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An Analysis of Generic Dairy Promotion in the United States

by
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- Facilitate the coordination of multi-commodity and multi-country research and evaluation efforts.
- Enhance both public and private policy maker's understanding of the economics of commodity promotion programs.
- Facilitate the development of new theory and research methodology.

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Preface

Harry M. Kaiser is an Associate Professor in the Department of Agricultural, Resource, and Managerial Economics at Cornell University, and Co-Director of the National Institute for Commodity Promotion Research and Evaluation (NICPRE). The author thanks Valerie Johnson for her thorough editing and layout of this bulletin.

This is the first research bulletin published by NICPRE. The mission of NICPRE is to enhance the overall understanding of economic and policy issues associated with commodity promotion programs. An understanding of these issues is crucial to ensuring continued authorization for domestic checkoff programs and to fund export promotion programs. The intent of this first NICPRE research bulletin is to assist program managers on the National Dairy Promotion and Research Board to better understand the economic impacts of their advertising and promotion efforts. The bulletin will help program managers consider the impacts of various allocation strategies used for promoting different milk and dairy products. Future NICPRE research bulletins will look at similar topics regarding other agricultural commodities.

Executive Summary

The purpose of this study was to analyze the economic impacts of alternative generic dairy advertising strategies on the retail, wholesale, and farm sectors of the national dairy industry. A disaggregated industry model of the retail, wholesale, and farm levels with markets for fluid milk, frozen products, cheese, and butter was developed to conduct the analysis. An econometric model of the dairy industry was estimated using quarterly data from 1975 through 1993. The econometric results were then used to simulate the market impacts of three sets of generic advertising scenarios on demand for milk and dairy products, farm and consumer prices, and producer welfare. In the first set of scenarios, market conditions were compared with and without the National Dairy Promotion and Research Board (NDPRB). In the second set of scenarios, total generic expenditure levels were varied from 5% to 200% of their historical values. In the third set of scenarios, total generic advertising expenditures were held constant, but the revenue was reallocated among fluid milk, cheese, and butter to determine which of the products has the largest consumption and price response to advertising.

The results of the first scenario indicate that the presence of the NDPRB had a major impact on market conditions at all levels of the dairy industry. These results included:

- An increase in farm milk price, milk supply, and dairy farmer welfare. Over the period from 1984 through 1993, the farm milk price was found to be 6.6% higher, farm milk supply was 0.6% higher, and dairy farmer producer surplus was 23.7% higher. The advertising effort of the NDPRB resulted in a 1% increase in the total demand for farm milk. The rate of return to the national program was computed to be 5.4, i.e., every dollar invested in the program resulted in $5.40 in producer surplus.

  An increase in demand for all products except frozen dairy products. Specifically, there was an average increase over this period of 1.2%, 1.4%, and 0.7% in fluid milk, butter, and cheese demand, respectively. Frozen product demand actually declined marginally by 0.1% due to an increase in the retail frozen product price.

- An increase in all retail prices. Between 1984 and 1993, this program resulted in an increase of 14.3%, 0.6%, 3.8%, and 0.4% in retail fluid milk, cheese, butter, and frozen product prices, respectively.

- An increase in wholesale fluid milk and frozen dairy product prices, but no change in wholesale cheese and butter prices. On average, fluid milk and frozen dairy product prices increased by 11.8% and 0.9%, respectively, from 1984 to 1993. However, cheese and butter demand was not increased sufficiently to raise the wholesale prices of these products above government supported levels.

- A decreased in Government purchases of dairy products under the Dairy Price Support Program. The results indicated that there was a 21.2% decrease in Government purchases of cheese, a 5.2% decrease in Government purchases of butter, and a 6.7% decrease in Government purchases of all dairy products compared with what would have occurred in the program's absence.

Consequently, it is clear that dairy farmers benefited from the presence of the NDPRB since farm prices and producer surplus were impacted positively. Tax payers also benefited because Government purchases of dairy products were significantly lower.

The results of the second set of scenarios indicated that the level of generic advertising does have an impact on market prices and quantities. For example, doubling actual generic advertising expenditures from historical levels resulted in the following:

- An increase in the farm milk price, milk supply, and dairy farmer welfare. The impact of doubling advertising expenditures was a 7.3% increase in the farm milk price, a 0.6% increase in milk supply, and a 8.4% increase in producer surplus. Hence, farmers would be better off, as a group, to increase the amount they spend on generic dairy promotion.
- An increase in retail demand for fluid milk, butter, and cheese, but not frozen dairy products. Specifically, doubling generic advertising resulted in an average increase of 1.3%, 0.8%, and 0.2% in fluid milk, cheese, and butter demand, respectively, from 1984 to 1993. Frozen product demand was only marginally impacted by doubling advertising expenditures, decreasing by 0.1%, on average.
- An increase in all retail prices for milk and dairy products. The increase in advertising caused an increase of 15.7%, 0.7%, 0.5%, and 0.4% in the retail prices of fluid milk, cheese, butter, and frozen products, respectively.
- An increase in wholesale prices for fluid milk and frozen dairy products, but no change in wholesale butter and cheese prices. Doubling generic advertising resulted in a 12.9% and 1.0% increase in wholesale fluid milk and frozen dairy product prices.
- A decrease in Government purchases under the Dairy Price Support Program. The increase in generic dairy advertising caused a 32.2% decrease in Government purchases of cheese, a 4.7% decrease in Government purchases of butter, and a 6.9% decrease in Government purchases of all dairy products.

It should be noted that while the results indicate that farmers would benefit from increased generic advertising expenditures, marginal benefits begin to decrease as expenditures are increased above historical levels. This means that the incremental level of benefits become less and less as the advertising effort increases. This is called the law of diminishing marginal returns in the economics literature.

The results of the third set of scenarios indicate that the allocation of revenue among products also can have a major impact on market variables. For instance, in the heavy fluid milk advertising scenario (where generic fluid milk advertising was doubled at the expense of cheese and butter advertising) the following results were obtained relative to the actual allocation of advertising among fluid milk, cheese, butter, and ice cream:

- An increase in the farm milk price, milk supply, and dairy producer surplus. Investing a greater proportion of generic advertising on fluid milk resulted in a 5.7% increase in the farm milk price, a 0.5% increase in the farm milk supply, and a 6.5% increase in dairy producer surplus.
- An increase in fluid milk demand, but a decrease in cheese, butter, and frozen product demand. Total demand for milk remained unchanged. Specifically, increasing fluid milk advertising at the expense of other dairy product advertising resulted in a 1.0% increase in fluid milk demand, and a 1.1%, 0.3%, and 0.1% decrease, respectively, in cheese, butter, and frozen dairy product demand.
- An increase in retail fluid milk and frozen dairy product prices, but a decrease in retail cheese and butter prices. Reallocating advertising expenditures in this way resulted in an average increase of 7.6% and 0.1% in fluid milk and frozen dairy product prices, respectively. Alternatively, an average decrease of 1.0% and 0.7%, respectively, occurred in retail cheese and butter prices from 1984 to 1993.
- An increase in wholesale fluid milk and frozen dairy product prices, and no change in wholesale cheese and butter prices. Increased fluid milk advertising resulted in a 10.1% and 0.6% increase in wholesale fluid milk and frozen product prices, and no change in wholesale cheese and butter prices.
- A marginal decrease in total Government purchases under the Dairy Price Support Program. This reallocation strategy resulted in a 35.0% increase in Government purchases of cheese, a 3.4% decrease in Government purchases of butter, and a 0.3% decrease in Government purchases of all dairy products.

In conclusion, while dairy farmers are receiving a relatively high return on their investment from advertising, producer welfare could be improved by investing more money in fluid milk advertising, and less in dairy product advertising. This is because farmers receive a higher price for milk processed into fluid milk products, than milk used to make manufactured products.

Introduction

Since 1984, dairy farmers have paid a mandatory assessment of 15 cents per hundred pounds of milk marketed in the continental United States to pay for a national demand expansion program to help increase consumer demand for milk and dairy products. Legislative authority for these assessments, which exceed $200 million annually, is contained in the *Dairy and Tobacco Adjustment Act* of 1983. The stated goals of this program are to increase consumption of milk and dairy products, enhance dairy farmer income, and reduce the amount of surplus milk purchased by the government under the Dairy Price Support Program. To increase milk and dairy product consumption, the National Dairy Promotion and Research Board (NDPRB) was established to invest in generic dairy advertising and promotion, nutrition research, education, and new product development.

A substantial amount of research on the effectiveness of generic milk advertising has been conducted over the last 20 years. Forker and Kinnucan (1991) summarized the results of 47 studies of generic dairy advertising programs. Twenty-seven studies were for advertising programs for fluid milk, ten for butter, five for cheese, three for cream, and one was for yogurt. Twenty-one of the 47 studies were conducted in the United States, 12 in the United Kingdom, 12 in Canada, one in France, and one in the Netherlands. All of the studies provided some measure of the market impact of the generic advertising program being studied.

Methodology and estimation techniques have evolved to provide more reliable estimates of the economic relationship between sales or consumption and advertising expenditures, while controlling for other demand factors such as own price, income level, price of substitutes, and demographic factors. The early studies, as well as some of the more recent studies, involved single-equation demand functions estimated for single products and limited market areas (Kinnucan and Fearon, 1986; Kinnucan and Forker, 1986; Thompson and Eiler, 1975). These evolved into single-equation, single-product, multiple-market studies. Ward and Dixon (1989) combined data from 12 fluid milk markets for a pooled cross-section and time-series analysis. Liu and Forker (1990) developed single equations for three separate markets and used the equations to arrive at an optimal advertising allocation strategy among the three markets. In an earlier study, Liu and Forker (1988) incorporated a supply response function to account for any production response that may be generated by advertising-induced demand expansion and price increase. All of the fluid milk studies used aggregate market data to represent demand. In each of the fluid milk studies, models were specified as quantity-dependent, i.e., advertising was assumed to directly influence the volume of sales but not price.

There have also been studies that have estimated the impact of generic advertising of manufactured dairy products (e.g., cheese, butter, and cream) on demand (e.g., Blaylock and Blisard, 1990; Chang and Kinnucan, 1990; Kinnucan and Fearon, 1986; Lewandowski and Rojek, 1991; Liu et al., 1990, Strak and Gill, 1983; Yau, 1990). Two separate studies estimated a single demand equation for cheese which included a variable for generic cheese advertising expenditures (Blaylock and Blisard, 1990; Kinnucan and Fearon, 1986). A similar study was conducted for cream (Yau, 1990). Another study used multiple equations to account for the simultaneous impact of advertising on butter and other edible oils (Chang and Kinnucan, 1990). These and other studies have provided useful information to evaluate, *ex post*, the performance of generic dairy advertising programs. One shortcoming of most of these studies is that it was not possible to simultaneously determine the impact of generic advertising on price and quantity.

An industry model of the U.S. dairy sector was developed by Liu et al. (1990, 1991) that could determine simultaneously the impact of advertising on price and quantity. The authors concluded that it was feasible to develop a multiple-product, multiple-market level model that would simultaneously account for the direct demand impact as well as the cross-product impacts of concurrent advertising programs for fluid milk and manufactured dairy products. The model concurrently takes into account the price and quantity impacts at three levels of trade — retail, wholesale, and farm. The study was the first to explicitly incorporate the Dairy Price Support Program into the manufactured product market. Kaiser and Forker (1993) developed a similar, but more disaggregated model of the dairy industry. A key conclusion of both studies was that generic advertising has different effects on market variables depending on whether the market is competitive or in a government-support regime where market prices are at support prices.

The purpose of this study was to analyze the effectiveness of various generic advertising scenarios using a model similar to Kaiser and Forker (1993).

The model used is based on a dynamic econometric model of the U.S. dairy industry estimated using quarterly data from 1975 through 1993. Econometric results were used to simulate the impacts of three sets of generic advertising scenarios on demand for milk and dairy products, farm and consumer prices, and producer welfare. In the first set of scenarios market conditions were compared with and without the NDPRB. The purpose of these scenarios was to determine whether the creation of the NDPRB has had a significant impact on retail, wholesale, and farm quantity, price, and producer welfare. In the second set of scenarios, total generic expenditure levels were varied from 5% to 200% of their historical values. The purpose of this simulation was to determine the marginal impacts of generic advertising based on alternative expenditure levels. In the third set of scenarios, total generic advertising expenditures were held constant, but revenue was reallocated among fluid milk, cheese, butter, and ice cream to determine which of the products had the largest consumption and price response to advertising. In this case, four cases were examined: baseline (historical) generic advertising, heavy generic fluid milk advertising, heavy generic cheese advertising, and heavy generic butter advertising. The purpose of the third set of scenarios was to see whether reallocation of existing advertising revenue could further increase farm prices and welfare, and lower government purchases of dairy products.

The Conceptual Model

The econometric model presented here is similar in structure to the Liu et al. (1990, 1991) industry model, with one importance difference. While Liu et al. (1990, 1991) classified all manufactured products into one category (Class III), the present model disaggregates manufactured products into three classes: frozen products, cheese, and butter. This greater degree of product disaggregation provides for additional insight into the impacts of advertising on individual product demand, e.g., cheese demand.

In the farm market, Grade A (fluid eligible) milk is produced by farmers and sold to wholesalers. The wholesale market was disaggregated into four submarkets: fluid (beverage) milk, frozen products, cheese, and butter.[1] Wholesalers process the milk into these four dairy products and sell them to retailers, who then sell the products to consumers.

It was assumed that the two major federal programs that regulate the dairy industry (Federal milk marketing orders and the Dairy Price Support Program) are in effect. Since this is a national model, it was assumed that there is one Federal milk marketing order regulating all milk marketed in the nation. The Federal order program was incorporated by restricting the prices wholesalers pay for raw milk to be the minimum class prices. For example, fluid milk wholesalers pay the higher Class I price, while cheese wholesalers pay the lower Class III price.[2] The Dairy Price Support Program was incorporated into the model by restricting the wholesale cheese and butter prices to be greater-than-or-equal-to the government purchase prices for these products. With the government offering to buy unlimited quantities of storable manufactured dairy products at announced purchase prices, the program indirectly supports the farm milk price by increasing farm level milk demand. A conceptual overview of the model is presented in Figure 1.

Retail markets were defined by sets of supply and demand functions and equilibrium conditions that require supply and demand to be equal. Since the market was disaggregated into fluid milk, frozen products, cheese, and butter, there were four sets of these equations, with each set having the following general specification:

$$(1.1)\quad Q^{rd} = f(P^{r} \mid S^{rd}),$$

$$(1.2)\quad Q^{rs} = f(P^{r} \mid S^{rs}),$$

$$(1.3)\quad Q^{rs} = Q^{rd} \equiv Q^{r},$$

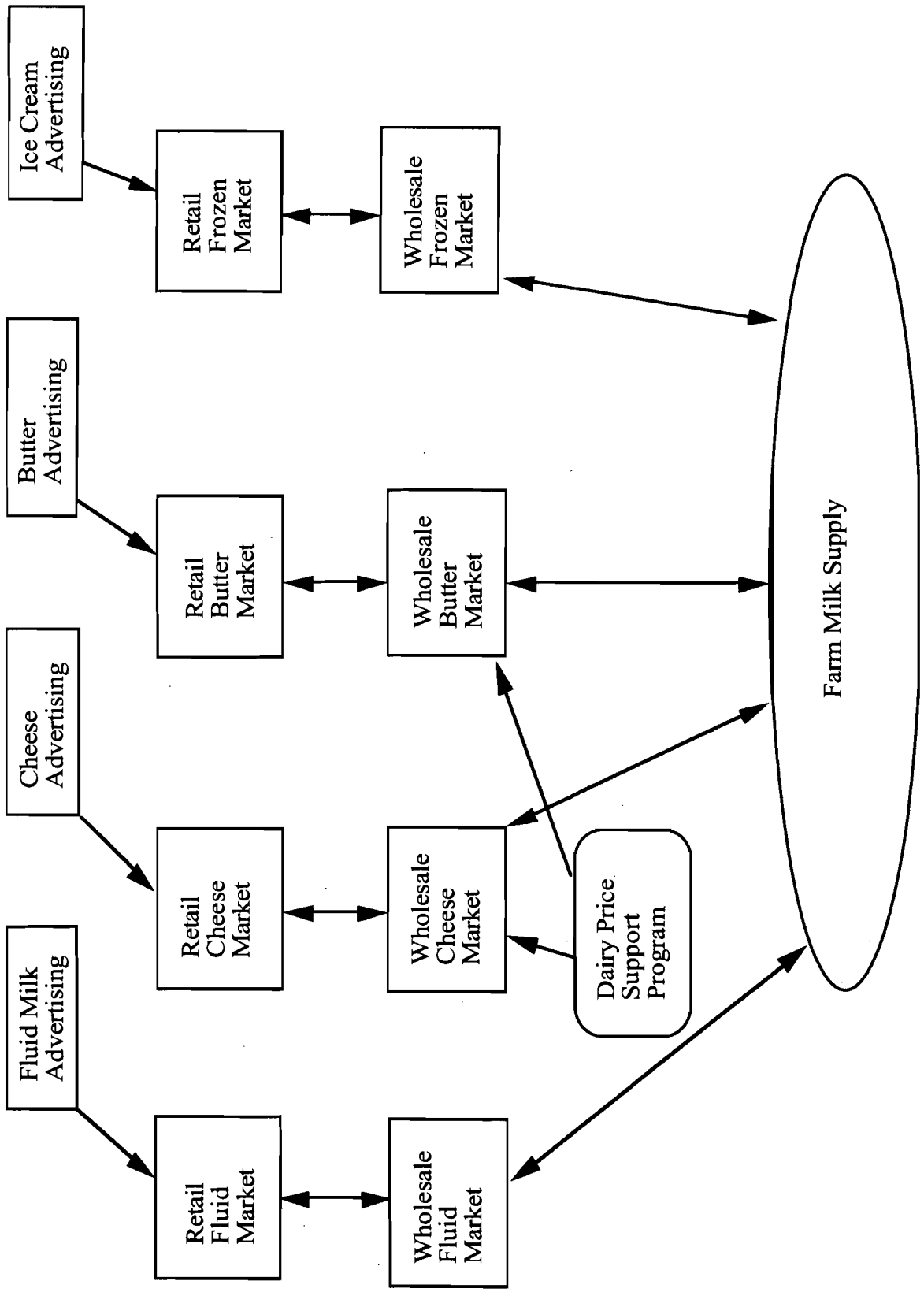
where: Q^{rd} and Q^{rs} are retail demand and supply, respectively, P^{r} is the retail own price, S^{rd} is a vector of retail demand shifters including generic advertising, S^{rs} is a vector of retail supply shifters including the wholesale own price, and Q^{r} is the equilibrium retail quantity.

The wholesale market was also defined by four sets of supply and demand functions and equilibrium conditions. The wholesale fluid milk and frozen prod-

[1]All quantities in the model are expressed on a milkfat equivalent basis. Consequently, nonfat dry milk was not considered in the model.

[2]Most federal milk marketing orders utilize four product classes with Class I being fluid products, Class II being soft dairy products, Class III being most hard dairy products, and Class IIIa being nonfat dry milk. A two class system was used in this study, with all fluid products considered Class I and all manufactured products considered Class II.

Figure 1. Overview of the conceptual dairy industry model.



uct markets had the following general specification:

(2.1) $Q^{wd} = Q^{r}$,

(2.2) $Q^{ws} = f(P^{w} \mid S^{ws})$,

(2.3) $Q^{ws} = Q^{wd} \equiv Q^{w} \equiv Q^{r}$,

where: Q^{wd} and Q^{ws} are wholesale demand and supply, respectively, P^{w} is the wholesale own price, and S^{ws} is a vector of wholesale supply shifters. In the wholesale fluid milk supply equation, S^{ws} included the Class I price, which is equal to the Class III milk price (i.e., the Minnesota-Wisconsin price) plus a fixed fluid milk differential. In the frozen products, cheese, and butter wholesale supply functions, S^{ws} included the Class III price, which is the most important variable cost to dairy processors. Note that the wholesale-level demand functions did not have to be estimated since the equilibrium conditions constrained wholesale demand to be equal to the equilibrium retail quantity. The assumption that wholesale demand equals retail quantity implies a fixed-proportions production technology. Recent research by Wohlgenant and Haidacher (1989) suggest that this may not be a realistic assumption. However, the data used as a proxy for national demand were commercial disappearance statistics which do not distinguish between wholesale and retail levels. Consequently this assumption is necessary.

The direct impacts of the Dairy Price Support Program occur at the wholesale cheese and butter markets level. It is at this level that the Commodity Credit Corporation (CCC) provides an alternative source of demand at announced purchase prices. In addition, cheese and butter can be stored as inventories, which represent another source of demand not present with the other two products. Consequently, the equilibrium conditions for the butter and cheese wholesale markets were different than those for the fluid milk and frozen wholesale markets. The wholesale cheese and butter markets had the following general specification:

(3.1) $Q^{wd} = Q^{r}$,

(3.2) $Q^{ws} = f(P^{w} \mid S^{ws})$,

(3.3) $Q^{ws} = Q^{wd} + \Delta INV + QSP \equiv Q^{w}$,

where: Q^{wd} and Q^{ws} are wholesale demand and supply, respectively, P^{w} is the wholesale own price, S^{ws} is a vector of wholesale supply shifters including the Class III milk price, DINV is change in commercial inventories, QSP is quantity of product sold by specialty plants to the government, and Q^{w} is the equilibrium wholesale quantity. The variables DINV and QSP represent a small proportion of total milk production and were assumed to be exogenous in this model.[3]

The Dairy Price Support Program was incorporated in the model by constraining the wholesale cheese and butter prices to be not less than their respective government purchase prices, i.e.:

(4.1) $P^{wc} \geq P^{gc}$,

(4.2) $P^{wb} \geq P^{gb}$,

where: P^{gc} and P^{gb} are the government purchase prices for cheese and butter, respectively.

Because of the Dairy Price Support Program, four regimes were possible: (1) $P^{wc} > P^{gc}$ and $P^{wb} > P^{gb}$; (2) $P^{wc} > P^{gc}$ and $P^{wb} = P^{gb}$; (3) $P^{wc} = P^{gc}$ and $P^{wb} > P^{gb}$; or (4) $P^{wc} = P^{gc}$ and $P^{wb} = P^{gb}$. In the cheese and butter markets, specific versions of equilibrium condition (3.3) were applicable to the first regime, which is the competitive case. In the second case where the cheese market was competitive, but the butter market was not, the wholesale butter price was set equal to the government purchase price for butter and the equilibrium condition was changed to:

(3.3b) $Q^{wbs} = Q^{wbd} + \Delta INV_{b} + QSP_{b} + Q^{gb} \equiv Q^{wb}$,

where: Q^{gb} is government purchases of butter which becomes the new endogenous variable, replacing the wholesale butter price. For the third case where the butter market was competitive, but the cheese market was not, the wholesale cheese price was set equal to the government purchase price for cheese and the

[3] Certain cheese and butter plants sell products to the government only, regardless of the relationship between the wholesale market price and the purchase price. These are general balancing plants that remove excess milk from the market when supply is greater than demand, and process the milk into cheese and butter which is then sold to the government. Because of this, the quantity of milk purchased by the government was disaggregated into purchases from these specialized plants and other purchases. In a competitive regime, the "other purchases" are expected to be zero, while the purchases from specialty plants may be positive. The QSP_{c} and QSP_{b} variables were determined by computing the average amount of government purchases of cheese and butter during competitive periods, i.e., when the wholesale price was greater than the purchase price for these two products.

equilibrium condition was changed to:

(3.3c) $Q^{wcs} = Q^{wcd} + \Delta INV_c + QSP_c + Q^{gc} \equiv Q^{wc}$,

where: Q^{gc} is government purchases of cheese which becomes the new endogenous variable, replacing the wholesale cheese price. Finally, for the last case where both the cheese and the butter markets were not competitive, the wholesale cheese and butter prices were set equal to their respective government purchase prices and the equilibrium conditions were changed to (3.3b) and (3.3c).[4]

The farm raw milk market was represented by the following milk supply equation:

(5.1) $Q^{fm} = f(E[P^{fm}] \mid S^{fm})$,

where: Q^{fm} is commercial milk marketings in the United States, $E[P^{fm}]$ is the expected farm milk price, S^{fm} is a vector of milk supply shifters. Similar to Liu et al. (1990, 1991), it was assumed that farmers have naive price expectations, i.e., $E[P^{fm}]_t = P^{fm}_{t-1}$. Thus, the farm milk supply was predetermined and could be estimated using ordinary least squares. This assumption made the industry model recursive, with the wholesale and retail markets forming a system, the farm market being independent from that system.

The farm milk price is a weighted average of the Class prices for milk, with the weights equal to the utilization of milk among products:

$$(5.2)\ P^{fm} = \frac{(P^{III}+d) * Q^{wfs} + P^{III} * Q^{wfzs} + P^{III} * Q^{wcs} + P^{III} * Q^{wbs}}{Q^{wfs} + Q^{wfzs} + Q^{wcs} + Q^{wbs}}$$

where: P^{III} is the Class III price, d is the Class I fixed fluid milk differential (therefore the Class I price is equal to $P^{III} + d$), Q^{wfs} is wholesale fluid milk supply, Q^{wfzs} is wholesale frozen product supply, Q^{wcs} is wholesale cheese supply, and Q^{wbs} is wholesale butter supply

Finally, the model was closed by the following equilibrium condition:

(5.3) $Q^{fm} = Q^{wfs} + Q^{wfzs} + Q^{wcs} + Q^{wbs} + FUSE + OTHER$,

where FUSE is on-farm use of milk and OTHER is milk used in dairy products other than fluid milk, frozen products, butter, and cheese. Both of these variables represented a small share of total milk production and were treated as exogenous.

The Econometric Results

The retail and wholesale market equations were estimated simultaneously using two stage least squares and quarterly data from 1975 through 1993. The econometric package used was Micro TSP. The farm market was estimated using ordinary least squares and quarterly data from 1975 through 1993. All equations in the model were specified in double-logarithm functional form. Estimation results are presented in Table 1 with t-values given in parentheses under each coefficient, and all variables and data sources are defined in Table 2. R^2 is the adjusted coeffi-cient of determination, and DW is the Durbin-Watson statistic.

The retail market demand functions were estimated on a per capita basis. Retail demand for each product was specified to be a function of the following variables: 1) retail product price, 2) price of substitutes, 3) per capita disposable income, deflated by the Consumer Price Index, 4) quarterly dummy variables to account for seasonal demand, 5) a time trend variable to capture changes in consumer tastes and preferences over time, and 6) generic advertising expenditures to measure the impact of advertising on retail demand. In all demand functions except butter, own prices were deflated by the price of substitute products. For the butter demand function, the own price was deflated by per capita income since the substitute price approach yielded inferior statistical results. To capture the dynamics of advertising,

[4]Because the market structure is different under each of these four regimes, using conventional two-stage least squares to estimate equations (1.1) through (4.2) may result in selectivity bias. Theoretically, a switching simultaneous system regression procedure should be applied, which is described in Liu, et al (1990, 1991). However, this procedure was not used here because it was beyond the scope of this project. Applying this procedure to the level of disaggregation of this model's manufactured product market would have been extremely cumbersome, and the costs of doing so were judged to be greater than the potential benefits.

[5]All generic advertising expenditures came from various issues of Leading National Advertisers. Due to their survey procedures, these expenditures are regarded as being lower than actual expenditures. However, alternative data sources for generic advertising expenditures were not available. As is pointed out by Maddala (pp. 292-94), this creates an error in variable problem that may bias the estimated advertising coefficients downward (as opposed to upward bias, as one might intuitively expect). Consequently, some care should be exercised in interpreting these coefficients.

Table 1. Econometric results for the dairy industry model.

Retail Market

Retail Fluid Milk Demand:

$$\ln (Q^{rfd}/POP) = \underset{(-11.23)}{-2.234} - \underset{(-1.56)}{0.041} \ln (P^{rf}/P^{bev}) + \underset{(4.35)}{0.270} \ln (INC/CPI) - \underset{(-7.49)}{0.070} \ln TREND - \underset{(-5.25)}{0.016} DUMQ1 - \underset{(-18.02)}{0.061} DUMQ2 - \underset{(-18.29)}{0.055} DUMQ3$$
$$+ \underset{(3.77)}{0.004} \ln DGFAD + \underset{(3.77)}{0.006} \ln DGFAD_{-1} + \underset{(3.77)}{0.007} \ln DGFAD_{-2} + \underset{(3.77)}{0.006} \ln DGFAD_{-3} + \underset{(3.77)}{0.004} \ln DGFAD_{-4} + \underset{(3.80)}{0.446} AR(1)$$

$R^2 = 0.93$; DW = 1.97

Retail Frozen Demand:

$$\ln (Q^{rfzd}/POP) = \underset{(-9.92)}{-3.061} - \underset{(-2.14)}{0.453} \ln (P^{rfz}/P^{foo}) + \underset{(4.39)}{0.609} \ln (INC/CPI) - \underset{(-6.25)}{0.00004} TREND^2 + \underset{(6.14)}{0.058} DUMQ1 + \underset{(33.63)}{0.321} DUMQ2 + \underset{(36.01)}{0.346} DUMQ3$$
$$+ \underset{(0.66)}{0.0001} \ln DGFZAD + \underset{(0.66)}{0.0002} \ln DGFZAD_{-1} + \underset{(0.66)}{0.0002} \ln DGFZAD_{-2} + \underset{(0.66)}{0.0002} \ln DGFZAD_{-3} + \underset{(0.66)}{0.0001} \ln DGFZAD_{-4}$$

$R^2 = 0.97$; DW = 1.53

Retail Cheese Demand:

$$\ln (Q^{rcd}/POP) = \underset{(-63.20)}{-3.470} - \underset{(-1.09)}{0.241} \ln (P^{rc}/P^{mea}) + \underset{(7.36)}{0.00005} TREND^2 - \underset{(-4.89)}{0.058} DUMQ1 - \underset{(-6.31)}{0.074} DUMQ3 - \underset{(-8.81)}{0.267} DUM_{83.1} + \underset{(1.61)}{0.002} \ln DGCAD$$
$$+ \underset{(1.61)}{0.003} \ln DGCAD_{-1} + \underset{(1.61)}{0.004} \ln DGCAD_{-2} + \underset{(1.61)}{0.003} \ln DGCAD_{-3} + \underset{(1.61)}{0.002} \ln DGCAD_{-4} + \underset{(2.91)}{0.32} AR(1)$$

$R^2 = 0.87$; DW = 2.06

Retail Butter Demand:

$$\ln (Q^{rbd}/POP) = \underset{(-3.02)}{-3.487} - \underset{(-0.22)}{0.103} \ln (P^{rb}/INC) - \underset{(-0.49)}{0.00004} TREND^2 - \underset{(-5.50)}{0.211} DUMQ1 - \underset{(-6.55)}{0.254} DUMQ2 - \underset{(-4.12)}{0.158} DUMQ3 + \underset{(1.65)}{0.0005} \ln DGBAD$$
$$+ \underset{(1.65)}{0.0008} \ln DGBAD_{-1} + \underset{(1.65)}{0.0009} \ln DGBAD_{-2} + \underset{(1.65)}{0.0008} \ln DGBAD_{-3} + \underset{(1.65)}{0.0005} \ln DGBAD_{-4}$$

$R^2 = 0.40$; DW = 1.87

Retail Fluid Milk Supply:

$$\ln Q^{rfs} = \underset{(4.90)}{1.001} + \underset{(2.62)}{0.290} \ln (P^{rf}/P^{wf}) - \underset{(-3.69)}{0.045} \ln (P^{fe}/P^{wf}) + \underset{(6.97)}{0.599} \ln Q^{rfs}_{-1} + \underset{(4.55)}{0.018} \ln TREND - \underset{(-8.27)}{0.048} DUMQ1 - \underset{(-17.98)}{0.087} DUMQ2 - \underset{(-14.29)}{0.052} DUMQ3$$

$R^2 = 0.95$; DW = 2.14

Retail Frozen Products Supply:

$$\ln Q^{rfzs} = \underset{(26.33)}{0.922} + \underset{(1.24)}{0.345} \ln (P^{rfz}/P^{wfz}) - \underset{(-0.77)}{0.055} \ln (P^{fe}/P^{wfz}) + \underset{(7.57)}{0.056} DUMQ1 + \underset{(37.31)}{0.320} DUMQ2 + \underset{(46.94)}{0.348} DUMQ3 + \underset{(11.69)}{0.836} AR(1)$$

$R^2 = 0.96$; DW = 2.42

Retail Cheese Supply:

$$\ln Q^{rcs} = \underset{(-2.09)}{-1.141} + \underset{(6.11)}{1.138} \ln (P^{rc}/P^{wc}) - \underset{(-4.11)}{0.877} \ln (P^{lab}/P^{wc}) - \underset{(-2.80)}{0.157} \ln (P^{fe}/P^{wc}) + \underset{(6.28)}{0.179} \ln TREND - \underset{(-4.29)}{0.087} DUMQ1 - \underset{(-3.62)}{0.072} DUMQ3$$

$R^2 = 0.85$; DW = 1.82

Retail Butter Supply:

$$\ln Q^{rbs} = \underset{(2.17)}{0.700} + \underset{(3.04)}{0.356} \ln (P^{rb}/P^{wb}) - \underset{(-1.65)}{0.134} \ln (P^{fe}/P^{wb}) - \underset{(-5.71)}{0.221} DUMQ1 - \underset{(-6.60)}{0.256} DUMQ2 - \underset{(-4.05)}{0.157} DUMQ3$$

$R^2 = 0.44$; DW = 1.81

Table 1. Continued.

Wholesale Market

Wholesale Fluid Milk Supply:

$$\ln Q^{wfs} = \underset{(4.30)}{0.878} + \underset{(4.03)}{0.179} \ln (P^{wf}/(P^{III}+d)) - \underset{(-3.03)}{0.032} \ln (P^{fe}/P(P^{III}+d)) + \underset{(5.22)}{0.559} \ln Q^{wfs}_{-1} - \underset{(-6.35)}{0.044} DUMQ1 - \underset{(-16.23)}{0.086} DUMQ2 - \underset{(-13.99)}{0.053} DUMQ3$$

$R^2 = 0.95$; DW = 2.44

Wholesale Frozen Supply:

$$\ln Q^{wfzs} = \underset{(1.27)}{0.185} + \underset{(1.01)}{0.060} \ln (P^{wfz}/P^{III}) - \underset{(-1.17)}{0.032} \ln (P^{fe}/P^{III}) + \underset{(3.77)}{0.432} \ln Q^{wfzs}_{-1} + \underset{(2.59)}{0.038} \ln TREND + \underset{(5.19)}{0.211} DUMQ1 + \underset{(12.91)}{0.447} DUMQ2 + \underset{(34.46)}{0.360} DUMQ3$$

$R^2 = 0.97$; DW = 2.06

Wholesale Cheese Supply:

$$\ln Q^{wcs} = \underset{(0.38)}{0.261} + \underset{(0.06)}{0.020} \ln (P^{wc}/P^{III}) - \underset{(-0.13)}{0.005} \ln (P^{lab}/P^{III}) + \underset{(13.95)}{1.101} \ln (Q^{wcs})_{-1} - \underset{(-10.85)}{0.878} \ln (Q^{wcs})_{-2} + \underset{(8.72)}{0.723} \ln (Q^{wcs})_{-3} - \underset{(-3.24)}{0.044} MDP - \underset{(-9.66)}{0.140} DUMQ1 - \underset{(-13.17)}{0.179} DUMQ2$$

$R^2 = 0.97$; DW = 1.94

Wholesale Butter Supply:

$$\ln Q^{wbs} = \underset{(11.98)}{2.231} + \underset{(3.54)}{0.326} \ln (P^{wb}/P^{III}) + \underset{(5.46)}{0.007} TREND - \underset{(-1.73)}{0.068} DTP - \underset{(-3.37)}{0.133} MDP + \underset{(17.18)}{0.212} DUMQ1 + \underset{(7.86)}{0.112} DUMQ2 - \underset{(-15.46)}{0.192} DUMQ3 + \underset{(8.53)}{0.730} AR(1)$$

$R^2 = 0.93$; DW = 1.81

Farm Milk Market

Farm Milk Supply:

$$\ln Q^{fm} = \underset{(2.92)}{1.366} + \underset{(3.34)}{0.115} \ln (P^{fm}/P^{feed})_{-1} - \underset{(-2.36)}{0.051} \ln (P^{cow}/P^{feed}) + \underset{(7.63)}{0.593} \ln Q^{fm}_{-1} - \underset{(-5.47)}{0.334} \ln Q^{fm}_{-2} + \underset{(5.85)}{0.421} \ln Q^{fm}_{-3} - \underset{(-3.85)}{0.031} DTP - \underset{(-2.36)}{0.021} MDP + \underset{(11.24)}{0.063} DUMQ2 + \underset{(2.17)}{0.041} \ln TREND$$

$R^2 = 0.96$; DW = 1.66

generic advertising expenditures were specified as a second-order polynomial distributed lag with both endpoint restrictions imposed.[5] A lag length of four quarters was chosen since this length generally resulted in coefficients with highest t-values. An intercept dummy variable to capture outliers for quarter 1 of 1983 was included in the retail cheese demand function, since cheese demand for this quarter was well out of the range of all other observations. Finally, a first-order moving average error structure was imposed on the retail fluid milk and cheese demand equations to correct for autocorrelation.

Based on the econometric estimation, generic fluid milk advertising had the largest advertising coefficient, where the sum of current and lagged coefficients totaled 0.027.[6] This was followed by generic cheese and butter advertising, respectively, whose current and lagged coefficients summed to 0.015 and 0.004. The sum of current and past generic frozen dairy product advertising coefficients was 0.0007, but was not statistically significant.

The retail supply for each product was estimated as a

[6]These coefficients are partial advertising elasticities from the structural retail demand equations. They are not the total elasticities from the reduced-form price equations.

Table 2. Variable definitions for the econometric model.

Endogenous Variables

Q^{rfd} = Retail fluid milk demand measured in bil. lbs. of milkfat equivalent,
P^{rf} = Consumer retail price index for fresh milk and cream (1982-84 = 100),
Q^{rfzd} = Retail frozen dairy product demand measured in bil. lbs. of milkfat equivalent,
P^{rfz} = Consumer retail price index for frozen dairy products (1982-84 = 100),
Q^{rcd} = Retail cheese demand measured in bil. lbs. of milkfat equivalent,
P^{rc} = Consumer retail price index for cheese (1982-84 = 100),
Q^{rbd} = Retail butter demand measured in bil. lbs. of milkfat equivalent,
P^{rb} = Consumer retail price index for butter (1982-84 = 100),
Q^{rfs} = Retail fluid milk supply measured in bil. lbs. of milkfat equivalent,
($Q^{rfs} = Q^{rfd}$),
P^{wf} = Wholesale fluid milk price index (1982 = 100),
Q^{rfzs} = Retail frozen dairy product supply measured in bil. lbs. of milkfat equivalent, ($Q^{rfzs} = Q^{rfzd}$),
P^{wfz} = Wholesale frozen dairy products price index (1982 = 100),
Q^{rcs} = Retail cheese supply measured in bil. lbs. of milkfat equivalent,
($Q^{rcs} = Q^{rcd}$),
P^{wc} = Wholesale cheese price measured in cents/lb.,
Q^{rbs} = Retail butter supply measured in bil. lbs. of milkfat equivalent,
($Q^{rbs} = Q^{rbd}$),
P^{wb} = Wholesale butter price measured in cents/lb.,
Q^{wfs} = Wholesale fluid milk supply measured in bil. lbs. of milkfat equivalent,
($Q^{wfs} = Q^{rfs} = Q^{rfd}$),
P^{III} = Class III price for raw milk measured in $/cwt.,
Q^{wfzs} = Wholesale frozen dairy product supply measured in bil. lbs. of milkfat equivalent,
($Q^{wfzs} = Q^{rfzs} = Q^{rfzd}$),
Q^{wcs} = Wholesale cheese supply measured in bil. lbs. of milkfat equivalent,
($Q^{wcs} = Q^{rcs} = Q^{rcd}$),
Q^{wbs} = Wholesale butter supply measured in bil. lbs. of milkfat equivalent,
($Q^{wbs} = Q^{rbs} = Q^{rbd}$),
Q^{fm} = U.S. milk production measured in bil. lbs.,
P^{fm} = U.S. average all milk price measured in $/cwt.

Exogenous Variables and Other Definitions

POP = U.S. population measured in millions,
P^{bev} = Consumer retail price index for nonalcoholic beverages 1982-84 = 100),
INC = Disposable personal income per capita, measured in thousand $,
CPI = Consumer price index for all items (1982-84 = 100),
TREND = Time trend variable for the retail and wholesale-level equations, equal to 1 for 1975.1,....,
DUMQ1 = Intercept dummy variable for first quarter of year,
DUMQ2 = Intercept dummy variable for second quarter of year,
DUMQ3 = Intercept dummy variable for third quarter of year,
DGFAD = Generic fluid milk advertising expenditures deflated by the media price index, measured in thousand $,
AR(1) = First-order autoregressive error term,
P^{foo} = Consumer retail price index for food (1982-84 = 100),
DGFZAD = Generic frozen dairy product advertising expenditures deflated by the media price index, measured in thousand $,
P^{mea} = Consumer retail price index for meat (1982-84 = 100),
$DUM_{83.1}$ = Intercept dummy variable equal to 1 for 1983.1, equal to 0 otherwise,
DGCAD = Generic cheese advertising expenditures deflated by the media price index, measured in thousand $,
DGBAD = Generic butter advertising expenditures deflated by the media price index, measured in thousand $,
P^{fe} = Producer price index for fuel and energy (1967 = 100),
P^{lab} = Average hourly wage in food manufacturing sector ($/hour),
d = Class I fixed price differential for raw milk measured in $/cwt.,
MDP = Intercept dummy variable for the Milk Diversion Program equal to 1 for 1984.1 through 1985.2; equal to 0 otherwise,
DTP = Intercept dummy variable for the Dairy Termination Program equal to 1 for 1986.2 through 1987.3; equal to 0 otherwise,
P^{feed} = U.S. average price per ton of 16% protein dairy feed,
P^{fr} = U.S. index of prices received by farmers,
P^{cow} = U.S. average slaughter cow price measured in $/cwt.

function of the following variables: 1) retail price, 2) wholesale price, which represents the major variable cost to retailers, 3) producer price index for fuel and energy, 4) average hourly wage in the food manufacturing sector, 5) time trend variable, 6) quarterly dummy variables, and 7) lagged retail supply. The producer price index for fuel and energy was used as a proxy for variable energy costs, while the average hourly wage was used to capture labor costs in the retail supply functions. All prices and costs were deflated by the wholesale product price associated with each equation. The quarterly dummy variables were included to capture seasonality in retail supply, while the lagged supply variables were incorporated to represent capacity constraints. The time trend variable was included as a proxy for technological change in retailing. Not all of these variables remained in each of the final estimated retail supply equations. Finally, a first-order moving average error structure was imposed on the retail frozen product supply equation.

The wholesale supply for each product was estimated as a function of the following variables: 1) wholesale price, 2) the appropriate Class price for milk, which represents the main variable cost to wholesalers, 3) producer price index for fuel and energy, 4) average hourly wage in the food manufacturing sector, 5) time trend variable, 6) quarterly dummy variables, and 7) lagged wholesale supply. The producer price index for fuel and energy was included because energy costs are important variable costs to wholesalers, while the average hourly wage was used to capture labor costs in the wholesale supply functions. All prices and costs were deflated by the price of farm milk, i.e., Class price. The quarterly dummy variables were used to capture seasonality in wholesale supply, lagged wholesale supply was included to reflect capacity constraints, and the trend variable was incorporated as a measure of technological change in dairy product processing.

For the farm milk market, the farm milk supply was estimated as a function of the following variables: 1) ratio of the farm milk price to feed price (16% protein content), lagged one period, 2) ratio of the price of slaughter cows to the feed price, 3) lagged milk supply, 4) intercept dummy variables to account for the quarters that the Milk Diversion and Dairy Termination Programs were in effect, 5) a dummy variable for the second quarter, and 6) time trend variable. The 16% protein feed price represents the most important variable costs in milk production, while the price of slaughtered cows represents an important opportunity cost to dairy farmers. Lagged milk supply was included as biological capacity constraints to current milk supply.

In terms of statistical fit, most of the estimated equations were found to be reasonable with respect to R^2. In all but two equations, the adjusted coefficient of determination was above 0.85. The two equations that were the most difficult to estimate were the retail butter demand and supply equations. The retail butter demand equation had the lowest R^2 (0.40), while the retail butter supply equation had an R^2 of 0.44. On the whole, the equations were deemed reasonable for the simulation model.

Analysis of Advertising Scenarios

The equilibrium values for the price and quantity variables were simulated from the third quarter of 1984 (i.e., 1984.3) to the fourth quarter of 1993 (i.e., 1993.4) for three sets of generic advertising scenarios. The first set of scenarios compared market conditions with and without the NDPRB. The second set of scenarios varied total generic advertising expenditures, while proportions allocated among products were held constant. The third set of scenarios held constant total generic advertising expenditures and varied the proportions allocated among fluid milk, cheese, and butter advertising. The results for each set of scenarios are summarized below.

Impacts of the NDPRB

Table 3 presents the results of the first simulation, which compared market conditions with and without the NDPRB. The values in this table are quarterly averages over the period 1984.3 through 1993.4. The last column in this table gives the percentage change in each variable due to the NDPRB. It is clear from these results that the NDPRB has had a significant impact on the dairy market. Results of the two simulations show that the national program resulted in a 1.2% increase in fluid demand and a 14.3% increase in retail fluid price, compared with what would have occurred in the program's absence. The increase in fluid demand also caused the wholesale fluid price to increase by 11.8%. The NDPRB had a positive impact on retail butter and cheese markets. Retail butter quantity and price were 1.4% and 3.8% higher, respectively, while retail cheese quantity and price were 0.7% and 0.6% higher, respectively, due to the NDPRB. However, there was no increase in the wholesale butter and cheese prices, which were equal

Table 3. Simulated values for market variables with and without the NDPRB, averaged over 1984.3-1993.4.

Variable	Unit	With NDPRB	Without NDPRB	Percent Change
Fluid demand/supply	bil lbs me	13.57	13.41	1.2
Frozen demand/supply	bil lbs me	3.29	3.29	-0.1
Cheese demand	bil lbs me	10.09	10.03	0.7
Cheese supply	bil lbs me	10.37	10.38	-0.1
Butter demand	bil lbs me	3.29	3.25	1.4
Butter supply	bil lbs me	6.71	6.85	-2.1
Total demand	bil lbs me	30.24	29.97	0.9
Retail fluid price	1982-84=100	117.81	103.08	14.3
Retail frozen price	1982-84=100	125.87	125.37	0.4
Retail cheese price	1982-84=100	118.39	117.67	0.6
Retail butter price	1982-84=100	34.23	32.99	3.8
Wholesale fluid price	1982=100	116.78	104.47	11.8
Wholesale frozen price	1982=100	106.57	105.62	0.9
Wholesale cheese price	$/lb	1.18	1.18	0.0
Wholesale butter price	$/lb	1.16	1.16	0.0
Class III price	$/cwt	12.18	11.38	7.0
All milk price	$/cwt	13.17	12.36	6.6
CCC cheese purchases	bil lbs me	0.30	0.38	-21.2
CCC butter purchases	bil lbs me	3.41	3.60	-5.2
CCC purchases	bil lbs me	3.71	3.97	-6.7
Milk supply	bil lbs	36.52	36.32	0.6
Producer surplus	bil $	4.96	4.01	23.7
Producer rate of return	$	5.40		

to the government purchase prices under both advertising scenarios. Frozen product demand declined slightly (0.1%) with the national program since total milk demand increased by almost 1 percent under the national program. This caused farm and wholesale-level prices for all products to rise. The average increase in the wholesale frozen price was 0.9%, which resulted in the retail frozen price rising an average of 0.4%.

Butter supply decreased by 2.1% under the national program due to an average increase of 7% in the Class III price. The Class III price was the most important wholesale butter supply shifter. The leftward shift in wholesale butter supply, however, was not enough to cause the wholesale butter price to increase because even after the shift, the Government still purchased excess butter supply. Consequently, the wholesale butter price was the same as the purchase price for butter in both advertising scenarios. The national program resulted in an average decrease of 0.2 billion pounds (per quarter) of butter purchased by the Government. This was because of the 1.4% increase in commercial butter demand and the 2.1% decrease in wholesale supply of butter.

Cheese supply decreased slightly by 0.1% under the national program. The decrease in wholesale cheese supply was again due to the result of the Class III price increasing by 7%. The modest increase in demand and decrease in wholesale supply caused cheese purchases by the Government to fall by 0.08 billion pounds (per quarter) under the national program.

Table 4. Quarterly average values (1984.3 - 1993.4) of endogenous variables for generic advertising levels between 5% and 200% of actual levels.

Variable	Unit	5%	50%	Baseline	150%	200%
Fluid milk demand	bil lbs	12.84	13.40	13.57	13.67	13.74
Frozen product demand	bil lbs	3.31	3.29	3.29	3.28	3.28
Cheese demand	bil lbs	9.74	10.01	10.09	10.14	10.18
Cheese supply	bil lbs	10.42	10.39	10.37	10.37	10.36
Butter demand	bil lbs	3.26	3.29	3.29	3.30	3.30
Butter supply	bil lbs	7.36	6.86	6.71	6.61	6.55
Retail fluid price	82-84=100	63.76	101.99	117.81	128.25	136.26
Retail frozen price	82-84=100	123.69	125.34	125.87	126.18	126.41
Retail cheese price	82-84=100	114.73	117.53	118.39	118.89	119.25
Retail butter price	82-84=100	33.46	34.05	34.23	34.34	34.42
Wholesale fluid price	1982=100	70.58	103.64	116.78	125.33	131.83
Wholesale frozen price	1982=100	102.26	105.51	106.57	107.21	107.67
Wholesale cheese price	$/lb	1.18	1.18	1.18	1.18	1.18
Wholesale butter price	$/lb	1.16	1.16	1.16	1.16	1.16
Class III price	$/cwt	9.02	11.32	12.18	12.72	13.13
Farm milk price	$/cwt	9.96	12.30	13.17	13.72	14.13
CCC cheese	bil lbs	0.70	0.39	0.30	0.24	0.20
CCC butter	bil lbs	4.10	3.57	3.41	3.32	3.25
CCC all	bil lbs	4.79	3.96	3.71	3.56	3.45
Milk supply	bil lbs	35.43	36.26	36.52	36.61	36.74
Producer surplus	bil $	3.14	4.00	4.31	4.52	4.68
Farm rate of return[1]	%	NA	34.83	11.43	7.34	5.77

[1]Farm rate of return is equal to the change in producer surplus divided by the respective change in advertising expenditures.

The introduction of the NDPRB also had an impact on the farm market. The Class III and farm milk prices increased by 7% and 6.6% under the national program due to an increase of almost 1% in milk demand. Farm supply, in turn, increased by 0.6%. Farmers were better off under the NDPRB since producer surplus averaged 23.7% higher with the program. One measure of the net benefits of the NDPRB to farmers is the rate of return, which gives the ratio of benefits to costs of the national program. Specifically, this rate of return measure was calculated as the change in producer surplus, due to the NDPRB, divided by the costs of funding this program. The results showed that the rate of return from the NDPRB was 5.4. This means that every dollar invested in generic advertising returned $5.40 in producer surplus to farmers. The farm-level rate of return was quite close to estimates of 4.77 by Liu et al. (1990) for the period 1975.1 through 1987.4, and of 4.60 by Kaiser and Forker (1993) for the period 1975.1 through 1990.4.

Alternative Generic Advertising Expenditure Levels

In the second set of advertising scenarios, total generic advertising expenditures were varied from 5% to 200% of historical levels in 50% increments. It was assumed that the proportion of revenue allocated among fluid milk, cheese, butter, and frozen products was the same as the actual quarterly percentages occurring between 1984.3 and 1993.4. The results of these scenarios are reported in Table 4,

Table 5. Percentage change from baseline of endogenous variables for generic advertising levels between 5% and 200% of actual levels.

Variable	Unit	Baseline	5%	50%	150%	200%
			percentage change from baseline			
Fluid milk demand	bil lbs	13.57	-5.3	-1.3	0.7	1.3
Frozen product demand	bil lbs	3.29	0.6	0.1	-0.1	-0.1
Cheese demand	bil lbs	10.09	-3.5	-0.8	0.5	0.8
Cheese supply	bil lbs	10.37	0.4	0.1	-0.1	-0.1
Butter demand	bil lbs	3.29	-0.8	-0.2	0.1	0.2
Butter supply	bil lbs	6.71	9.8	2.3	-1.4	-2.3
Retail fluid price	82-84=100	117.81	-45.9	-13.4	8.9	15.7
Retail frozen price	82-84=100	125.87	-1.7	-0.4	0.2	0.4
Retail cheese price	82-84=100	118.39	-3.1	-0.7	0.4	0.7
Retail butter price	82-84=100	34.23	-2.3	-0.5	0.3	0.5
Wholesale fluid price	1982=100	116.78	-39.6	-11.3	7.3	12.9
Wholesale frozen price	1982=100	106.57	-4.0	-1.0	0.6	1.0
Wholesale cheese price	$/lb	1.18	0.0	0.0	0.0	0.0
Wholesale butter price	$/lb	1.16	0.0	0.0	0.0	0.0
Class III price	$/cwt	12.18	-25.9	-7.0	4.5	7.8
Farm milk price	$/cwt	13.17	-24.3	-6.6	4.2	7.3
CCC cheese	bil lbs	0.30	135.3	31.9	-18.8	-32.2
CCC butter	bil lbs	3.41	20.1	4.7	-2.8	-4.7
CCC all	bil lbs	3.71	29.3	6.9	-4.0	-6.9
Milk supply	bil lbs	36.52	-3.0	-0.7	0.2	0.6
Producer surplus	bil $	4.31	-27.1	-7.3	4.7	8.4

which gives quarterly averages[7] for all endogenous variables for generic expenditures based on 5%, 50%, 100% (baseline), 150%, and 200% of historical levels. The results in terms of percentage change from the baseline for the endogenous variables under the various expenditure scenarios are given in Table 5.

The level of generic promotion has had an effect at all levels of the dairy industry. For example, at the retail level, commercial demand for milk and dairy products (on a milk equivalent basis) ranged from 29.2 billion pounds, under the 5% of historical generic advertising, to 30.5 billion pounds, under two times the historical advertising expenditures. This represents an increase of 4.5%. Fluid milk demand had the highest responsiveness to generic advertising of all four products, which increased from 12.8 billion pounds to 13.7 billion pounds for the 5% to 200% advertising levels, respectively. The retail prices of all four products increased with advertising expenditure levels. The retail fluid price was the most responsive to increased advertising levels, rising by 114% from 5% to 200% expenditure levels. In contrast, retail frozen products, cheese, and butter prices only increased by 2%, 4%, and 2.8%, respectively, between 5% and 200% advertising levels.

The wholesale market was also impacted by the level of generic advertising. As was the case in the retail market, the wholesale fluid milk price was most effected by alternative generic advertising expenditures. The wholesale fluid milk price index increased by 86.7% as generic advertising increased from 5% to 200% of historical levels (Tables 4 and 5). government purchases under the Dairy Price Sup-

[7]The quarterly average for all endogenous variables was based on a simple average for the time period from 1984.3 through 1993.4.

port Program. For example, net CCC purchases of dairy products declined from an average of 4.8 billion pounds per quarter under the 5% generic advertising case, to 3.5 billion pounds in the 200% scenario (see Table 4). The results indicate that the national dairy promotion program lowered government removals of surplus dairy products from the market. However, the results also suggest diminishing marginal returns in lower CCC purchases as generic advertising increased. As Tables 4 and 5 show, there was a substantial decline in CCC purchases as generic advertising was increased from 5% to 50% of historical levels. However, any increases in generic advertising above historical levels resulted in only a marginal decrease in CCC purchases.

Generic advertising also had an impact on the farm sector. On the price side, the farm milk price increased from an average of $9.96 per hundredweight, under the 5% generic advertising scenario, to an average of $14.13 per hundredweight, under the 200% scenario, an increase of 41.9%. Because the farm milk price was higher under higher generic advertising, the farm milk supply was higher. The farm supply of raw milk increased from 35.4 billion pounds per quarter in the 5% scenario to 36.7 billion pounds per quarter in the 200% scenario, an increase of 3.7%. The increase in the farm milk supply with higher advertising was one of the reasons why CCC purchases did not decrease when advertising was increased above historical levels. The results indicate that farmers benefited from higher generic advertising levels. As shown in Table 4, producer surplus increased from $3.14 billion in the 5% scenario to $4.68 billion in the 200% scenario. However, the rate of increase diminished as generic advertising levels were increased.

A marginal rate of return based on specific advertising levels was calculated as the change in producer surplus, due to an incremental increase in generic advertising, divided by the change in advertising costs. The marginal rate of return varied from 34.8, under the 50% of advertising expenditures scenario, to 5.8, under the 200% of historic advertising expenditures scenario. These results indicate that farm welfare could be improved by increasing advertising levels above 200% of current levels.

It should be noted that the farther the simulation scenario is from actual observations, the less reliable the model becomes. This is due to the fact that all equations in the model were estimated based on actual observations. Consequently, some caution should be made in interpreting the results coming from the more extreme scenarios such as the 5% and 200% generic advertising scenarios.

Alternative Allocations of Generic Advertising Across Products

In the third set of advertising scenarios, the proportion of generic advertising expenditures allocated among fluid milk, cheese, and butter was varied, while total generic expenditures were held constant at historical levels. Four scenarios were specified. In the first scenario (baseline), the proportions were set according to their 1991 levels from the National Dairy Board budget: 49.3% for fluid milk, 36.3% for cheese, 8.7% for butter, and 5.7% for frozen products. The second scenario was the heavy generic fluid milk advertising case, which had 80% of total generic advertising for fluid milk, 14.3% for generic cheese, 3.4% for butter, and 2.2% for frozen products. In the third scenario (heavy generic cheese advertising), the allocation of generic advertising favored cheese with 70% allocated to cheese, 23.2% to fluid milk, 4.1% to butter, and 2.7% to frozen products. Finally, the fourth scenario (heavy generic butter advertising) more than doubled generic butter advertising from its historical levels with the following allocation: 20% for butter, 43.2% for fluid milk, 31.8% for cheese, and 5% for frozen products. The results of these scenarios are reported in Table 6, which gives quarterly averages for all endogenous variables for the baseline, heavy fluid milk, heavy cheese, and heavy butter advertising scenarios. Table 7 provides the percentage change in endogenous variables from the baseline for the three re-allocation scenarios.

It is clear from Tables 6 and 7 that of all scenarios the heavy generic fluid milk advertising scenario had the largest effect on the dairy industry. At the retail level, fluid milk demand increased by 1% compared to the current (baseline) situation. At the same time, however, frozen product, cheese, and butter demand declined under this scenario by 0.1%, 1.1%, and 0.3%, respectively. The decline in dairy product demand resulted from lower generic advertising levels for these products. Retail prices for fluid milk and frozen products increased by 7.6% and 0.1%, respectively, compared with the baseline. Retail prices for cheese and butter decreased by 1% and 0.7%, respectively, compared with the baseline. The wholesale prices for fluid milk and frozen products also increased relative to the baseline, with the wholesale fluid milk price increasing by 10.1% and the wholesale frozen product price increasing by 0.6%. The wholesale cheese and butter price were unaffected.

Table 6. Quarterly average values (1984.3-93.4) of endogenous variables for alternative advertising scenarios among products.

Variable	Unit	Baseline	Heavy Fluid Milk	Heavy Cheese	Heavy Butter
Fluid milk demand	bil lbs	13.61	13.74	13.44	13.59
Frozen product demand	bil lbs	3.29	3.28	3.29	3.29
Cheese demand	bil lbs	10.09	9.98	10.17	10.08
Cheese supply	bil lbs	10.37	10.36	10.38	10.37
Butter demand	bil lbs	3.30	3.30	3.30	3.31
Butter supply	bil lbs	6.67	6.54	6.82	6.68
Retail fluid milk price	82-84=100	121.62	130.85	101.01	114.97
Retail frozen price	82-84=100	126.84	127.03	126.30	126.78
Retail cheese price	82-84=100	118.38	117.22	119.19	118.21
Retail butter price	82-84=100	34.69	34.44	34.49	34.91
Wholesale fluid price	1982=100	119.85	131.96	106.44	118.49
Wholesale frozen price	1982=100	107.56	108.22	106.48	107.44
Wholesale cheese price	$/lb	1.18	1.18	1.18	1.18
Wholesale butter price	$/lb	1.16	1.16	1.16	1.16
Class III price	$/cwt	12.36	13.12	11.49	12.27
Farm milk price	$/cwt	13.36	14.12	12.47	13.26
CCC cheese	bil lbs	0.29	0.40	0.23	0.31
CCC butter	bil lbs	3.36	3.25	3.52	3.37
CCC all	bil lbs	3.66	3.64	3.75	3.68
Milk supply	bil lbs	36.56	36.75	36.32	36.53
Producer surplus	bil $	4.39	4.67	4.06	4.36

Net government purchases under the Dairy Price Support Program were 0.3% lower due to the heavy generic fluid milk advertising scenario compared with the baseline. This scenario had the largest impact on the farm milk price, which increased by 5.7% above the baseline. Accompanying this increase in price was a small increase of 0.5% in milk supply. Farmers were best off under this scenario since producer surplus increased by 6.5% from the current allocation.

In terms of the heavy generic cheese advertising scenario, it is interesting that average cheese demand only increased modestly (0.8%) from the baseline level (see Tables 6 and 7). Fluid milk demand declined by 1.2% because of the accompanying decrease in generic fluid milk advertising. Butter and frozen product demand were only marginally different relative to the baseline. Retail prices for all products except cheese were lower under the heavy generic cheese advertising scenario. This was because there was a slight decrease in total demand for milk and dairy products from the baseline. Wholesale prices for fluid milk and frozen products were 11.2% and 1.0% lower, respectively, under the heavy cheese advertising scenario compared with the baseline. While CCC purchases of cheese decreased by 23.4% relative to the baseline, CCC purchases of butter increased by 4.8% with the net result of a 2.5% increase in total purchases by the Government. The average farm milk price was lowest under this scenario, falling by 6.6% from the baseline. This decrease resulted from the decline in fluid milk demand, which caused Class I utilization to drop. Consequently, the share of the higher Class I price became smaller in determining the average farm milk price. Since producer surplus was the lowest in this scenario (7.4% lower than the baseline), the allocation of genericadvertising was the worst in this case from the point of view of farmers.

Table 7. Percentage change from baseline of endogenous variables for alternative advertising scenarios among products.

Variable	Unit	Baseline	Heavy Fluid	Heavy Cheese	Heavy Butter
			—— Percentage change from baseline ——		
Fluid demand	bil lbs	13.61	1.0	-1.2	-0.1
Frozen demand	bil lbs	3.29	-0.1	0.1	0.0
Cheese demand	bil lbs	10.09	-1.1	0.8	-0.2
Cheese supply	bil lbs	10.37	-0.1	0.1	0.0
Butter demand	bil lbs	3.30	-0.3	-0.2	0.2
Butter supply	bil lbs	6.67	-1.8	2.3	0.2
Retail fluid price	82-84=100	121.62	7.6	-16.9	-5.5
Retail frozen price	82-84=100	126.84	0.1	-0.4	-0.1
Retail cheese price	82-84=100	118.38	-1.0	0.7	-0.1
Retail butter price	82-84=100	34.69	-0.7	-0.6	0.6
Wholesale fluid price	1982=100	119.85	10.1	-11.2	-1.1
Wholesale frozen price	1982=100	107.56	0.6	-1.0	-0.1
Wholesale cheese price	$/lb	1.18	0.0	0.0	0.0
Wholesale butter price	$/lb	1.16	0.0	0.0	0.0
Class III price	$/cwt	12.36	6.1	-7.1	-0.8
Farm milk price	$/cwt	13.36	5.7	-6.6	-0.7
CCC cheese	bil lbs	0.29	35.0	-23.4	5.8
CCC butter	bil lbs	3.36	-3.4	4.8	0.2
CCC all	bil lbs	3.66	-0.3	2.5	0.7
Milk supply	bil lbs	36.56	0.5	-0.7	-0.1
Producer surplus	bil $	4.39	6.5	-7.4	-0.8

The heavy generic butter advertising scenario had the least impact on market variables of all three alternatives to the baseline. Similar to the previous scenario, butter demand only increased marginally (0.2%) under the heavy generic butter advertising scenario (see Tables 6 and 7). Fluid milk, frozen product, and cheese demand were virtually unchanged under this scenario relative to the baseline. This was due to the fact that there was not as much re-allocation among products in this scenario as there was for the heavy fluid milk and heavy cheese advertising scenarios. Because of this, there was very little change in retail and wholesale prices, with the exception of the retail fluid price which decreased by 5.5% relative to the baseline. Government purchases of dairy products under the Dairy Price Support Program were slightly higher (0.7%) than the baseline. The farm milk price was only marginally lower (0.7%) than the baseline and the milk supply was virtually identical. Producer surplus was only slightly lower under this scenario (0.8%) compared with the baseline. Hence, this scenario had the smallest impact on the market relative to the current situation.

Summary

The purpose of this study was to analyze the impacts of several generic dairy advertising scenarios on retail, wholesale, and farm dairy markets. A disaggregated industry model of the retail, wholesale and farm levels with markets for fluid milk, frozen products, cheese, and butter was developed to conduct the analysis. An econometric model of the dairy industry was estimated using quarterly data from 1975 through 1993. The econometric results were then used to simulate the market impacts of three sets of

generic advertising scenarios on demand for milk and dairy products, farm and consumer prices, and producer welfare. in the first set of scenarios, market conditions were compared with and without the National Dairy Promotion and Research Board. In the second set of scenarios, total generic expenditure levels were varied from 5% to 200% of their historical values. In the third set of scenarios, total generic advertising expenditures were held constant, but the revenue among fluid milk, cheese, and butter was reallocated to determine which of the products had the largest consumption and price response to advertising.

The results of the first scenario indicated that NDPRB had a major impact on market conditions. The NDPRB resulted in a 1.2% increase in fluid demand, a 14.3% increase in retail fluid price, and a 11.8% increase in the wholesale fluid price compared with what would have occurred in the program's absence. The national program had a positive impact on retail butter and cheese markets, with butter quantity and price increasing by 1.4% and 3.8%, respectively, and cheese quantity and price increasing 0.7% and 0.6%, respectively. However, there was no increase in the wholesale butter and cheese prices, which were equal to the government purchase prices under both advertising scenarios. Frozen product demand declined slightly (0.1%) with the national program. Since total milk demand increased by almost 1 percent under this program, farm and wholesale-level prices for all products rose. The national program resulted in an average decrease in CCC purchases of butter and cheese of 0.2 billion pounds and 0.08 billion pounds per quarter, respectively. The introduction of the NDPRB also had an impact on the farm market. The Class III and farm milk prices increased by 7% and 6.6% under the national program because of an increase of almost 1% in milk demand. Farm supply, in turn, increased by 0.6%. Farmers were better off under the NDPRB since producer surplus averaged 23.7% higher with the program. Finally, the rate of return from the NDPRB was computed to be 5.4, meaning that every dollar invested in generic advertising returned $5.40 in producer surplus to farmers.

The results of the second set of scenarios indicated that the level of generic advertising has an impact on market prices and quantities. Increases in total generic advertising greatly increased the demand for fluid milk. Retail and wholesale level prices increased with greater generic advertising expenditures, with fluid milk prices rising the most. Increases in generic advertising resulted in decreases in government purchases of dairy products. However, CCC purchases declined marginally for generic advertising levels above historical amounts. Finally, the results showed that the benefits to farmers from higher generic advertising is higher milk prices and producer surplus.

The results of the third set of scenarios indicated that the allocation of revenue among products also can have a major impact on market variables. For instance, in the heavy fluid milk advertising scenario (where generic fluid milk advertising was doubled at the expense of cheese and butter advertising) fluid milk demand increased by 1%, retail fluid milk price increased by 7.6%, wholesale fluid milk price increased by 10.1%, Class III price increased by 6.1%, and farm milk price increased by 5.7% relative to the current allocation. The heavy cheese advertising scenario (where generic cheese advertising was more than doubled at the expense of generic fluid milk and butter advertising) had almost the opposite effect as the heavy fluid milk advertising scenario: demand and prices for products other than cheese decreased. For instance, in the heavy cheese advertising case, fluid milk demand declined by 1.2%, retail fluid milk price declined by 16.9%, retail cheese price increased by 0.7%, wholesale fluid milk price declined by 11.2%, Class III price declined by 7.1%, and farm milk price declined by 6.6% relative to the baseline. Finally, the results of the heavy butter advertising scenario indicated that this scenario was quite similar to the baseline. This was not surprising because the allocation of advertising expenditures were quite similar under the heavy butter advertising and baseline scenarios. The results therefore indicated that producer welfare was highest under the heavy fluid milk advertising scenario, lowest under the heavy cheese advertising case, and virtually identical to the baseline situation under the heavy butter advertising scenario.

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