (1.64) (1.64) (1.64)

$$- 1.436 \ln DPAFH + 0.071 \ln TIME - 0.050\, SIN1 - 0.085\, COS1 + \ln POP$$
(-2.09) (2.64) (-4.92) (-8.29)

Adj. $R^2 = 0.85$ Durbin-Watson = 2.07

Reta. Flui. Supply

$$\ln Q_s^{rf} = 2.809 + 0.940 \ln (P^{rf}/P^{wf}) - 0.111 \ln (PFE/P^{wf}) - 0.015\, UNEMP$$
(6.00) (1.82) (-3.68) (-3.95)

$$+ 0.237 \ln Q^{rf}_{s_{-1}} - 0.227 \ln Q^{rf}_{s_{-4}} - 0.001\, TIME - 0.052\, SIN1 + 0.094\, COS1$$
(1.76) (-1.98) (-1.90) (-3.90) (8.14)

Adj. $R^2 = 0.90$ Durbin-h = 1.60

Whol. Flui. Supply

$$\ln Q_s^{Wf} = 2.184 + 0.381 \ln (P^{Wf}/P^{I}) - 0.093 \ln (PFE/P^{I}) - 0.016\, UNEMP$$
(4.03) (2.66) (-2.85) (-3.98)

$$+ 0.240 \ln Q^{Wf}_{s_{-1}} - 0.223 \ln Q^{Wf}_{s_{-4}} - 0.003\, TIME - 0.050\, SIN1 + 0.094\, COS1$$
(1.79) (-1.96) (-3.74) (-3.74) (8.18)

Adj. $R^2 = 0.90$ Durbin-h = 1.13

Reta. Manu. Supply

$$\ln Q_s^{rm} = -1.507 + 0.683 \ln (P^{rm}/P^{wm}) - 0.334 \ln (MWAGE/P^{wm}) - 0.042\, COS1$$
(-1.69) (2.37) (-1.51) (-2.78)

$$+ 0.163 \ln Q^{rm}_{s_{-1}} + 0.581 \ln Q^{rm}_{s_{-4}}$$
(2.21) (6.55)

Adj. $R^2 = 0.93$ Durbin-h = 1.36

Whol. Manu. Supply

$$\ln Q_s^{wm} = 0.528 + 0.870 \ln (P^{wm}/P^{II}) - 0.544 \ln (MWAGE/P^{II}) - 0.122\, POLICY$$
(2.70) (1.50) (-2.86) (-4.37)

$$+ 0.301 \ln Q^{wm}_{s_{-1}} + 0.351 \ln Q^{wm}_{s_{-4}} + 0.00017\, TIME^2 + 0.077\, SIN1 - 0.125\, COS1$$
(3.40) (4.15) (4.29) (4.08) (-6.42)

$$+ 0.751\, u^{wm}_{s_{-1}}$$
(4.05)

Adj. $R^2 = 0.96$ Durbin-h = 0.25

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expenditures (DGFA); a time trend (TIME); and two harmonic seasonal variables (COS1 and SIN1).[6] The specification of the two price to income ratios is consistent with the zero homogeneity assumption for prices and income (Phlips, pp. 37-38). The beverage price index is a proxy for the price of fluid product substitutes. The current and lagged advertising variables account for the impact of advertising on demand.[7] The sum of the advertising coefficients is about 0.018 which can be interpreted as the long term fluid advertising elasticity. The time trend (first quarter of 1975 equals one) captures the effect of changes in consumer preferences over time; specifically, the increasing concern about the link between heart disease and fluid milk consumption. The two harmonic seasonal variables capture seasonality in demand. Based on the estimated autocorrelation function and partial autocorrelation function of the residuals, a first order moving average error structure is imposed. All the coefficients remain stable after imposing the moving average term.

Per capita retail manufactured demand (Q_d^{rm}/POP) is estimated as a function of the ratio of retail manufactured price index (P^{rm}) to per capita income; the ratio of retail meat price index (PMEA) to per capita income; deflated generic manufactured advertising expenditures (DGMA);

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6 All deflated price variables are defined as the nominal measure divided by the Consumer Price Index for all items (1967 = 100). The variables COSi and SINi represent the i-th wave of the cosine and sine, respectively (Doran and Quilkey). The variable POP is the population of the United States.

7 The impact of current and lagged fluid advertising expenditures on demand is specified as a second order polynomial distributed lag with both end point restrictions imposed. The appropriateness of the end point restrictions are tested and not rejected (Maddala, 1977, p. 358). This specification is consistent with Ward and Dixon and is also used for the manufactured advertising expenditures in the retail manufactured demand equation that follows.

the deflated retail price index for food away from home (DPAFH); a time trend; and the two harmonic seasonal variables.[8] The meat price index is a proxy for the price of manufactured product substitutes. The sum of current and lagged advertising coefficients is 0.006 indicating the long term manufactured advertising elasticity is only about one third of that of fluid advertising. The away from home price index is included because a large portion of cheese is consumed away from home. The trend variable measures the increase in consumer preferences for cheese and yogurt; unlike fluid product, consumers do not perceive manufactured products such as cheese as high fat products even though they contain as much fat as whole milk (Cook, et al., p. 9).

Retail fluid supply (Q_s^{rf}) is estimated as a function of the ratio of retail fluid price index to wholesale fluid price index (P^{wf}); the ratio of fuels and energy price index (PFE) to wholesale fluid price index; lagged supply; unemployment rate (UNEMP); a time trend; and the harmonic seasonal variables. The specification of the retail to wholesale price ratio and energy price to wholesale price ratio is consistent with the zero homogeneity assumption for prices. The wholesale fluid and energy prices represent two of the most important

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8 Prior to 1980, the amount of generic manufactured advertising had been insignificant and for some periods the reported expenditures are zero. Due to the logarithmic specification, zero expenditures are set as 0.001. Previous studies found that parameter estimates are quite robust over a range of the specified value (Ward and Dixon; Blaylock and Blisard). Also, since there has been a significant amount of brand manufactured advertising, brand advertising is also included in the preliminary estimation. The resulting coefficient for this variable is insignificant and omitted from the final equation. The omission of this variable does not affect the estimation result in any significant way. The insignificant brand coefficient is consistent with Blaylock and Blisard, and may be explained by the fact that brand advertisements are geared toward increasing the market shares of individual firms rather than the total sales of the industry.

costs in fluid retailing. The two lagged dependent variables are included to capture short and longer term production capacity constraints.[9] The unemployment rate is used as a proxy for the state of the economy while the time trend is included to capture other determinants of supply such as labor costs in the retail fluid sector, which are unavailable.[10]

Wholesale fluid supply (Q_s^{wf}) is estimated as a function of the ratio of wholesale fluid price index to Class I price for raw milk ($P^I = P^{II} + DIFF$); the ratio of fuels and energy price index to Class I price; lagged supply; unemployment rate; a time trend; and the harmonic seasonal variables. The Class I price is included because it represents the most important cost in fluid wholesaling.

Retail manufactured supply (Q_s^{rm}) is estimated as a function of the ratio of retail manufactured price to wholesale manufactured price (P^{wm}); the ratio of average hourly wages in the manufactured sector (MWAGE) to wholesale manufactured price; lagged supply; and a harmonic seasonal variable. The wholesale manufactured price accounts for the largest portion of variable costs, and the manufactured wage rate measures labor costs in manufactured retailing. The energy price and unemployment rate were included in the initial estimation of this equation, but are subsequently omitted because their coefficients are

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[9] The eigenvalues for this dynamic system have real parts all less than one in absolute value indicating the equation is stable. The stability condition is also satisfied for other dynamic supply equations to be presented.

[10] The unemployment rate and trend variables are not measured in logarithms. Using the logarithm of the unemployment rate does not alter the results, except that the trend variable becomes marginally insignificant. Using the logarithm of trend results in a wrong sign for the coefficient of retail fluid price variable.

the wrong sign. Also, the trend variable and SIN1 are omitted because their coefficients are insignificant. The exclusion of TIME and SIN1 does not change the results of the estimation significantly. In general, this equation is the most difficult to estimate among all equations in the subsystem.

Wholesale manufactured supply (Q_s^{wm}) is estimated as a function of the ratio of wholesale manufacturing price to Class II price (P^{II}); the ratio of manufactured wage to Class II price; lagged supply; a policy dummy variable (POLICY); a time trend; and the harmonic seasonal variables. The Class II price is included because it represents the most important variable cost in manufactured wholesaling. The policy dummy variable (equal to 1 for the first quarter of 1984 through the second quarter of 1985 and the second quarter of 1986 through the third quarter of 1987) accounts for the significant reductions in raw milk supply due to the implementation of the Milk Diversion Program and the Dairy Termination Program, which had significant impacts on the wholesale manufactured market. A first order moving average error structure is imposed to correct for serial correlation in the residuals. All the coefficients remain stable after imposing the moving average term.

Farm Milk Supply Equation

The farm milk supply (Q_s^f) is specified as a function of lagged milk supply, the lagged ratio of farm milk price (P^f) to 16% protein dairy feed cost (PFEED), lagged deflated farm wage (DFWAGE), the policy dummy variable (POLICY), a time trend (FTIME), and harmonic seasonal variables. Lagged supply is included to account for capacity constraints while the feed price and farm wage represent two major input costs of dairy farming. The policy dummy captures the farm supply impact of the Milk Diversion and Dairy Termination Programs. The trend variable (first quarter of 1970 equals one) captures genetic improvements of the dairy cows over time. The estimated equation is in Table 2.

Table 2: Estimated Farm Milk Supply Equation

$$\ln Q_s^f = \underset{(5.16)}{1.727} + \underset{(4.81)}{0.492} \ln Q_{s-1}^f + \underset{(2.44)}{0.065} \ln (P^f/PFEED)_{-1}$$

$$- \underset{(-2.88)}{0.201} \ln DFWAGE_{-1} - \underset{(-3.33)}{0.028} \, POLICY + \underset{(5.26)}{0.002} \, FTIME$$

$$+ \underset{(2.28)}{0.018} \, SIN1 - \underset{(-20.74)}{0.068} \, COS1 + \underset{(5.84)}{0.014} \, COS2$$

Adj. $R^2 = 0.96$ Durbin h = 0.72

Model Validation

To determine the validity of the estimated dairy model in conducting advertising evaluation analysis, the model is dynamically simulated to assess its ability to replicate the historical values for the endogenous variables. The simulation procedure is first outlined followed by a report on the root-mean-square percent simulation error pertaining to each variable.

First, given the values for the exogenous variables, lagged dependent variables, and the predetermined farm milk supply in the initial simulation period, equations (1)-(5) and (6.3) are solved simultaneously by the Newton method to obtain the first period simulated solutions for the endogenous variables in the retail-wholesale subsystem. Second, with these solutions, the endogenous farm milk price is determined through (6.2). Third, the first period solution for the farm milk price is fed into (6.1) to compute the second period's farm milk supply. The above constitutes a one-step-ahead simulation of the endogenous and predetermined variables of the model. Then, one proceeds to the second period of the simulation. With the previous period solutions for the endogenous quantity variable becoming the lagged dependent variables and the farm milk supply becoming the predetermined variable for the second period simulation, the above simulation procedure is repeated. The recursive procedure is iterated until the last period of the simulation is reached.[11]

The root-mean-square percent simulation error (RMSP) pertaining to each variable under historical simulation are presented in the second column of Table 3. The model does a reasonably good job in forecasting fluid and manufactured quantity variables with the RMSP's ranging from 2.80% to 5.14%. The model also performs well in forecasting such price variables as retail fluid price, retail manufactured price, wholesale fluid price and wholesale manufactured price. Among these price variables, the lowest RMSP pertains to the retail manufactured price (1.23%) and the highest RMSP pertains to the wholesale fluid price (7.20%). As to the farm milk supply, the RMSP is a lovely 3.28%.

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11 Since the purpose of the paper is to assess the impact of the dairy advertising program at the national level and the national program started its expenditures on September 1984, the simulation is conducted from the third quarter of 1984 through the last quarter of 1987.

Table 3: Root-Mean-Square Percent Simulation Errors (%)*/

	Without Shock Adjustments	With Shock Adjustments
Retail-Wholesale Subsystem		
Q^{rf}, Q^{wf}:	2.80	0.20
Q^{rm}, Q_d^{wm}:	4.84	0.25
Q_s^{wm}:	5.14	0.32
Q^g:	49.7	13.0
P^{rf}:	4.97	0.72
P^{rm}:	1.23	0.38
P^{wf}:	7.20	1.08
P^{wm}:	3.16	1.27
P^{II}:	18.5	2.49
Farm Market		
P^f:	17.1	2.29
Q_s^f:	3.28	0.16

*/ The variables are: retail and wholesale fluid equilibrium quantity ($Q^{rf} = Q^{wf}$), retail manufactured equilibrium quantity and wholesale manufactured demand ($Q^{rm} = Q_d^{wm}$), wholesale manufactured supply (Q_s^{wm}), government purchases (Q^g), retail fluid price (P^{rf}), retail manufactured price (P^{rm}), wholesale fluid price (P^{wf}), wholesale manufactured price (P^{wm}), Class II price (P^{II}), farm milk price (P^f), and farm milk supply (Q_s^f).

However, the model does not do well in forecasting Class II and farm milk prices with their RMSP's at 18.5% and 17.1%, respectively. A comparison between the simulated values with the historical values indicates that the reason for the unsatisfactory performance is due to the model's overprediction of the seasonal pattern of the above two price variables. The RMSP associated with the government quantity is also very large (49.7%). However, this is due to the relatively small magnitude of the variable; i.e., a modest deviation from the historical value would result in a rather high RMSP. A time plot of the simulated and observed values of the variable indicates that the simulation tracks the history reasonably well.

In the ex post policy evaluation context of the current study, the performance of the model can be further improved as the historical shocks in each equation can be observed and subsequently adjusted. Upon incorporating the observed residuals into each equation in the simulation, the RMSP's are reduced substantially as reported in the third column of Table 3. The RMSP associated with the government quantity is reduced to 13.0% while those for Class II and farm milk prices to less than 2.5%. Furthermore, the RMSP's pertaining to other price and quantity variables become totally awesome ranging from 0.16% for the farm milk quantity to 1.27% for the wholesale manufactured price.

Advertising Analysis

The equilibrium price and quantity values in the dairy sector are simulated from the third quarter of 1984 through the last quarter of 1987 under four advertising scenarios. The base scenario assumes no fluid and manufactured advertising during the period. The second scenario takes the historical fluid advertising spending level as given but assumes no manufactured advertising. The third scenario takes the historical manufactured advertising spending level as given but assumes no fluid advertising. Finally, the fourth scenario takes the historical spending levels of both fluid and manufactured advertising as given.[1] The simulated endogenous variables averaged over all quarters under the four advertising scenarios are presented in Table 4.

A comparison of the simulated endogenous variables between the no advertising scenario with the fluid-only scenario provides the impact of fluid advertising. Similarly, a comparison between the no advertising scenario with the manufactured-only scenario yields the impact of manufactured advertising. Finally, a comparison between the no advertising scenario with fluid plus manufactured scenario gives the impact of the combined advertising. Since the impacts of advertising vary depending on whether the market is competitive or government supported, it is useful to note that the first three scenarios result only in government support solutions for the entire simulation period, while the fourth scenario of allowing for both types of advertising

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1 Due to the logarithmic specification, advertising expenditures are set at one, rather than zero, in the scenarios involving no fluid and/or manufactured advertising. This amounts to assuming a minimal goodwill spending of $1000 per quarter in 1967 dollars as the variables in the estimated equations are deflated by consumer price index and measured in thousand dollars. Notice that the fluid-only scenario does not assume that all historical fluid and manufactured expenditures are spent on fluid advertising. Rather, it takes the historical fluid spending level as given and assumes no manufactured advertising. Likewise, the manufactured-only scenario does not assume that all historical fluid and manufactured expenditures are spent on manufactured advertising. Rather, it takes the historical manufactured spending level as given and assumes no fluid advertising.

Table 4: Simulated Endogenous Variables Under the Four Advertising Scenarios (Quarterly Average)*/

	No Advertising	Manufactured-Only Advertising	Fluid-Only Advertising	Combined Advertising
<u>Retail-Wholesale Subsystem</u>				
Q^{rf}, Q^{wf}:	14.1081	14.1081	14.4911	14.4800
Q^{rm}, Q_d^{wm}:	17.7586	17.9379	17.7586	17.9143
Q_s^{wm}:	20.3147	20.3147	20.0197	20.0636
Q^g:**/	2.6188	2.4395	2.3238	2.2118
P^{rf}:	0.6291	0.6291	0.6922	0.6939
P^{rm}:	0.8939	0.9007	0.8939	0.9021
P^{wf}:	0.5712	0.5712	0.6179	0.6202
P^{wm}:	0.0392	0.0392	0.0392	0.0394
P^{II}:	0.0337	0.0337	0.0345	0.0348
<u>Farm Market</u>				
P^f:	0.0367	0.0367	0.0375	0.0378
Q_s^f:	35.0764	35.0764	35.1643	35.1972

*/ The variables are: retail and wholesale fluid equilibrium quantity ($Q^{rf} = Q^{wf}$), retail manufactured equilibrium quantity and wholesale manufactured demand ($Q^{rm} = Q_d^{wm}$), wholesale manufactured supply (Q_s^{wm}), government purchases (Q^g), retail fluid price (P^{rf}), retail manufactured price (P^{rm}), wholesale fluid price (P^{wf}), wholesale manufactured price (P^{wm}), Class II price (P^{II}), farm milk price (P^f), and farm milk supply (Q_s^f). All quantity variables are in billion pounds of milk equivalent. The retail fluid, retail manufactured, and wholesale fluid prices are price indices (1967=100), while wholesale manufactured price, Class II price and farm milk price are measured in dollars per cwt of milk equivalent. All price variables are deflated by the consumer price index (1967=100) before averaging.

**/ Including specialized manufacturing plants quantity (QSP).

yields two competitive solutions.[13] The levels and percentage changes of the above three pairwise comparisons are in Table 5.

Fluid-Only Advertising Impacts

The variables positively affected by fluid-only advertising are retail and wholesale fluid equilibrium quantity ($Q^{rf} = Q^{wf}$), retail fluid price (P^{rf}), wholesale fluid price (P^{wf}), Class II price (P^{II}), farm milk price (P^{f}), and farm milk supply (Q^{f}_{s}). The variables negatively affected by fluid advertising are wholesale manufactured supply (Q^{wm}_{s}) and government quantity (Q^{g}). Finally, the variables not affected by fluid advertising are retail manufactured equilibrium quantity and wholesale manufactured demand ($Q^{rm} = Q^{wm}_{d}$), retail manufactured price (P^{rm}), and wholesale manufactured price (P^{wm}).

The results are illustrated graphically in Figure 2. For exposition purposes, the figure considers only the effect of advertising on the retail-wholesale subsystem at any given period, given the predetermined farm milk supply. Once the impact on the subsystem is determined, the effects on the farm milk price and the next period farm milk supply can be straightforwardly assessed. For simplicity, the wholesale fluid demand curve and the wholesale manufactured demand curves are not drawn in Figure 2. Rather, they are "derived" from the respective retail equilibrium quantities. Also, notice that in the price-quantity planes in the figure, the positions of retail fluid supply curve and retail manufactured supply curve are conditional on their endogenous input prices; wholesale fluid and wholesale

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13 There were actually five competitive solutions in the historical sample of the simulation period.

Table 5: Impact of Advertising Scenarios, Compared to No Advertising*/ (Quarterly Average)

	Fluid Advertising		Manufactured Advertising		Combined Advertising	
	change	% change	change	% change	change	% change
Retail-Wholesale Subsystem						
Q^{rf}, Q^{wf}:	0.3830	2.74	0	0	0.3719	2.67
Q^{rm}, Q^{wm}_d:	0	0	0.1793	0.99	0.1557	0.85
Q^{wm}_s:	-0.2950	-1.44	0	0	-0.2511	-1.21
Q^g:	-0.2950	-16.2	-0.1793	-9.63	-0.4069	-18.7
P^{rf}:	0.0631	10.2	0	0	0.0648	10.5
P^{rm}:	0	0	0.0068	0.77	0.0082	0.92
P^{wf}:	0.0467	8.32	0	0	0.0490	8.71
P^{wm}:	0	0	0	0	0.0002	0.44
P^{II}:	0.0007	2.24	0	0	0.0011	3.15
Farm Market						
P^f:	0.0008	2.27	0	0	0.0011	3.09
Q^f_s:	0.0879	0.25	0	0	0.1209	0.34

*/ The variables are: retail and wholesale fluid equilibrium quantity ($Q^{rf} = Q^{wf}$), retail manufactured equilibrium quantity and wholesale manufactured demand ($Q^{rm} = Q^{wm}_d$), wholesale manufactured supply (Q^{wm}_s), government purchases (Q^g), retail fluid price (P^{rf}), retail manufactured price (P^{rm}), wholesale fluid price (P^{wf}), wholesale manufactured price (P^{wm}), Class II price (P^{II}), farm milk price (P^f), and farm milk supply (Q^f_s). All quantity variables are in billion pounds of milk equivalent. The retail fluid, retail manufactured, and wholesale fluid prices are price indices (1967=100), while wholesale manufactured price, Class II price and farm milk price are measured in dollars per cwt of milk equivalent. All price variables are deflated by the consumer price index (1967=100) before averaging.

manufactured prices, respectively. Similarly, the positions of wholesale fluid supply curve and wholesale manufactured supply curve are conditional on the endogenous Class II price. As the values for the above endogenous variables change, the supply curves will shift.

As illustrated in Figure 2, since fluid advertising shifts the retail fluid demand curve to the right, the retail fluid quantity, and, hence, the wholesale fluid quantity must increase. As the wholesale fluid quantity increases, the wholesale fluid price must rise which requires the retail fluid supply curve to shift to the left. The increase in the wholesale fluid price also means the Class II price must increase.[14] Since the Class II price is increased, the wholesale fluid supply curve must shift to the left as well. The final result in the fluid market is higher prices and quantities both at retail and wholesale level.

Regarding the manufactured market, since the Class II price is increased, the wholesale manufactured supply curve must shift to the left. However, due to the result that both the fluid-only and the base scenario of no advertising yield only government support solutions, the leftward shift in the above supply curve does not result in an increase in the wholesale manufactured price. As such, the retail manufactured supply curve does not shift. Hence, fluid advertising reduces the wholesale manufactured supply and government quantity, while leaving unchanged the retail manufactured equilibrium quantity, wholesale manufactured demand, retail manufactured price, and wholesale

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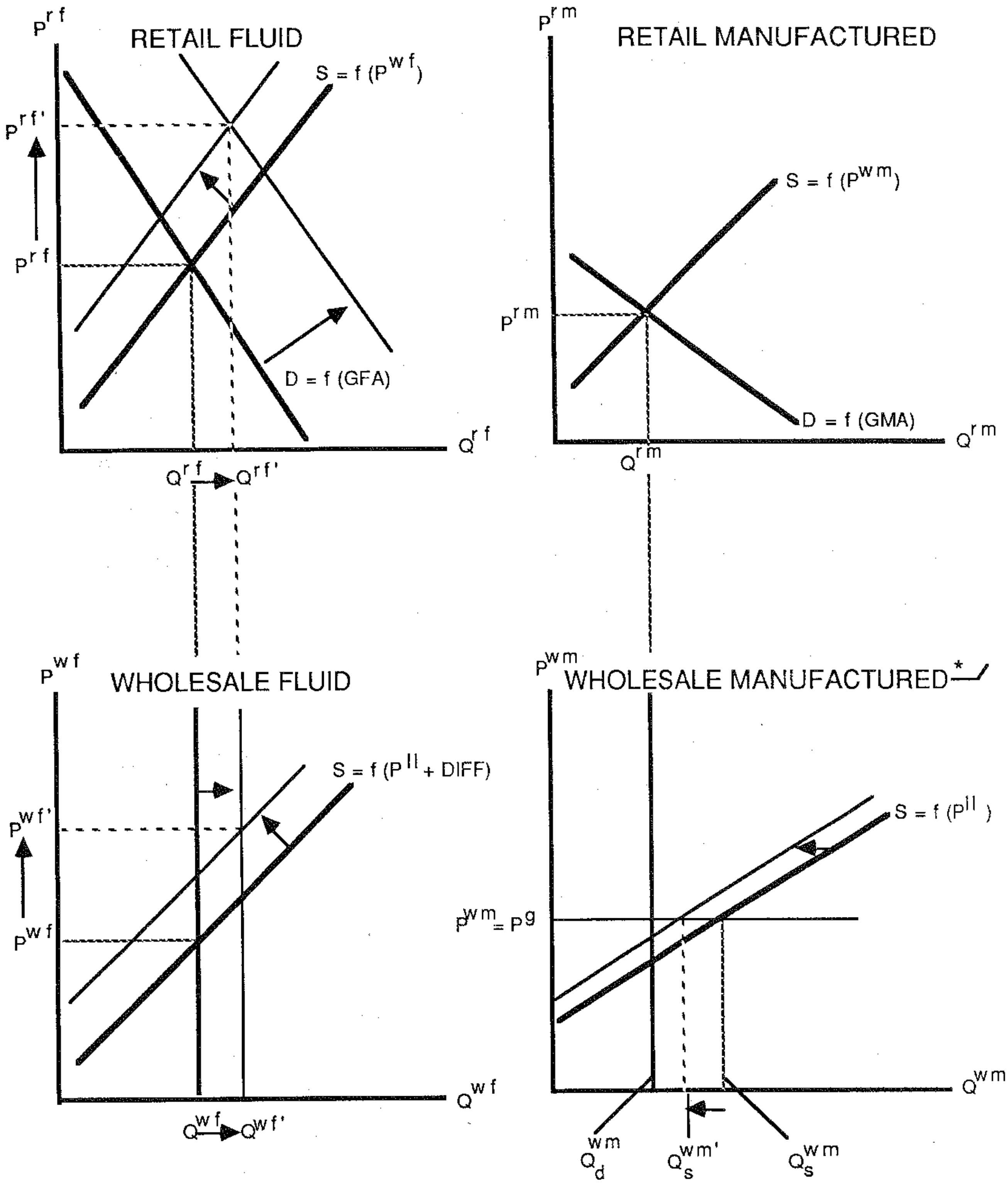
[14] The wholesale fluid supply equation in (3.1), the wholesale manufactured supply equation in (3.2), and the farm level equilibrium condition in (6.3) can be used to solve for the Class II price as a monotonically increasing function of the wholesale fluid price and wholesale manufactured price, given the predetermined farm milk supply.

Figure 2: Impact of Fluid Advertising on the Retail-Wholesale Subsystem (Government Supported Case).



*/ $P^{II} = f(P^{wf}, P^{wm} | Q_s^f)$

manufactured price. Finally, with the increase in class prices and the fluid utilization rate, the farm milk price increases leading to an increase in the subsequent farm milk supply.

As shown in the third column of Table 5, the variable most affected by fluid advertising (in percentage) is government quantity. Comparing to the no advertising scenario, fluid advertising reduces government purchases by 16.2% which amounts to a saving of $390,900 per quarter in 1987 dollars.[15] Fluid advertising also affects retail and wholesale fluid price significantly with the increase of 10.2% and 8.32%, respectively. The percentage changes in fluid quantity, wholesale manufactured supply, Class II price, and farm milk price are at rates of 2.74%, -1.44%, 2.24%, and 2.27%, respectively. The impact of fluid advertising on farm supply is small, only 0.25%. With an increase in the farm milk price and a small supply response, the farm level rate of return is estimated at $7.04 for every dollar spent in fluid advertising.[16]

Manufactured-Only Advertising Impacts

The variables positively affected by manufactured-only advertising are retail manufactured equilibrium quantity and wholesale manufactured

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15 Government costs are computed by multiplying the purchase price by government quantity. This is a conservative estimate because it does not consider storage, transportation, and other costs of the dairy price support program.

16 Given the predetermined farm milk supply for each period, the additional fluid quantity must come entirely from a reduction in the government purchases. As reported in the second column of Table 5, the average increase in fluid quantity is greater than the average reduction in government quantity. The discrepancy is due to the fact that farm supply response is allowed in the subsequent period. As will be shown later, the manufactured-only scenario does not induce farm supply response and, hence, the average increase in manufactured quantity equals the average reduction in government quantity.

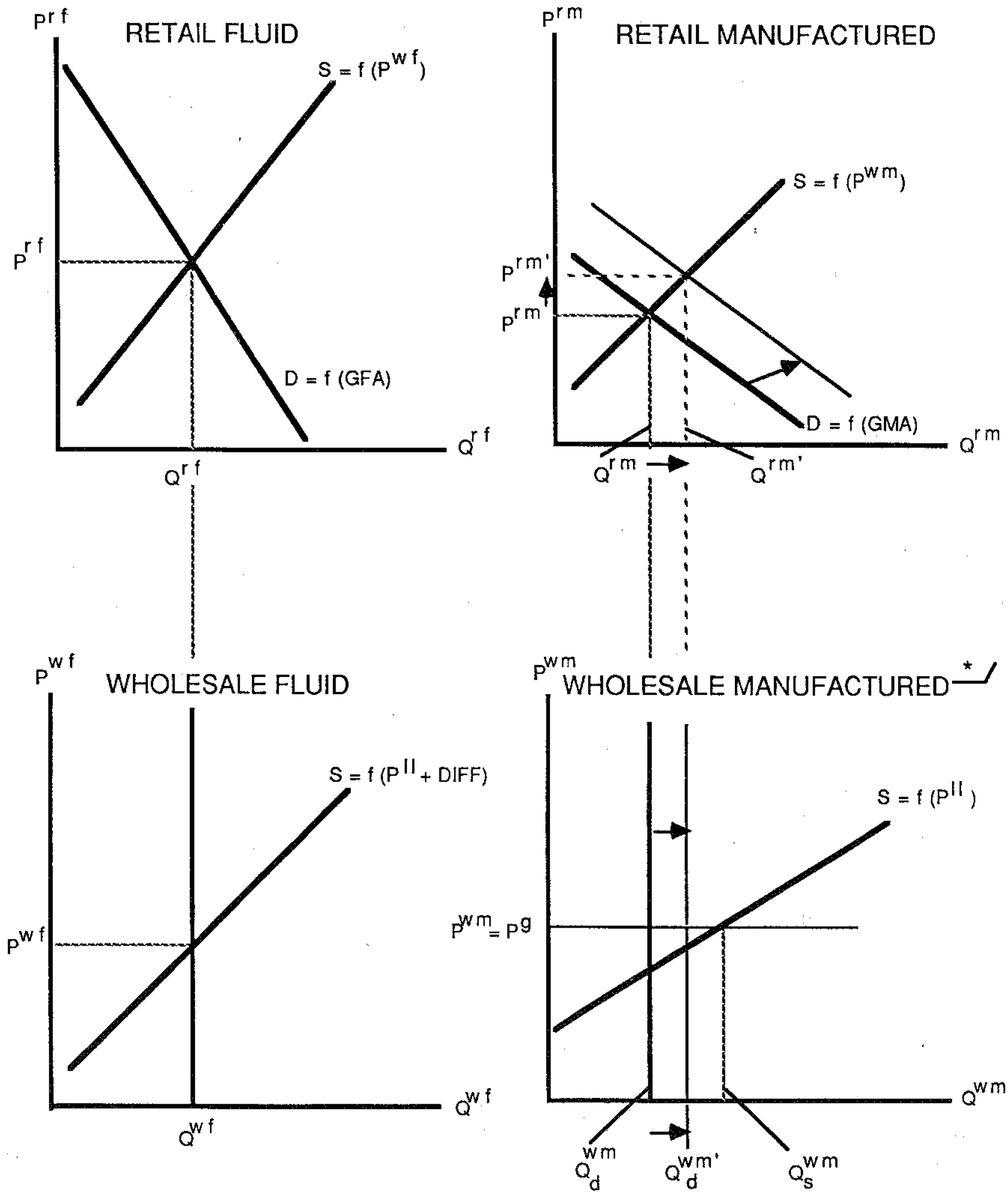
demand ($Q^{rm} = Q_d^{wm}$), and retail manufactured price (P^{rm}). The variable negatively affected by manufactured advertising is government quantity (Q^g). Other variables including wholesale manufactured supply (Q_s^{wm}) and wholesale manufactured price (P^{wm}) are not affected by manufactured advertising.

As illustrated in Figure 3, since manufactured advertising shifts the retail manufactured demand curve to the right, the equilibrium retail manufactured price and quantity must increase. Accordingly, the wholesale manufactured demand must also increase. However, due to the result that both the manufactured-only and the base scenario of no advertising yield only government support solutions, the increase in wholesale manufactured demand is not accompanied by an increase in the wholesale manufactured price. Since there is no change in the wholesale manufactured price, the retail manufactured supply curve does not shift. It also means no changes in the Class II price and, hence, the wholesale manufactured supply curve does not shift as well. As such, the quantity of wholesale manufactured supply stays the same and the government quantity decreases.

Since the Class II price does not change, the fluid market is not affected. Finally, since the class price and the fluid utilization rate stay the same, the farm milk price is unaffected and, hence, so is the subsequent farm milk supply.

As shown in the fifth column of Table 5, the variable most affected by manufactured advertising (in percentages) is government quantity. Compared to the no advertising scenario, manufactured advertising reduces the government purchases by 9.63% which amounts to a saving of $234,432 per quarter in 1987 dollars. The percentage changes

Figure 3: Impact of Manufactured Advertising on the Retail-Wholesale Subsystem (Government Supported Case).



*/ $P^{II} = f(P^{wf}, P^{wm} | Q_s^f)$

in commercial manufactured quantity and retail manufactured price are at rates of 0.99% and 0.77%, respectively. Since manufactured advertising results in only a replacement of government purchases by the increased private consumption, the corresponding farm level rate of return is zero.[17]

Combined Advertising Impacts

In the actual scenario of allowing for both fluid and manufactured advertisings, the variables negatively affected are wholesale manufactured supply (Q_s^{wm}) and government quantity (Q^g). All other variables are positively affected as compared with no advertising. Further, the above directions of the impact of combined strategy is consistent with those when combining the individual impacts of fluid-only and manufactured-only scenario. However, the magnitudes of the combined impact is not the sum of the individual impacts. Unlike previous scenarios, the combined advertising strategy results in some competitive solutions. Compared to the sum of the individual impacts of fluid-only and manufactured-only strategies, the added competition yields larger price impacts and smaller quantity impacts for those variables in the retail-wholesale subsystem.

To simplify the illustration, consider first the situation of changing from the manufactured-only strategy to the combined strategy

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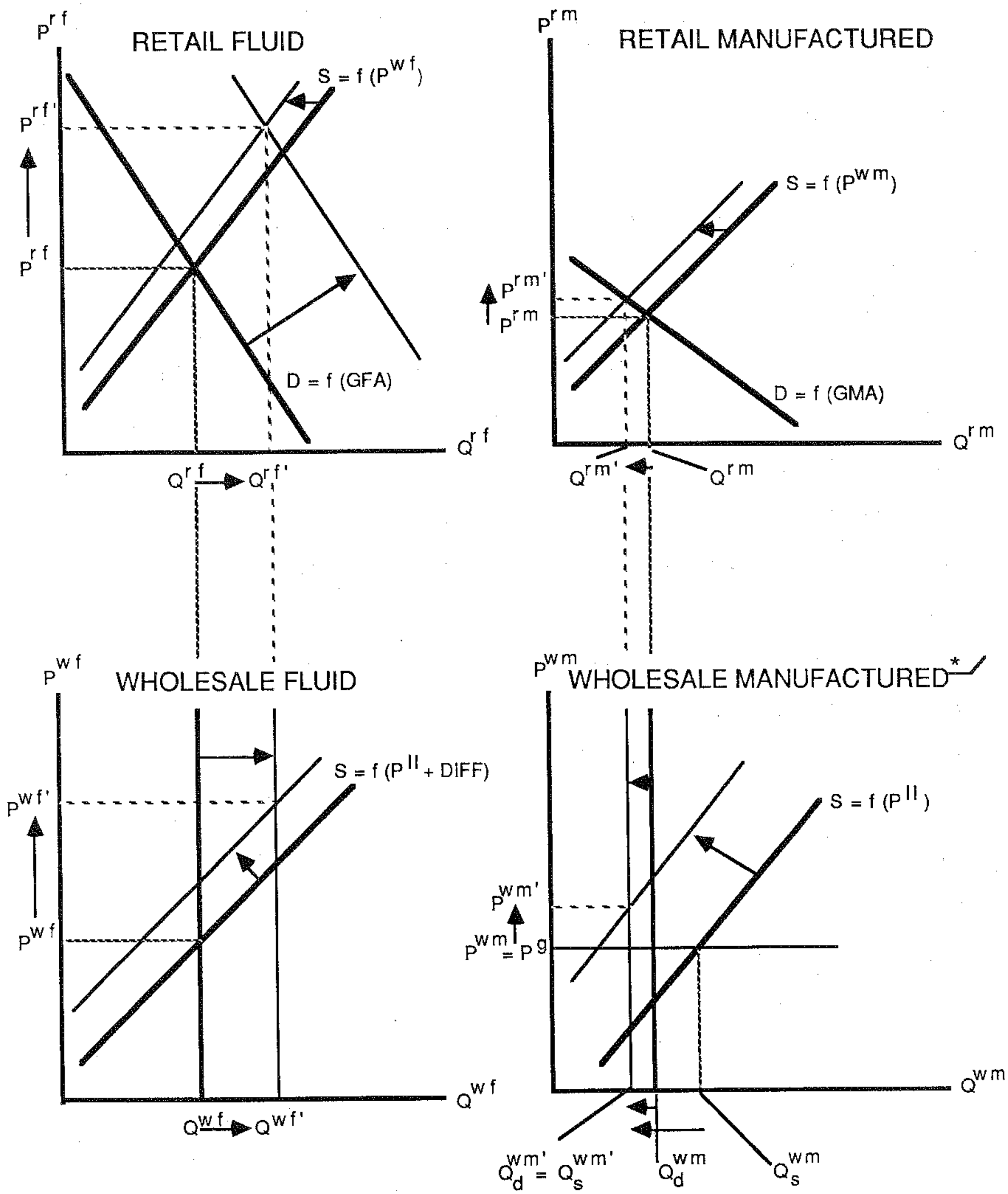
17 This ignores the fact that political goodwill may accrue when advertising efforts increase demand and thereby reduce government expenditures on the dairy support program. In light of the 1985 Food Security Act, which gives the Secretary of Agriculture the power to adjust dairy support prices in response to surplus levels, the potential for political goodwill is of increasing importance to dairy farmers. To account for the political economy of the dairy industry, one would need to include in the model the behavior of government in setting support prices.

(and hence only one retail demand curve is shifting). As illustrated in Figure 4, the additional fluid advertising causes an outward shift in the retail fluid demand curve and an increase in the equilibrium fluid quantity (both at the retail and wholesale level). With the increase in wholesale fluid quantity, the wholesale fluid price rises which causes a leftward shift in the retail fluid supply curve. The increase in wholesale fluid price also means that the Class II price must rise. As such, the wholesale fluid supply curve shifts to the left as well. Hence, the additional fluid advertising results in higher retail and wholesale fluid prices.

As to the manufactured market, the increase in Class II price means the wholesale manufactured supply curve must shift to the left. This results in a decrease in the wholesale manufactured supply quantity and an increase in the wholesale manufactured price which becomes greater than the government price. As a result of the price increase, the retail manufactured supply curve shifts to the left as well. Hence, the additional fluid advertising decreases retail manufactured quantity (and, hence, wholesale manufactured demand) and increases retail manufactured price.

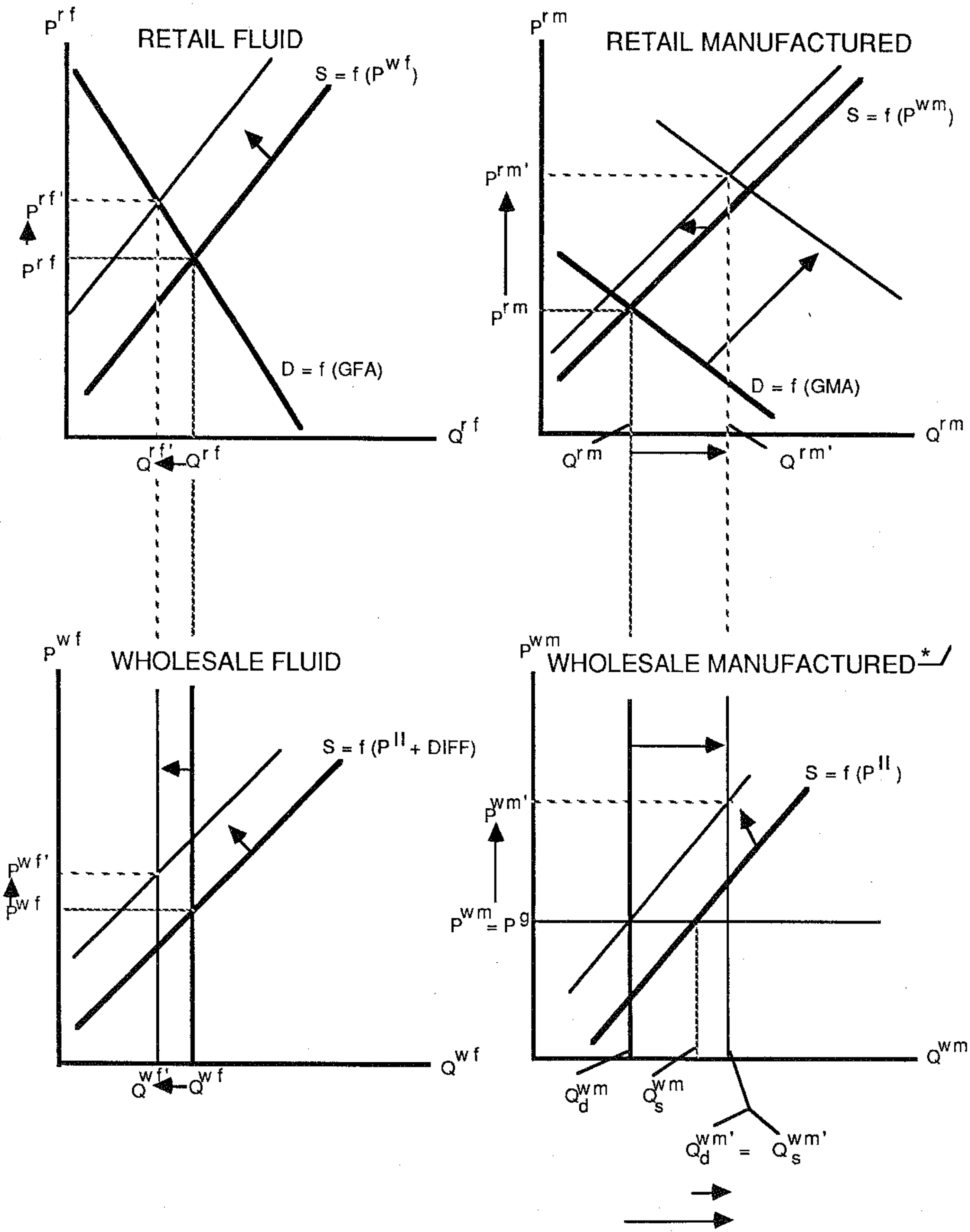
Now consider the case of changing from the fluid-only strategy to the combined strategy. As illustrated in Figure 5, the additional manufactured advertising causes an outward shift in the retail manufactured demand curve and results in a wholesale manufactured price greater than the government purchase price. Since the wholesale manufactured price is increased, the retail manufactured supply curve shifts to the left. The net result is an increase in the equilibrium retail manufactured price and quantity and, hence, the wholesale

Figure 4: Impact of Fluid Advertising on the Retail-Wholesale Subsystem (Competitive Case).



*/ $P^{ll} = f(P^{wf}, P^{wm} | Q_s^f)$

Figure 5: Impact of Manufactured Advertising on the Retail-Wholesale Subsystem (Competitive Case).



*/ $P^{II} = f(P^{wf}, P^{wm} | Q_s^f)$

manufactured demand. In addition, with an the increase in wholesale manufactured price, the Class II price must increase which requires the wholesale manufactured supply curve to shift to the left. The resulting wholesale manufactured supply quantity (and, hence, demand quantity) is greater than the supply quantity under fluid-only case.[18]

Regarding the fluid market, the increase in the Class II price implies a leftward shift in the wholesale fluid supply curve which results in an increase in the wholesale fluid price. This price increase indicates that the retail fluid supply curve must also shift to the left. Accordingly, the additional manufactured advertising increases fluid prices and decreases fluid quantities both at the retail and wholesale levels.

From the above discussion, the following conclusions hold when the market is competitive. Compared to the manufactured-only scenario, the additional fluid advertising in the combined advertising scenario has the effect of depressing the equilibrium manufactured quantity and enhancing the manufactured prices. Likewise, compared to the fluid-only scenario, the additional manufactured advertising in the combined advertising scenario has the effect of reducing the equilibrium fluid quantity and increasing the fluid prices. Since the combined advertising strategy adds some competitive solutions to the otherwise government supported market environment and since there are spillover effects from the fluid sector to the manufactured sector and vice versa

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18 The leftward shift in the wholesale manufactured supply curve can never result in a reduction in the wholesale manufactured supply quantity as this would require an increase in the fluid equilibrium quantity, given the predetermined farm milk supply. An increase in the fluid quantity would require a decrease in the Class II price which is not consistent with a rising wholesale manufactured price.

when the market is competitive, the impact of allowing for both types of advertising is not simply the sum of the individual impacts of fluid-only and manufactured-only strategy. The combined strategy yields larger price impacts and smaller quantity impacts for variables in the retail-wholesale subsystem.

As shown in the last column of Table 5, the variable most affected by combined advertising (in percentages) is government quantity. Compared to the no advertising scenario, the combined advertising strategy reduces the government purchases by 18.7% which amounts to a saving of $531,830 per quarter in 1987 dollars. The combined strategy also affects the retail fluid price and wholesale fluid price significantly at 10.5% and 8.71%, respectively. The percentage changes in fluid quantity, retail manufactured quantity and wholesale manufactured demand, wholesale manufactured supply, retail manufactured price, Class II price, and farm milk price are at rates of 2.67%, 0.85%, -1.21%, 0.92%, 3.15%, and 3.09%, respectively. The impact on wholesale manufacture price and farm milk supply are small with the percentage changes at 0.44%, and 0.34%, respectively. The farm rate of return for the combination of fluid and manufactured advertising is estimated at $4.77 for every dollar invested. Time plots of the impact of combined advertising on each of the endogenous variables can be found in Appendix D.

Summary

The purpose of this paper was to examine the impact of U.S. generic dairy advertising on milk price and milk volume at the retail, wholesale and farm level in the dairy sector. To improve on earlier studies, the analysis was based on a dairy industry model encompassing supply and demand conditions in various markets within the dairy sector and government intervention of the dairy price support program. Consequently, additional insights concerning the impact of generic dairy advertising were realized. The model were recursive in that the farm milk supply is predetermined in each period. The retail-wholesale subsystem was estimated simultaneously while the farm milk supply equation was estimated separately. The estimated model was used to simulate price and quantity values under four advertising scenarios: (1) no advertising, (2) historical fluid advertising, (3) historical manufactured advertising, and (4) historical fluid and manufactured advertising.

Compared to no advertising, the fluid-only scenario increased retail fluid sales by 2.74% while the manufactured-only scenario increased retail manufactured sales by 0.99%. The scenario of allowing for both fluid and manufactured advertising resulted in the market becoming competitive during some periods. In this latter scenario, due to the price effect of the added competition, the sales increase was reduced slightly to 2.67% for fluid milk and 0.85% for manufactured dairy products.

The farm level rate of return was estimated at $7.04 for every dollar spent in fluid-only advertising. The rate of return for manufactured-only advertising was zero because the strategy results in only a replacement of government purchases by the increased commercial consumption. With the scenario of both fluid and manufactured advertising, the overall farm level rate of return was $4.77. The fluid-only advertising reduced government purchases by 16.2%, which amounts to an average saving in government costs of about $390,900 per quarter in 1987 dollars. Manufactured-only advertising reduced government purchases by 9.63% with a saving of $234,432 per quarter. The actual scenario of combining fluid and manufactured advertisings resulted in a reduction of government purchases by 18.7% with a saving of $531,830 per quarter. In addition to the above, the following general conclusions regarding the impact of advertising emerged.

Fluid advertising increased price and quantity variables in the fluid sector. Given the predetermined farm milk supply in each simulation period, it also increased the Class II price and, hence, reduced the wholesale manufactured supply and government quantity in the manufactured sector. However, the impact of fluid advertising on other variables in the manufactured sector varied depending on whether the market was competitive or government supported. In the case where the government purchase price for manufactured dairy products is above the market price (government supported regime), other manufactured variables remain unchanged as they were insulated from the impact of fluid advertising by the binding government purchase price. On the other hand, if the market is competitive, fluid advertising increased the price variables and reduced the quantity variables in the manufactured sector. In both regimes, fluid advertising raised the farm milk price and subsequent farm milk supply since the Class II price and the fluid utilization rate were increased.

Manufactured advertising increased retail manufactured price and quantity and, hence, wholesale manufactured demand. However, its impact on other variables in the sector as well as those in the fluid sector depends on whether the market is competitive or government supported.

In the government supported case, manufactured advertising did not affect other variables in the manufactured sector as the binding government purchase price prevented the impact of the demand shock from reaching the rest of the sector. Further, since the wholesale manufactured price was not affected, the Class II price stayed the same which isolated the fluid sector from being affected by manufactured advertising. Consequently, the farm milk price and, hence, the subsequent farm milk supply remained unchanged. On the other hand, if the market is competitive, manufactured advertising increased other variables in the manufactured sector. Given the predetermined farm milk supply, the Class II price was also positively affected. Accordingly, the impact of manufactured advertising spilled over to the fluid sector with fluid prices positively affected and fluid quantities negatively influenced.

Compared to the previous studies, the dairy industry model provided additional insights into the way generic dairy advertising influences prices and quantities at the retail, wholesale, and farm level. To further the usefulness of the model, it is essential to improve the existing data base for advertising expenditure variables. The current advertising data are at best proxies. It is also useful to refine the model to include regional disaggregation. A national industry model with regional characteristics would enable researchers and program managers to assess the differential impact of the national and regional programs and determine the optimal expenditure pattern across regions.

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Appendix A: The Switching Simultaneous System Procedure

The dairy model is presented in equations (1) to (6) which contain supply and demand conditions in the retail, wholesale and farm markets. Since the farm milk supply in (6) is predetermined due to the assumption that farmers have naive price expectations, this equation can be estimated independent of the rest of the system. Other equations in the system has to be estimated by a switching simultaneous system procedure to avoid selectivity bias arising from the situation that the market is competitive in some periods and government supported in others. In this appendix, the dairy model is reproduced for conveniences followed by the estimation procedure for the switching system. A more detailed discussion can be found in Liu, Kaiser, Mount, and Forker.

The retail fluid supply, demand and equilibrium condition are:

(A1.1) $$Q_s^{rf} = \alpha_s^{rf} P^{rf} + \beta_s^{rf} P^{wf} + \gamma_s^{rf} Z_s^{rf} + \mu_s^{rf}$$

(A1.2) $$Q_d^{rf} = \beta_d^{rf} P^{rf} + \gamma_d^{rf} Z_d^{rf} + \mu_d^{rf}$$

(A1.3) $$Q_s^{rf} = Q_d^{rf} \equiv Q^{rf}$$

The retail manufactured supply, demand and equilibrium condition are:

(A2.1) $$Q_s^{rm} = \alpha_s^{rm} P^{rm} + \beta_s^{rm} P^{wm} + \gamma_s^{rm} Z_s^{rm} + \mu_s^{rm}$$

(A2.2) $$Q_d^{rm} = \beta_d^{rm} P^{rm} + \gamma_d^{rm} Z_d^{rm} + \mu_d^{rm}$$

(A2.3) $$Q_s^{rm} = Q_d^{rm} \equiv Q^{rm}$$

The wholesale fluid supply, demand and equilibrium condition are:

(A3.1) $$Q_s^{wf} = \alpha_s^{wf} P^{wf} + \beta_s^{wf} (P^{II} + DIFF) + \gamma_s^{wf} Z_s^{wf} + \mu_s^{wf}$$

(A3.2) $$Q_d^{wf} = Q^{rf}$$

(A3.3) $$Q_s^{wf} = Q_d^{wf} \equiv Q^{wf}$$

The wholesale manufactured supply, demand and equilibrium condition in the case where the market is competitive are:

(A4.1) $Q_s^{wm} = \alpha_s^{wm} P^{wm} + \beta_s^{wm} P^{II} + \gamma_s^{wm} Z_s^{wm} + \mu_s^{wm}$

(A4.2) $Q_d^{wm} = Q^{rm}$

(A4.3) $Q_s^{wm} = Q_d^{wm} + QSP + \Delta INV \equiv Q^{wm}$

On the other hand, if the market is government supported, the equilibrium condition of (A4.3) becomes:

(A4.3$_*$) $Q_s^{wm} = Q_d^{wm} + QSP + \Delta INV + Q^g \equiv Q^{wm}$

The government price intervention in the wholesale manufactured market requires:

(A5) $P^{wm} \geq P^g$

Given the predetermined farm milk supply Q_s^f, the retail-wholesale subsystem is closed by the following farm level equilibrium condition:

(A6) $Q_s^f = Q^{wf} + Q^{wm} + FUSE$

To summarize, the above subsystem encompasses two possible regimes. In the case of the market equilibrium regime, the endogenous variables are: retail manufactured demand and supply and wholesale manufactured demand ($Q_d^{rm} = Q_s^{rm} = Q_d^{wm}$), wholesale manufactured supply (Q_s^{wm}), retail and wholesale fluid supply and demand ($Q_d^{rf} = Q_s^{rf} = Q_d^{wf} = Q_s^{wf}$), retail manufactured price (P^{rm}), wholesale manufactured price (P^{wm}), retail fluid price (P^{rf}), wholesale fluid price (P^{wf}), and Class II price (P^{II}). The exogenous variables, denoted by Z, are:

$Z = (Z_s^{rm}, Z_d^{rm}, Z_s^{rf}, Z_d^{rf}, Z_s^{wm}, Z_s^{wf}, Q_s^f, DIFF, FUSE, QSP, \Delta INV)$

In the case of the government support regime, Q^g replaces P^{wm} as an endogenous variable in the above list, and the exogenous variables, denoted by Z_*, are

$Z_* = (Z, P^g)$

<u>The Switching System Estimation Procedure</u>

Taking the unconditional expectation of the structural equations (A1.1), (A1.2), (A2.1), (A2.2), (A3.1), and (A4.1) yields:

$$(A7.1)\quad E[Q_s^{rm}] = \alpha_s^{rm} E[P^{rm}] + \beta_s^{rm} E[P^{wm}] + \gamma_s^{rm} Z_s^{rm}$$

$$(A7.2)\quad E[Q_d^{rm}] = \beta_d^{rm} E[P^{rm}] + \gamma_d^{rm} Z_d^{rm}$$

$$(A7.3)\quad E[Q_s^{rf}] = \alpha_s^{rf} E[P^{rf}] + \beta_s^{rf} E[P^{wf}] + \gamma_s^{rf} Z_s^{rf}$$

$$(A7.4)\quad E[Q_d^{rf}] = \beta_d^{rf} E[P^{rf}] + \gamma_d^{rf} Z_d^{rf}$$

$$(A7.5)\quad E[Q_s^{wm}] = \alpha_s^{wm} E[P^{wm}] + \beta_s^{wm} E[P^{II}] + \gamma_s^{wm} Z_s^{wm}$$

$$(A7.6)\quad E[Q_s^{wf}] = \alpha_s^{wf} E[P^{wf}] + \beta_s^{wf} (E[P^{II}] + DIFF) + \gamma_s^{wf} Z_s^{wf}$$

The estimation procedure is analogous to conventional two-stage least squares, consisting of the following two steps. The first step is to estimate the expected prices in the right-hand-side of (A7.1) - (A7.6) to be used as price instruments. Once the price instruments are obtained, the second step involves a straightforward application of ordinary least squares to the structural equations (A1.1), (A1.2), (A2.1), (A2.2), (A3.1), and (A4.1) with the price instruments replacing the observed prices. The task is to obtain a consistent estimate of the reduced form price instruments.

Since the underlying market structures are different between regimes, there are two sets of reduced form equations with different endogenous variables (P^{wm} or Q^g) and different sets of exogenous variables (Z or Z_*). In the market equilibrium regime, the reduced form equations for the prices are:

$$(A8.1)\quad P^{wm} = \pi^{wm} Z + \epsilon^{wm} \quad > P^g$$

$$(A8.2)\quad P^i = \pi^i Z + \epsilon^i \qquad i = rm, rf, wf, II$$

In the government support regime, the reduced form equations are:

(A8.1$_*$) $P^{wm} = P^g$

(A8.2$_*$) $P^i = \pi_*^i \; Z_* + \epsilon_*^i$ i = rm, rf, wf, II

where equations (A8.2) and (A8.2$_*$) pertain to retail manufactured price, retail fluid price, wholesale fluid price, and Class II price. It is important to note that the parameters (π and π_*) and error terms (ϵ and ϵ_*) in (A8) and (A8$_*$) are different because the underlying market structures are different.

Consider first the reduced form equation for the wholesale manufactured price in (A8.1) and (A8.1$_*$). Since this price is constrained to not be less than the government purchase price, the use of ordinary least squares to estimate (A8.1) results in selectivity bias.

Define the probability that the government support solution occurs as Φ and the probability that the market equilibrium solution occurs as 1-Φ. That is,

$$\Phi \equiv PROB\ \{P^{wm} \leq P^g\}$$

$$1\text{-}\Phi \equiv PROB\ \{P^{wm} > P^g\}$$

Assuming that ϵ^{wm} is normally distributed, a consistent estimate of $E[P^{wm}|\ P^{wm} > P^g]$ can be obtained by using a maximum likelihood Tobit procedure on (A8.1) and can be expressed as (Maddala, 1983, p. 160):

(A9) $$E[P^{wm}|\ P^{wm} > P^g] = \pi^{wm} Z + \sigma\ \{\phi(c)/[1\text{-}\Phi(c)]\}$$

where $\Phi(c)$ and $\phi(c)$ are the cumulative standard normal and the standard normal density, both evaluated at c which is defined as $(P^g - \pi^{wm} Z) / \sigma$ and σ^2 is VAR[ϵ^{wm}]. The last term in (A9) is the Heckman correction term for selectivity bias.

Making use of the definition of Φ, the unconditional expectation (i.e., the instrument) of the wholesale manufactured price in (A7.1) and (A7.5) is:

(A10) $$E[P^{wm}] = (1-\Phi)\ E[P^{wm} | \ P^{wm} > P^{g}] + \Phi\ P^{g}$$

Then, by substituting (A9) into (A10), the price instrument for the wholesale manufactured price is:

(A11) $$E[P^{wm}] = (1-\Phi)\ \pi^{wm}\ Z + \Phi\ P^{g} + \sigma\ \phi$$

Now consider the reduced form equations for the unconstrained prices (i.e., retail manufactured price, retail fluid price, wholesale fluid price, and Class II price) in (A8.2) and (A8.2_*). Combining the two reduced form equations for the two solution regimes weighted by their respective probabilities, and taking the unconditional expectation of the resulting expression yields:

(A12) $$E[P^{i}] = (1-\Phi)\ \{\pi^{i}\ Z + E[\epsilon^{i} | \ P^{wm} > P^{g}]\} + \Phi\ \{\pi^{i}_{*}\ Z_{*} + E[\epsilon^{i}_{*} | \ P^{wm} \leq P^{g})\}$$

Assuming the joint density of ϵ^{wm} and ϵ^{i} is bivariate normal and making use of (A8.1), the following holds:*/

(A13) $$E[\epsilon^{i} | \ P^{wm} > P^{g}] = E[\epsilon^{i} | \ \epsilon^{wm} > P^{g} - \pi^{wm}\ Z] = (\sigma^{i}/\sigma)\ \{\phi(c)/[1-\Phi(c)]\}$$

where σ^{i} is $COV[\epsilon^{wm}\ \epsilon^{i}]$.

Similarly, assuming the joint density of ϵ^{wm} and ϵ^{i}_{*} is bivariate normal and making use of (A8.1), the following holds:

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*/ Assuming that the joint density of x and y is bivariate normal with zero means, Johnson and Kotz show that

$E[x | \ y > z] = \{ COV[x,y] \ / \ SD[y] \}\ \{ \phi(\xi) \ / \ (1- \Phi(\xi)) \}$, and

$E[x | \ y < z] = - \{ COV[x,y] \ / \ SD[y] \}\ \{ \phi(\xi) \ / \ \Phi(\xi) \}$,

where COV and SD are the covariance and standard deviation operators and ξ is defined as $z/SD[y]$.

(A14) $E[\epsilon_{*}^{i} | P^{wm} \leq P^{g}] = E[\epsilon_{*}^{i} | \epsilon^{wm} \leq Pg - pwm Z]$

$= - (\sigma_{*}^{i}/\sigma) \{\phi(c)/\Phi(c)\}$

where σ_{*}^{i} is $COV[\epsilon^{wm} \epsilon_{*}^{i}]$.

The price instrument for the retail manufactured price may be obtained by substituting (A13) and (A14) into (A12) to give:

(A15) $E[P^{i}] = \pi^{i} [(1-\Phi) Z] + \pi_{*}^{i} [\Phi Z_{*}] + (\sigma^{i} - \sigma_{*}^{i}) [\phi/\sigma]$

With estimates of Φ, ϕ, and σ from the Tobit estimation in (A9), the parameters π^{i}, π_{*}^{i}, and $(\sigma^{i}-\sigma_{*}^{i})$ in (A15) can be estimated by ordinary least squares with the observed values of P^{i} replacing $E[P^{i}]$ in (A15).

To summarize, rather than regressing each endogenous variable on all exogenous variables to obtain the price instrument, the reduced form equation for the wholesale manufactured price should be estimated by a Tobit procedure while those for other endogenous prices should be fitted to a weighted average of the exogenous variables from each regime with a Heckman-like correction term appended.

Appendix B: The Data and Sources

The data used to estimate the equations of the dairy industry are presented in Tables B.1 and B.2. The sources for the data are listed below. In the table, the number in parentheses corresponds to the sources that the data were collected from.

(1) Bureau of Economic Statistics, Inc., Economic Statistics Bureau of Washington, D.C., *Handbook of Basic Economic Statistics.* Washington, D.C., 1970-88.

(2) U.S. Department of Labor, Bureau of Labor Statistics, *Consumer Price Index.* Washington D.C., 1970-88.

(3) U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings.* Washington D.C., 1970-88.

(4) U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Index (and Wholesale Price Index).* Washington D.C., 1970-88.

(5) Leading National Advertisers, Inc., *Leading National Advertisers. Expenditures include network television, cable network television, spot television, network radio, magazine, newspaper, and outdoor advertising for the following generic dairy promotion units: American Dairy Association, California Milk Producers Advisory Board, National Dairy Promotion and Research Board, Oregon Dairy Products Commission, United Dairymen of Arizona, Washington Dairy Products Commission, and Wisconsin Milk Marketing board. Expenditures also include joint venture of the COW Group.*

(6) U.S. Department of Agriculture, Economic Research Service, *Dairy Situation and Outlook.* Washington D.C., 1970-88.

(7) U.S. Department of Agriculture, Agricultural Marketing Service, *Federal Milk Order Market Statistics.* Washington D.C., 1970-88.

(8) U.S. Department of Agriculture, Economics, Statistics, and Cooperative Service, *Agricultural Prices.* Washington D.C., 1970-88.

(9) Manufactured retail supply and demand, and wholesale demand is computed based on the following equation:

$$Q_s^{rm} = Q_d^{rm} = Q_d^{wm} = Q_s^f - Q^{rf} - Q^g - QSP - DINV - FUSE$$

where Q_s^f is milk production, Q^{rf} is retail fluid sales, Q^g is government purchases of dairy products, QSP specialized plant sales to government, DINV is change in commercial inventories, and FUSE is on-farm use of milk.

(10) Manufactured wholesale supply is computed from the following equation:

$$Q_s^{wm} = Q_s^f - Q^{wf} - FUSE$$

(11) The retail manufacturing price index was constructed as a weighted average of the retail cheese, butter, and ice cream price indices reported in *Dairy Situation and Outlook*, 1970-88.

(12) The manufacturing purchase price and wholesale price were constructed using data reported in *Dairy Situation and Outlook*, 1970-88. See Appendix C for the procedures of constructing these two prices.

Table B1: Data used for the Retail-Wholesale Subsystem

YEAR AND QUARTER	FLUID RETAIL AND WHOLESALE SUPPLY AND DEMAND (BIL LBS)	MANUFACT RETAIL SUPPLY AND DEMAND AND & WHOLESALE DEMAND (BIL LBS)	MANUFACT WHOLESALE SUPPLY (BIL LBS)	GOV'T PURCHASES OF MANF PRODUCTS (BIL LBS)	RETAIL FLUID PRICE INDEX (1967=100)	RETAIL MANUFACT PRICE INDEX (1967=100)	WHOLESALE FLUID PRICE INDEX (1967=100)	WHOLESALE MANUFACT PRICE ($/CWT)
1975.1	16.08	10.70	11.27	1.10	153.90	144.36	128.00	7.75
1975.2	15.13	14.33	15.44	1.20	151.07	145.38	128.40	8.10
1975.3	17.19	11.37	10.60	-0.30	150.20	150.14	129.50	8.93
1975.4	17.83	9.73	8.75	0.00	155.60	164.93	132.70	10.10
1976.1	16.38	12.07	12.05	0.00	160.37	174.23	137.50	9.39
1976.2	14.90	15.29	16.72	0.10	159.83	172.45	137.93	9.51
1976.3	15.79	12.57	13.60	0.10	159.83	178.12	138.67	10.04
1976.4	16.99	10.27	10.75	1.10	162.73	179.35	140.70	9.32
1977.1	14.87	12.34	14.17	2.10	161.63	177.33	139.47	9.32
1977.2	13.54	15.29	18.82	2.60	161.77	181.60	140.73	9.89
1977.3	15.96	13.14	14.19	1.10	162.33	184.55	142.07	9.91
1977.4	17.09	12.27	11.22	0.30	163.63	186.94	143.10	10.02
1978.1	15.38	12.73	13.64	1.20	165.53	190.70	144.63	10.12
1978.2	15.36	14.09	16.54	1.90	169.93	195.70	148.60	10.40
1978.3	15.99	13.72	13.70	-0.10	172.67	200.56	151.60	10.87
1978.4	17.02	12.08	11.13	-0.20	178.70	209.50	158.50	11.69
1979.1	15.77	13.08	13.36	0.20	185.33	216.52	165.10	11.78
1979.2	14.20	15.76	17.95	1.10	188.00	221.25	167.17	12.15
1979.3	15.39	14.49	15.05	0.00	192.73	226.61	170.80	12.67
1979.4	16.82	12.14	12.31	0.80	199.73	234.10	175.87	12.73
1980.1	15.07	14.43	15.55	1.47	203.17	238.19	178.90	12.78
1980.2	12.76	15.56	20.70	4.42	207.33	245.26	181.43	13.26
1980.3	14.90	15.36	16.71	1.50	209.63	252.99	183.50	13.41
1980.4	15.67	13.73	14.73	1.40	213.60	261.79	188.03	14.19
1981.1	13.37	13.99	18.52	4.28	219.13	268.05	193.97	14.09
1981.2	12.91	16.64	21.68	4.80	220.63	270.77	193.87	14.07
1981.3	14.60	16.18	17.91	2.12	220.30	271.98	194.23	14.11
1981.4	15.03	15.25	16.43	1.65	220.73	273.25	195.57	14.20
1982.1	13.07	14.70	19.50	4.66	221.47	276.17	196.80	13.98
1982.2	12.78	17.18	22.20	4.89	221.83	277.49	197.67	13.93
1982.3	14.05	17.43	19.28	2.65	221.20	279.03	198.13	14.00
1982.4	14.76	15.16	17.47	2.09	221.20	279.57	198.87	14.20
1983.1	12.19	15.50	21.38	5.64	223.50	281.16	199.80	14.01
1983.2	12.14	18.08	24.08	5.78	223.20	282.54	199.83	13.96
1983.3	13.75	17.49	20.59	3.12	222.87	282.89	199.47	14.02
1983.4	14.59	16.57	18.54	2.28	222.10	283.73	199.57	14.10
1984.1	13.26	15.59	19.97	4.46	222.97	282.94	199.67	13.72
1984.2	13.53	18.41	21.34	2.77	223.30	283.18	199.43	13.77
1984.3	14.99	17.10	17.77	0.84	223.73	288.69	200.17	14.18
1984.4	15.80	15.70	15.92	0.56	228.37	292.30	203.83	14.21

Table B1 (cont.): Data used for the Retail-Wholesale Subsystem

YEAR AND QUARTER	FLUID RETAIL AND WHOLESALE SUPPLY AND DEMAND (BIL LBS)	MANUFACT RETAIL SUPPLY AND DEMAND AND & WHOLESALE DEMAND (BIL LBS)	MANUFACT WHOLESALE SUPPLY (BIL LBS)	GOV'T PURCHASES OF MANF PRODUCTS (BIL LBS)	RETAIL FLUID PRICE INDEX (1967=100)	RETAIL MANUFACT PRICE INDEX (1967=100)	WHOLESALE FLUID PRICE INDEX (1967=100)	WHOLESALE MANUFACT PRICE ($/CWT)
1985.1	13.52	15.17	19.48	4.11	229.70	293.92	205.43	13.60
1985.2	13.00	19.37	23.77	4.24	228.83	292.51	203.77	13.04
1985.3	14.49	18.93	21.57	2.62	227.57	294.01	201.90	12.67
1985.4	15.44	17.58	19.37	2.21	226.23	293.70	204.23	12.60
1986.1	14.17	16.27	21.35	5.04	225.85	294.07	200.93	12.65
1986.2	13.44	17.52	22.08	4.23	225.73	293.00	201.03	12.70
1986.3	14.61	19.59	20.35	0.87	226.47	295.20	202.27	13.07
1986.4	15.71	17.58	17.36	0.49	228.55	297.73	206.03	13.29
1987.1	13.98	17.32	20.19	2.71	230.30	302.10	209.30	12.34
1987.2	13.86	20.77	22.89	1.50	229.90	302.70	206.07	12.43
1987.3	14.61	19.56	20.25	0.65	230.10	303.80	206.00	12.75
1987.4	14.95	17.98	19.13	1.84	233.90	305.50	208.77	12.11
SOURCE:	(7)	(9)	(10)	(6)	(1)	(11)	(4)	(12)

Table B1 (cont.): Data used for the Retail-Wholesale Subsystem

YEAR AND QUARTER	AGGREGATE PURCHASE PRICE ($/CWT)	CLASS II PRICE ($/CWT)	CLASS I PRICE DIFFER-ENTIAL ($/CWT)	RETAIL BEVERAGE PRICE INDEX (1967=100)	RETAIL MEAT PRICE INDEX (1967=100	RETAIL FOOD AWAY FROM HOME PRICE INDEX (1967=100)	FUEL AND ENERGY PRICE INDEX (1967=100)	AVERAGE HOURLY MANF WAGE ($/HR)
1975.1	7.75	6.84	2.07	176.70	162.67	170.27	233.00	4.49
1975.2	8.02	7.02	1.96	176.07	169.07	172.70	243.00	4.56
1975.3	8.02	7.77	1.47	175.70	188.63	175.33	254.90	4.63
1975.4	8.58	8.84	1.43	187.30	191.17	185.07	258.00	4.73
1976.1	8.64	8.58	2.45	191.93	183.23	181.87	255.70	4.86
1976.2	8.94	8.35	2.18	203.33	180.63	184.73	260.30	4.92
1976.3	8.95	8.72	1.82	222.37	181.60	187.80	270.90	5.01
1976.4	9.21	8.26	2.41	238.43	172.33	190.07	279.00	5.10
1977.1	9.24	8.22	2.12	272.60	174.00	187.40	293.70	5.24
1977.2	9.89	8.61	1.86	331.57	176.33	199.13	304.30	5.31
1977.3	9.91	8.68	2.05	347.30	181.43	202.80	309.90	5.40
1977.4	10.02	8.80	2.01	338.30	181.63	205.40	312.00	5.52
1978.1	10.04	9.00	1.96	339.43	188.77	210.33	315.30	5.67
1978.2	10.40	9.25	1.97	342.03	204.13	215.87	323.20	5.74
1978.3	10.52	9.64	1.75	340.70	210.37	221.60	326.70	5.83
1978.4	10.98	10.41	1.61	341.00	214.07	225.97	334.30	5.96
1979.1	10.98	10.55	2.07	346.77	230.87	233.20	350.90	6.10
1979.2	11.87	10.69	2.00	349.13	240.67	240.73	393.70	6.20
1979.3	11.86	11.09	1.78	361.37	233.40	246.33	454.80	6.29
1979.4	12.66	11.29	2.03	373.93	232.00	251.43	487.90	6.47
1980.1	12.65	11.44	2.00	383.37	237.33	258.43	553.50	6.64
1980.2	13.26	11.67	1.98	393.07	232.60	264.73	576.50	6.80
1980.3	13.41	11.89	1.91	401.37	244.63	269.57	593.50	6.91
1980.4	14.19	12.52	1.70	405.20	254.40	275.37	615.70	7.04
1981.1	14.09	12.66	2.05	411.27	252.70	283.90	696.50	7.23
1981.2	14.07	12.61	2.15	413.17	247.80	289.37	707.60	7.39
1981.3	14.11	12.49	2.20	412.37	255.87	293.63	703.50	7.50
1981.4	14.20	12.53	2.09	413.57	254.77	297.03	702.50	7.60
1982.1	13.98	12.49	2.21	422.30	255.80	301.13	689.70	7.78
1982.2	13.93	12.43	2.17	424.83	261.77	304.77	677.30	7.92
1982.3	14.00	12.44	2.13	423.60	267.23	308.70	700.40	7.88
1982.4	14.20	12.58	2.06	426.00	263.43	311.57	703.40	7.98
1983.1	14.01	12.58	2.18	432.00	263.73	315.40	670.10	8.14
1983.2	13.96	12.51	2.19	431.30	263.17	318.63	654.10	8.21
1983.3	14.02	12.49	2.17	430.20	259.30	321.00	670.90	8.16
1983.4	14.10	12.40	2.25	435.10	257.67	324.73	663.70	8.25
1984.1	13.72	12.06	2.33	441.47	270.50	328.50	655.60	8.37
1984.2	13.72	12.08	2.15	442.53	267.03	332.20	660.40	8.41
1984.3	13.73	12.37	1.90	442.73	264.93	335.23	658.40	8.36
1984.4	13.73	12.63	2.08	445.23	263.93	337.83	652.70	8.40

Table B1 (cont.): Data used for the Retail-Wholesale Subsystem

YEAR AND QUARTER	AGGREGATE PURCHASE PRICE ($/CWT)	CLASS II PRICE ($/CWT)	CLASS I PRICE DIFFER-ENTIAL ($/CWT)	RETAIL BEVERAGE PRICE INDEX (1967=100)	RETAIL MEAT PRICE INDEX (1967=100	RETAIL FOOD AWAY FROM HOME PRICE INDEX (1967=100)	FUEL AND ENERGY PRICE INDEX (1967=100)	AVERAGE HOURLY MANF WAGE ($/HR)
1985.1	13.60	12.19	2.54	452.03	266.57	341.30	629.10	8.54
1985.2	13.04	11.43	2.67	453.20	261.07	345.30	640.60	8.60
1985.3	12.67	11.10	2.31	450.20	260.27	348.53	630.50	8.53
1985.4	12.60	11.19	2.10	451.53	265.70	351.23	634.10	8.61
1986.1	12.65	11.06	2.27	472.50	269.95	353.65	566.50	8.73
1986.2	12.70	10.99	2.46	482.47	264.23	358.67	483.60	8.76
1986.3	12.75	11.31	2.25	476.97	280.87	361.97	445.10	8.70
1986.4	12.77	11.83	2.24	477.20	285.60	364.90	439.00	8.79
1987.1	12.34	11.33	3.06	479.97	287.37	369.70	468.80	8.91
1987.2	12.43	11.02	2.64	466.77	288.37	372.53	485.30	8.94
1987.3	12.52	11.29	2.26	458.57	294.77	376.07	506.20	8.88
1987.4	12.11	11.27	2.64	458.65	293.75	379.00	506.40	8.95
SOURCE:	(12)	(7)	(7)	(2)	(2)	(2)	(4)	(1)

Table B1 (cont.): Data used for the Retail-Wholesale Subsystem

YEAR AND QUARTER	DISPOS PERSONAL INCOME (BIL $)	UNEMPLOY-MENT RATE (%)	CIVILIAN POPULA-TION (MIL)	GENERIC FLUID AD-VERTISING EXPEND ($1000)	GENERIC MANF AD-VERTISING EXPEND ($1000)	ON-FARM MILK USE (BIL LBS)	COMMERCIAL INVENTORIES (BIL LBS)
1975.1	10,352	8.40	215.50	3,523	0	0.77	5.12
1975.2	11,052	8.80	216.00	3,504	0	0.77	5.02
1975.3	11,094	8.60	216.50	2,618	0	0.77	4.55
1975.4	11,345	8.50	217.00	3,502	0	0.77	3.56
1976.1	11,637	7.60	217.60	3,356	0	0.75	3.54
1976.2	11,808	7.40	218.10	3,859	0	0.75	4.86
1976.3	12,033	7.80	218.70	3,320	0	0.75	5.80
1976.4	12,296	7.90	219.20	4,064	0	0.75	5.19
1977.1	12,552	7.40	219.80	4,087	0	0.70	4.92
1977.2	12,919	7.10	220.30	4,044	0	0.70	5.86
1977.3	13,355	6.90	220.90	3,463	0	0.70	5.81
1977.4	13,735	6.60	221.50	4,828	0	0.70	4.45
1978.1	14,057	6.20	222.10	4,426	0	0.68	4.16
1978.2	14,513	6.00	222.70	3,940	0	0.68	4.71
1978.3	14,962	6.00	223.30	2,633	0	0.68	4.79
1978.4	15,427	5.80	223.90	5,361	0	0.68	4.03
1979.1	15,875	5.70	224.60	4,081	0	0.63	4.11
1979.2	16,240	5.80	225.10	5,892	0	0.63	5.20
1979.3	16,743	5.90	225.80	4,651	0	0.63	5.75
1979.4	17,149	5.90	226.40	5,329	0	0.63	5.12
1980.1	17,717	6.10	227.10	4,492	0	0.57	4.77
1980.2	17,898	7.40	227.70	5,722	88	0.57	5.49
1980.3	18,460	7.50	228.20	4,896	74	0.57	5.35
1980.4	19,080	7.50	228.80	7,593	50	0.57	4.94
1981.1	19,725	8.50	229.30	3,381	10	0.57	5.18
1981.2	20,060	7.90	229.80	3,269	60	0.57	5.43
1981.3	20,786	8.00	230.40	4,457	5	0.57	5.04
1981.4	21,098	8.60	230.90	5,887	119	0.57	4.57
1982.1	22,072	10.30	231.50	3,775	140	0.60	4.72
1982.2	22,418	10.30	232.00	4,756	19	0.60	4.85
1982.3	22,786	10.80	232.50	3,968	19	0.60	4.05
1982.4	23,181	11.30	233.00	8,372	76	0.60	4.26
1983.1	23,457	12.30	233.70	722	76	0.60	4.50
1983.2	23,954	11.10	234.20	659	86	0.60	4.73
1983.3	24,432	10.30	234.70	641	4	0.60	4.71
1983.4	25,279	9.30	235.30	596	1	0.60	4.40
1984.1	26,118	9.40	236.10	3,208	532	0.73	4.32
1984.2	26,428	8.40	236.70	8,411	1,928	0.73	4.48
1984.3	26,911	8.40	237.20	1,054	563	0.73	4.30
1984.4	27,286	8.00	237.80	16,764	946	0.73	3.97

Table B1 (cont.): Data used for the Retail-Wholesale Subsystem

YEAR AND QUARTER	DISPOS PERSONAL INCOME (BIL $)	UNEMPLOY-MENT RATE (%)	CIVILIAN POPULA-TION (MIL)	GENERIC FLUID AD-VERTISING EXPEND ($1000)	GENERIC MANF AD-VERTISING EXPEND ($1000)	ON-FARM MILK USE (BIL LBS)	COMMERCIAL INVENTORIES (BIL LBS)
1985.1	27,622	8.70	238.40	17,579	20,153	0.63	4.16
1985.2	28,484	8.30	238.90	15,394	14,035	0.63	4.33
1985.3	28,472	8.30	239.50	11,007	3,958	0.63	4.36
1985.4	29,066	7.80	240.10	15,505	16,235	0.63	3.93
1986.1	29,660	8.70	240.60	17,052	15,545	0.65	3.97
1986.2	30,224	8.40	241.20	16,951	16,854	0.65	4.30
1986.3	30,382	8.20	241.70	8,393	3,119	0.65	4.19
1986.4	30,616	7.70	242.40	20,390	17,339	0.65	3.48
1987.1	31,259	8.40	242.90	14,750	14,786	0.65	3.64
1987.2	31,306	7.40	243.40	15,334	19,474	0.65	4.25
1987.3	31,935	7.10	244.00	8,991	6,888	0.65	4.28
1987.4	32,576	7.20	244.60	12,129	19,710	0.65	3.60
SOURCE:	(3)	(3)	(1)	(5)	(5)	(6)	(6)

Table B2: Data Used for the Farm Milk Supply Equation

YEAR AND QUARTER	MILK PRO-DUCTION (BIL LBS)	FARM MILK PRICE ($/CWT)	FARM WAGE INDEX (1977=100)	PRICE OF 16% PROTEIN FEED RATION ($/TON)	CONSUMER PRICE INDEX ALL ITEMS (1967=100)
1970.1	28.36	5.94	55.00	74.00	113.90
1970.2	32.06	5.61	57.00	73.00	115.73
1970.3	29.15	5.87	56.00	74.33	117.03
1970.4	27.44	6.19	58.00	77.67	118.57
1971.1	28.80	5.98	58.00	80.33	119.47
1971.2	32.41	5.80	60.00	80.00	120.83
1971.3	29.48	5.98	59.00	78.33	122.13
1971.4	27.88	6.21	61.00	76.00	122.77
1972.1	29.59	6.17	60.00	77.67	123.67
1972.2	32.82	5.96	64.00	77.33	124.67
1972.3	29.89	6.25	63.00	79.33	125.80
1972.4	27.75	6.63	65.00	86.67	126.93
1973.1	28.67	6.70	65.00	100.33	128.70
1973.2	31.80	6.69	70.00	105.00	131.53
1973.3	28.40	7.37	69.00	118.67	134.43
1973.4	26.63	8.65	71.00	126.33	137.57
1974.1	28.09	9.27	78.00	133.33	141.43
1974.2	31.60	8.47	77.00	125.33	145.57
1974.3	29.02	7.70	79.00	142.00	150.13
1974.4	26.88	8.07	80.00	150.00	154.30
1975.1	28.13	8.05	84.00	138.33	157.03
1975.2	31.34	8.00	84.00	132.00	159.50
1975.3	28.56	8.68	85.00	133.33	162.90
1975.4	27.35	9.80	86.00	134.33	165.50
1976.1	29.18	9.99	94.00	136.00	167.10
1976.2	32.36	9.38	92.00	138.33	169.17
1976.3	30.14	9.70	94.00	145.67	171.87
1976.4	28.50	9.73	91.00	144.33	173.80
1977.1	29.74	9.30	101.00	148.67	176.87
1977.2	33.06	9.38	99.00	149.67	180.67
1977.3	30.85	9.76	102.00	133.67	183.30
1977.4	29.00	10.01	97.00	129.67	185.33
1978.1	29.69	10.04	108.00	135.00	188.47
1978.2	32.58	10.20	109.00	137.67	193.37
1978.3	30.36	10.58	107.00	137.33	197.93
1978.4	28.82	11.38	105.00	142.00	201.93
1979.1	29.76	11.68	117.00	148.67	206.97
1979.2	32.78	11.57	117.00	150.33	214.07
1979.3	31.06	11.99	117.00	160.33	221.13
1979.4	29.75	12.46	117.00	163.67	227.60

Table B2 (cont.): Data Used for the Farm Milk Supply Equation

YEAR AND QUARTER	MILK PRODUCTION (BIL LBS)	FARM MILK PRICE ($/CWT)	FARM WAGE INDEX (1977=100)	PRICE OF 16% PROTEIN FEED RATION ($/TON)	CONSUMER PRICE INDEX ALL ITEMS (1967=100)
1980.1	31.20	12.42	126.00	164.33	236.47
1980.2	34.04	12.43	126.00	165.33	245.00
1980.3	32.19	12.79	126.00	179.33	249.63
1980.4	30.98	13.39	126.00	198.33	256.17
1981.1	32.47	13.51	137.00	200.00	262.93
1981.2	35.17	13.42	137.00	198.00	269.03
1981.3	33.09	13.48	137.00	188.67	276.73
1981.4	32.04	13.53	137.00	181.33	280.70
1982.1	33.17	13.37	144.00	180.00	283.00
1982.2	35.58	13.23	144.00	179.67	287.33
1982.3	33.92	13.34	144.00	176.67	292.77
1982.4	32.83	13.52	144.00	172.33	293.37
1983.1	34.17	13.37	148.00	175.67	293.23
1983.2	36.83	13.24	148.00	183.33	296.90
1983.3	34.94	13.35	148.00	189.67	300.47
1983.4	33.73	13.39	148.00	203.00	303.07
1984.1	33.95	12.99	151.00	201.67	306.37
1984.2	35.59	12.91	151.00	197.00	309.73
1984.3	33.49	13.24	154.00	188.00	313.07
1984.4	32.45	13.66	150.00	177.33	315.37
1985.1	33.63	13.23	154.00	174.33	317.43
1985.2	37.39	12.37	158.00	169.67	321.23
1985.3	36.68	12.03	154.00	165.33	323.60
1985.4	35.43	12.13	150.00	163.33	326.50
1986.1	36.17	11.97	150.00	167.00	327.95
1986.2	36.17	11.92	164.00	164.00	326.50
1986.3	35.61	12.25	166.00	159.00	328.93
1986.4	33.72	12.89	159.00	151.00	330.65
1987.1	34.82	12.58	159.00	153.00	334.47
1987.2	37.40	12.02	160.00	152.00	338.83
1987.3	35.51	12.24	161.00	154.00	342.63
1987.4	34.73	12.43	162.00	156.00	345.55
SOURCE:	(6)	(6)	(8)	(8)	(2)

Appendix C:

Construction of the Aggregate Purchase Price and Wholesale Manufactured Price

Because the model aggregates all manufactured dairy products into one product, an aggregate purchase price and wholesale manufactured price needed to be constructed. The aggregate purchase price (P^g) and aggregate wholesale manufactured price (P^{wm}) were constructed using the following procedures.

First, purchase prices and wholesale prices for cheese, butter, and nonfat dry milk were converted from a price per pound of product basis to a value of product per hundred pounds of raw milk basis. This resulted in all prices being measured on a milk equivalent basis. The following formulas were used to make these conversions:

$$P^{wc}_{me}/cwt = P^{wc}/lb * 10.1$$

$$P^{wb}_{me}/cwt = P^{wb}/lb * 4.48$$

$$P^{wnf}_{me}/cwt = P^{wnf}/lb * 8.13$$

where:

P^{wc}_{me} = wholesale value (purchase price or wholesale price) of 100 pounds of raw milk used in cheese production,

P^{wc} = purchase price or wholesale market price of cheese per pound,

10.1 = yield factor for cheese (100 pounds of raw milk yields 10.1 pounds of cheese),

P^{wb}_{me} = wholesale value (purchase price or wholesale price) of 100 pounds of raw milk used in butter production,

P^{wb} = purchase price or wholesale market price of butter per pound,

4.48 = yield factor for butter,

P^{wnf}_{me} = wholesale value (purchase price or wholesale price) of 100 pounds of raw milk used in nonfat dry milk production,

P^{wnf} = purchase price or wholesale market price of nonfat dry milk per pound,

8.13 = yield factor for nonfat dry milk.

Next, the milk equivalent butter and nonfat dry milk prices were added together because they are joint products. Then, the aggregate purchase price and aggregate wholesale prices were computed by taking the weighted average of the prices. In the case of the aggregate purchase price, the weights were equal to the relative amount of cheese (g_1) and butter plus nonfat dry milk (g_2) purchased by the government. For the aggregate wholesale manufactured market price, the weights were equal to the market shares of cheese (w_1) and butter plus nonfat dry milk (w_2). The formulas used in calculating the two price aggregates are:

$$P^g = g_1 \, P^{gc}_{me} + g_2 \, P^{gbnf}_{me}, \text{ and}$$

$$P^{wm} = w_1 \, P^{wc}_{me} + w_2 \, P^{wbnf}_{me},$$

where:

P^g = aggregate government purchase price on per cwt. of milk equivalent basis,

P^{gc}_{me} = government purchase price for cheese on per cwt. of milk equivalent basis,

P^{gbnf}_{me} = purchase price for butter and nonfat dry milk on per cwt. of milk equivalent basis,

P^{wm} = aggregate wholesale price per cwt of raw milk,

P^{wc}_{me} = wholesale market price for cheese on per cwt. of milk equivalent basis,

P^{wbnf}_{me} wholesale market price for butter and nonfat dry milk on per cwt. of milk equivalent basis,

Appendix D: Time Plots of the Impact of Advertising

The simulated values under the actual scenario of allowing for both fluid and manufactured advertising and the base scenario of no advertising are ploted for each of the endogenous variables. Since the model tracks the historical pattern of the endogenous variables reasonably well, comparisons between the two scenarios provide the overall impact of the U.S. generic dairy advertising program.

Figure D1: Impact of Combined Advertising on Retail and Wholesale Fluid Quantity

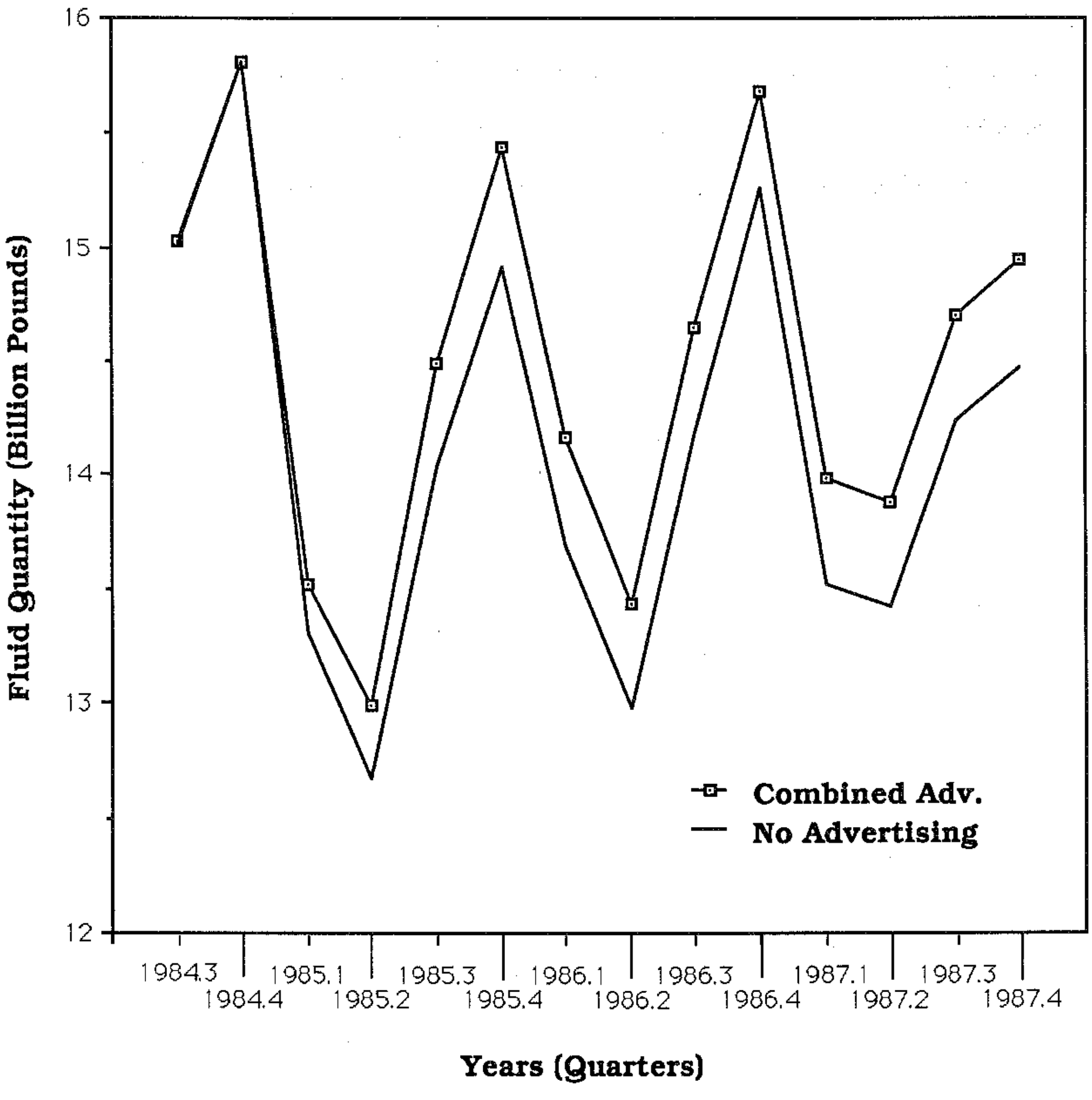


Figure D2: Impact of Combined Advertising on Retail Manufactured Quantity and Wholesale Manufactured Demand Quantity

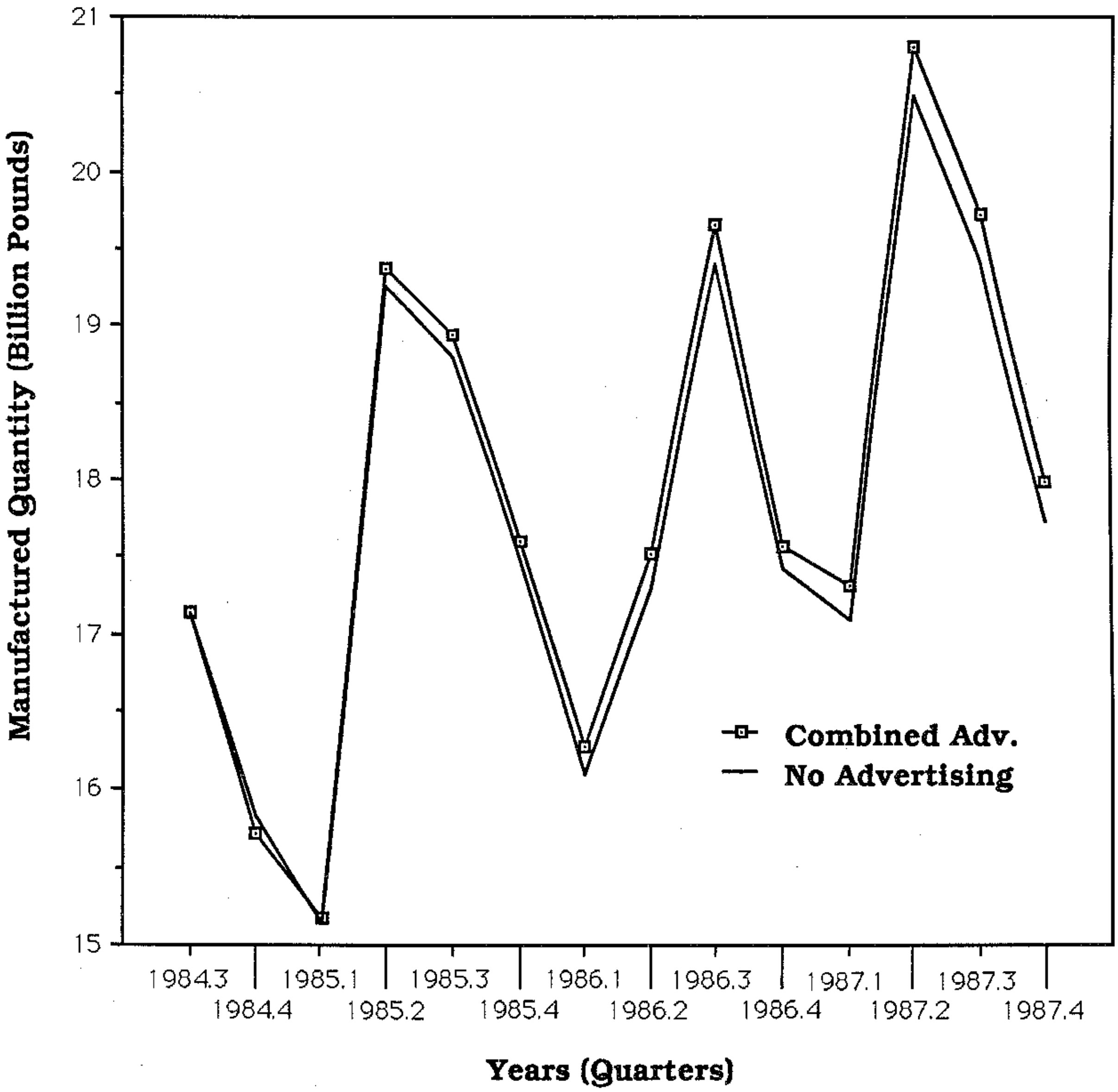


Figure D3: Impact of Combined Advertising on Wholesale Manufactured Supply Quantity

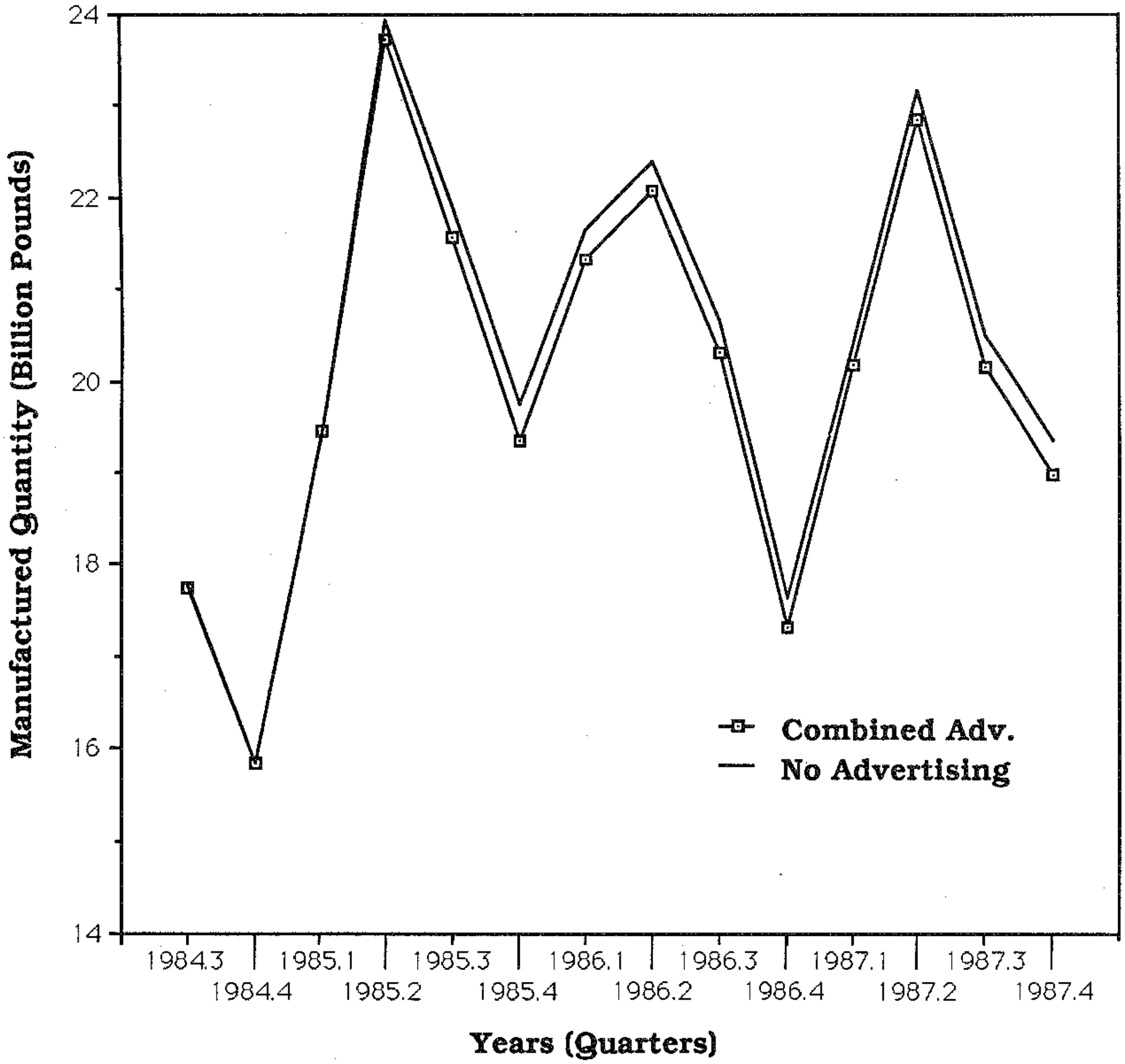


Figure D4: Impact of Combined Advertising on Government Purchases

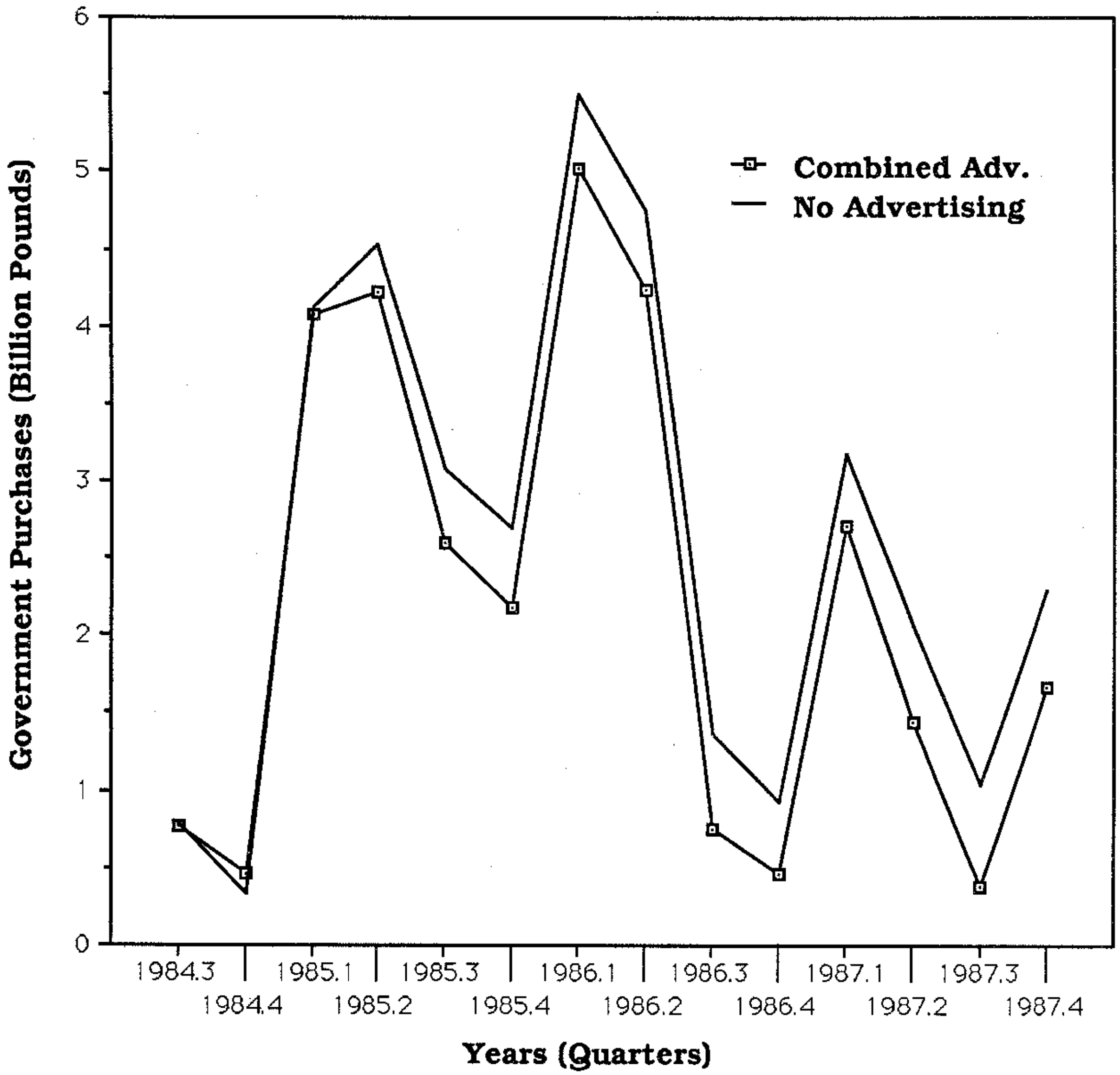


Figure D5: Impact of Combined Advertising on Retail Fluid Price Index

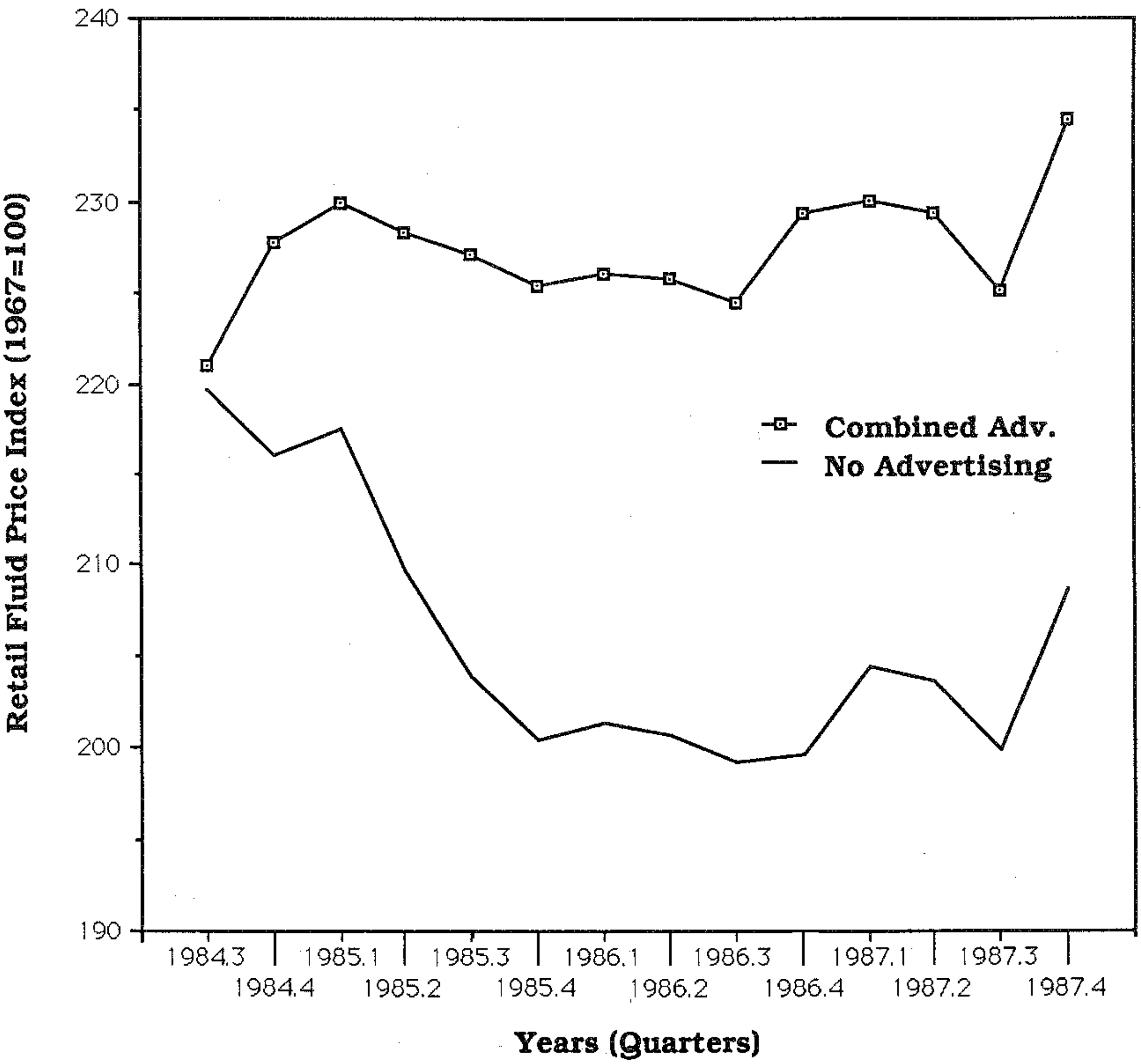


Figure D6: Impact of Combined Advertising on Retail Manufactured Price Index

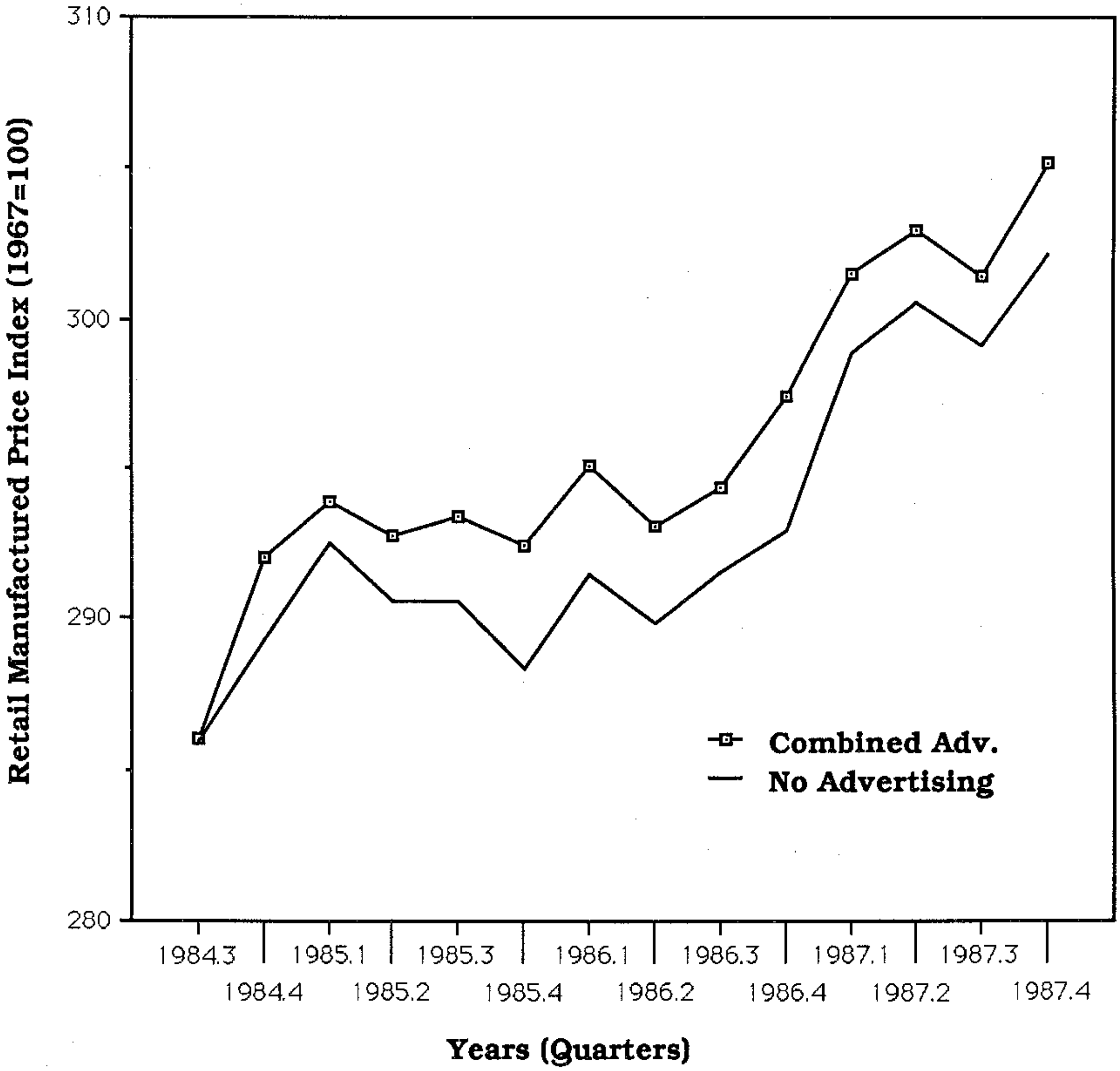


Figure D7: Impact of Combined Advertising on Wholesale Fluid Price Index

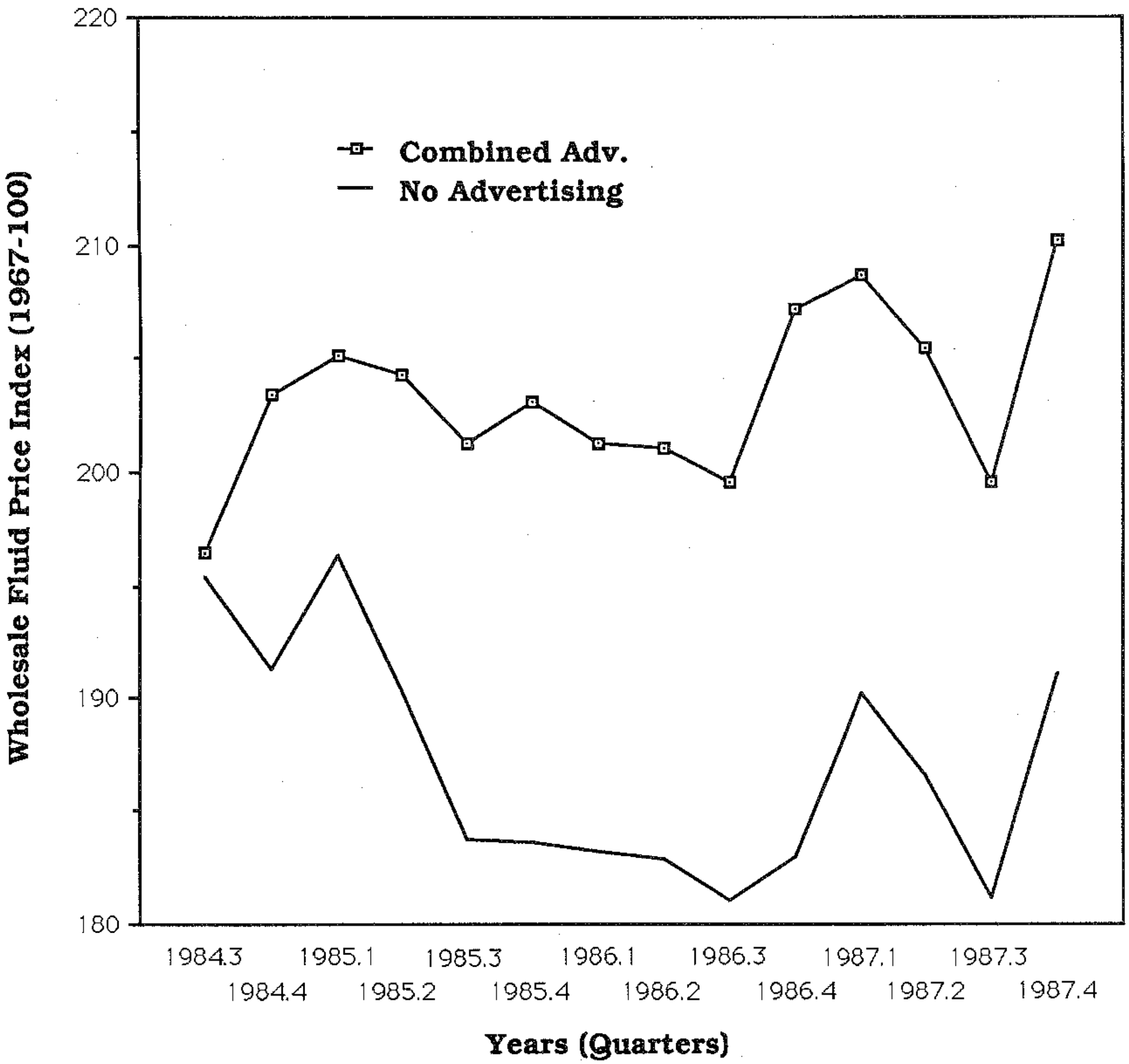


Figure D8: Impact of Combined Advertising on Wholesale Manufactured Price

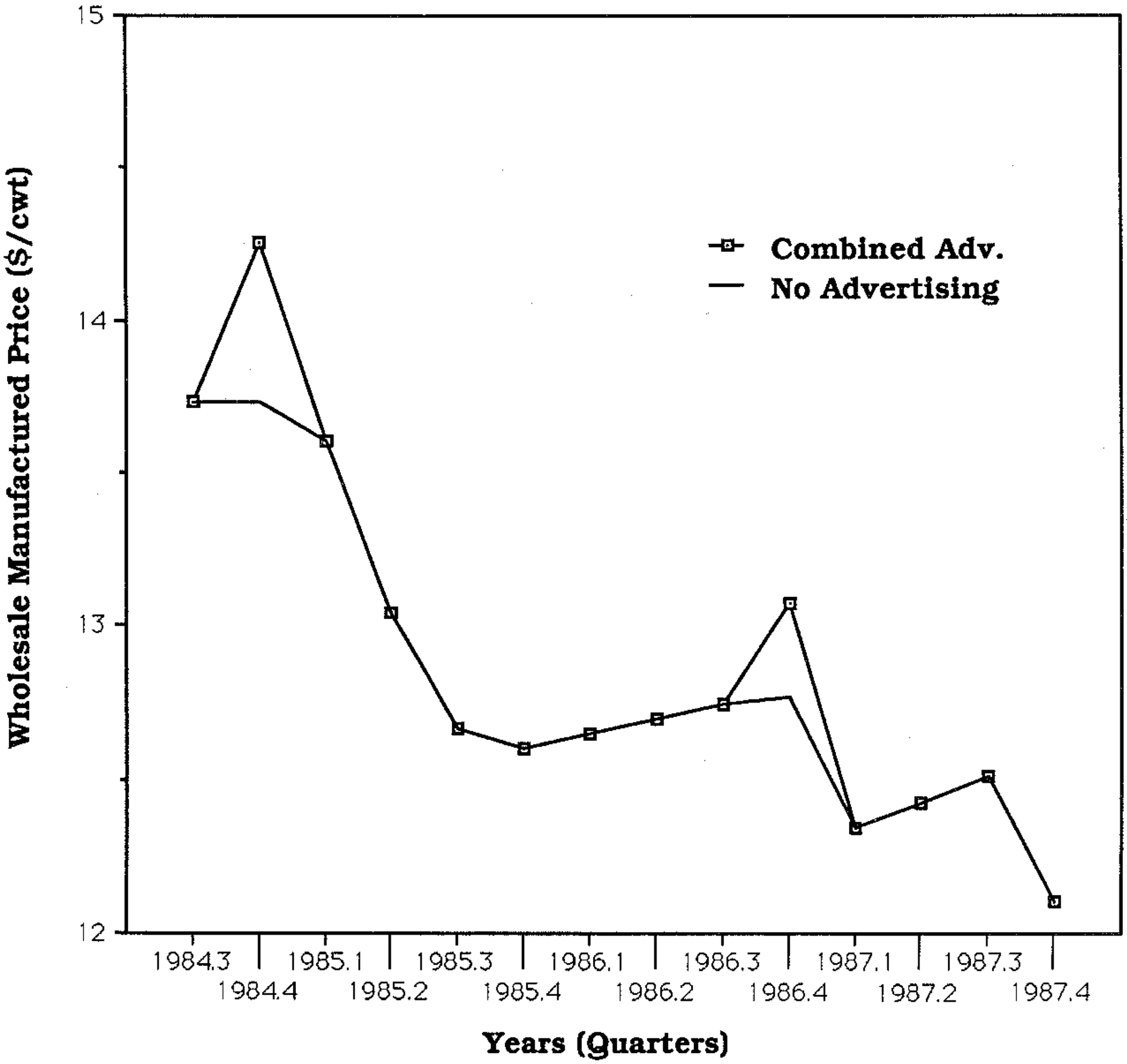


Figure D9: Impact of Combined Advertising on Class II Price

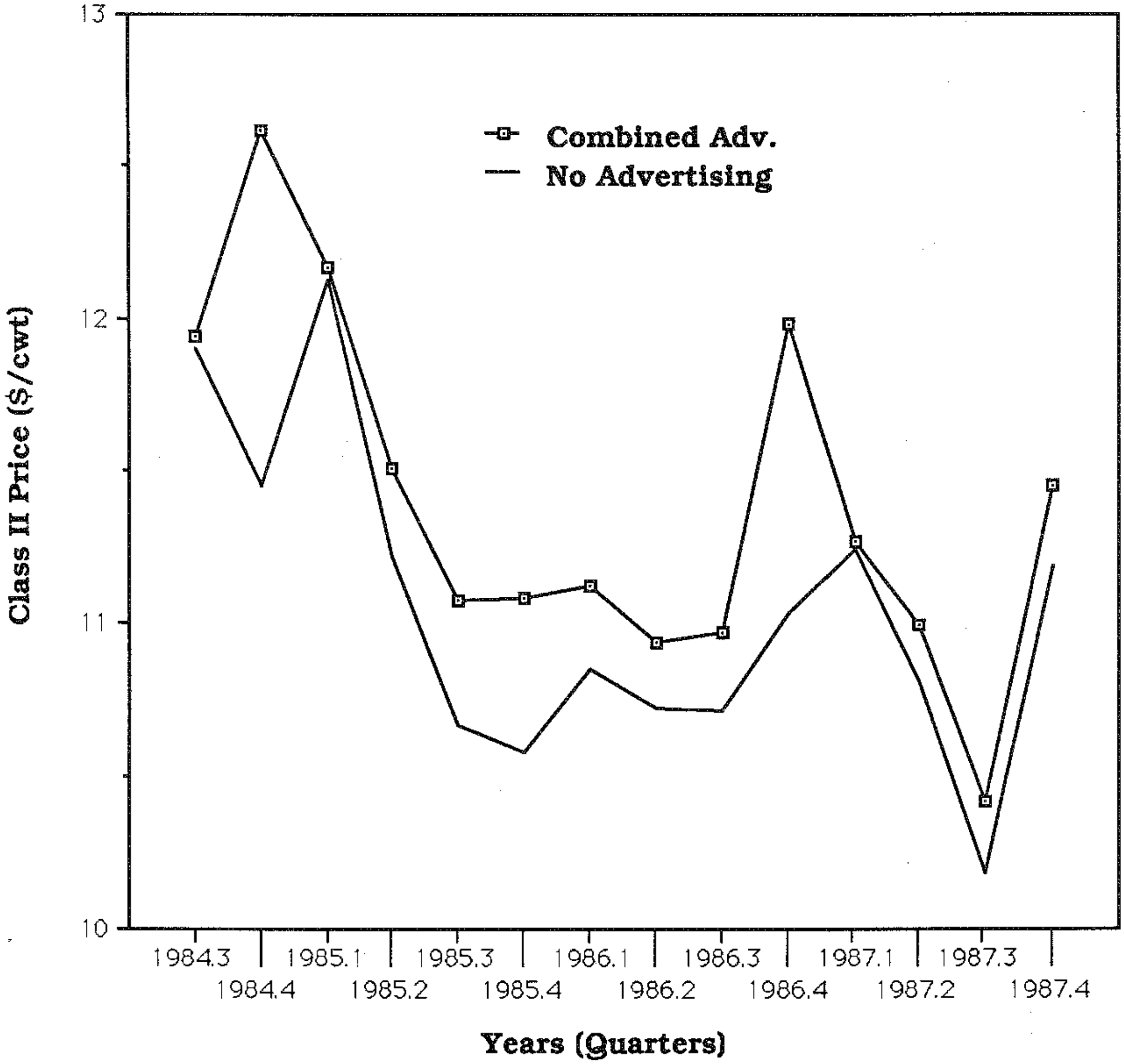


Figure D10: Impact of Combined Advertising on Farm Milk Price

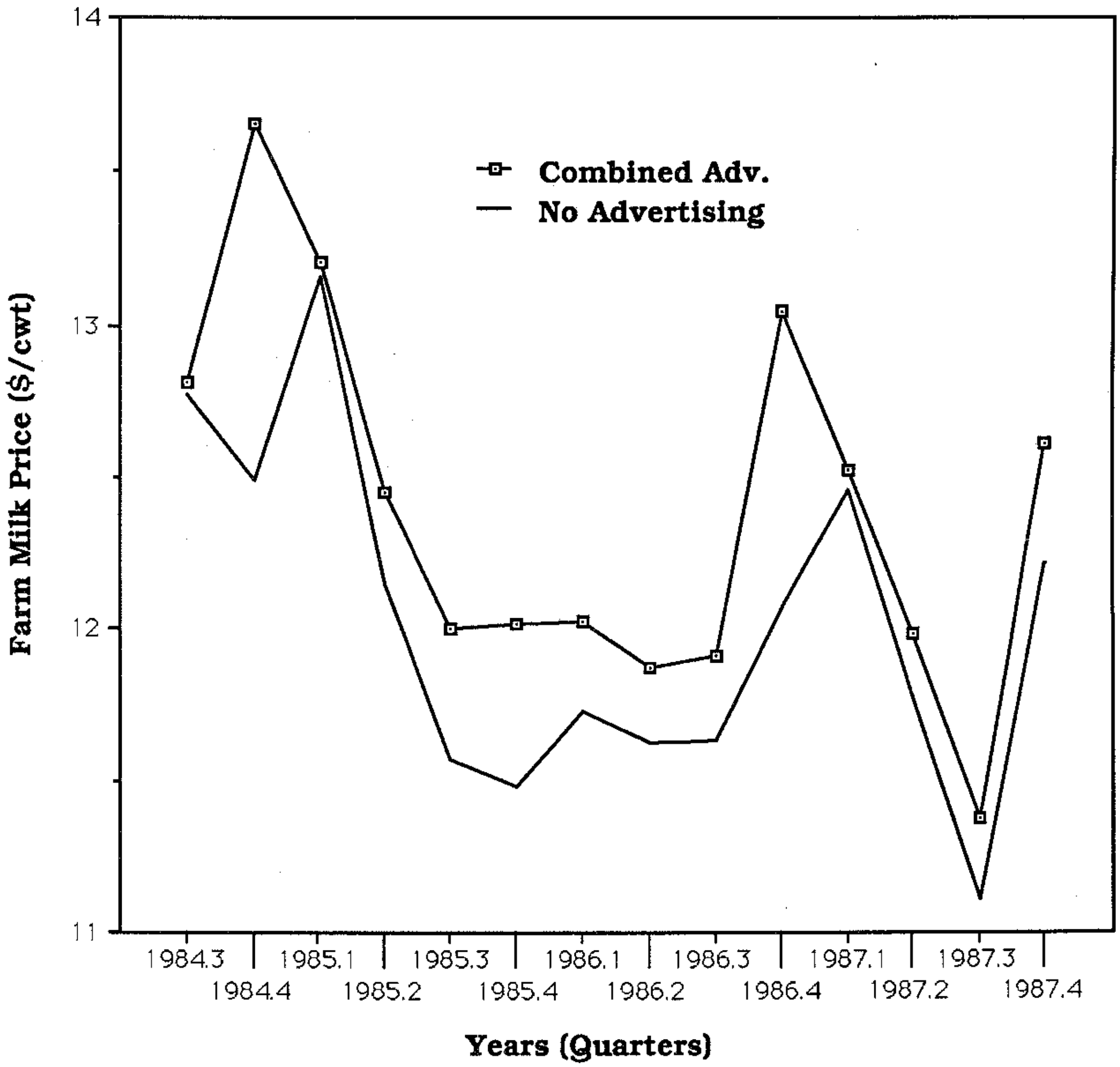
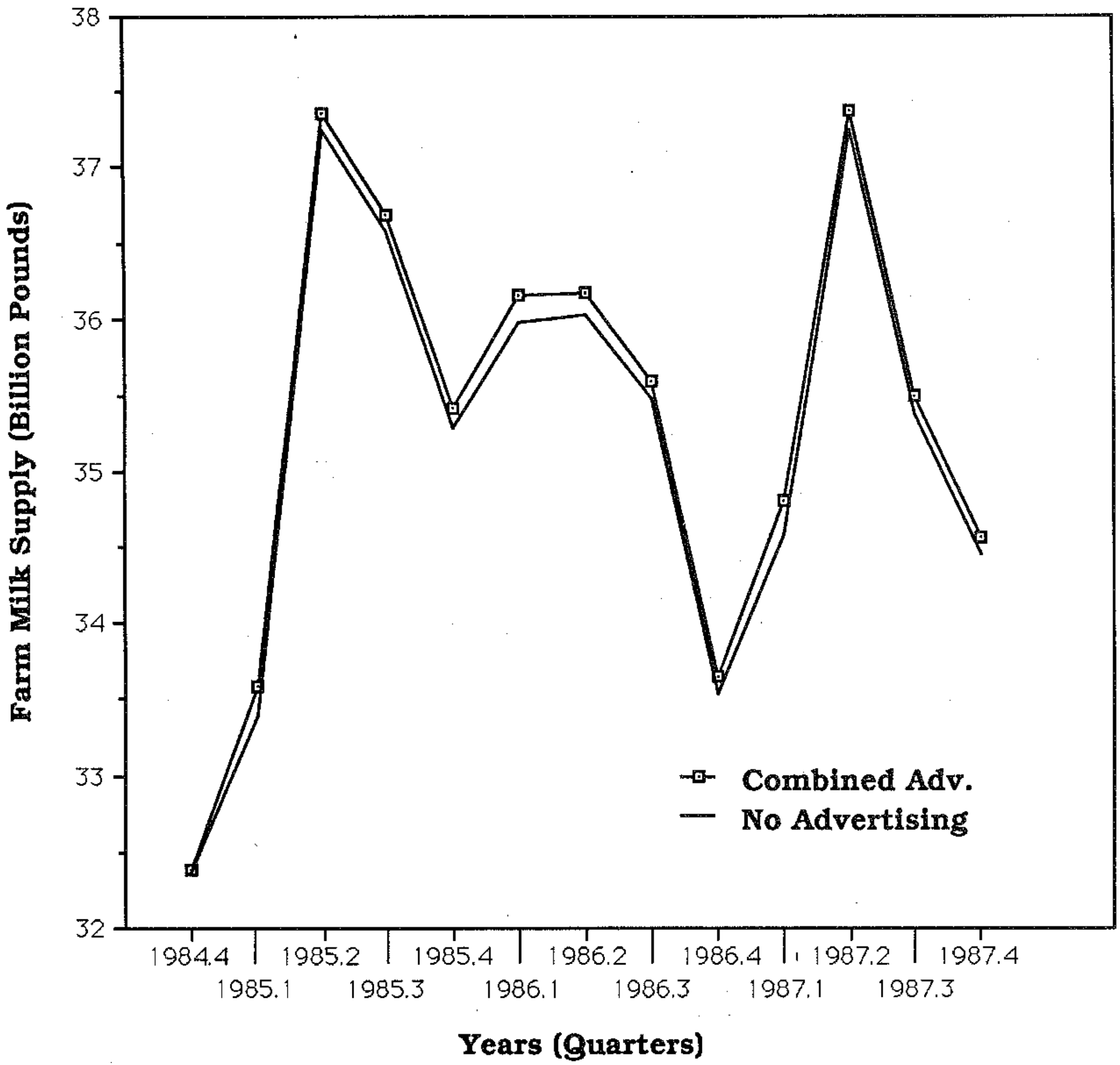


Figure D11: Impact of Combined Advertising on Farm Milk Supply



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